Conference Proceedings

15th International Conference on Disability, Virtual Reality & Associated Technologies

ICDVRAT

September 3rd to 6th, 2024

Prague, Czech Republic

NATIONAL INSTITUTE OF MENTAL HEALTH

THIRD FACULTY OF MEDICINE Charles University

CZECH INSTITUTE OF INFORMATICS ROBOTICS AND CYBERNETICS CTU IN PRAGUE

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The 15th International Conference on Disability, Virtual Reality and Associated Technologies Proceedings

Edited by:
Iveta Fajnerová
Pedro Gamito
David J Brown
Emil Rosenlund Høeg
Nicholas Shopland

September 3rd to 6th, 2024 Prague, Czech Republic

Preface

The papers appearing in this book comprise the proceedings of the 15th International Conference on Disability, Virtual Reality and Associated Technologies, held between the 3rd and 6th of September 2024 in Prague, Czech Republic. The papers presented reflect the authors' opinions and are published as presented and without change (formatting and minor editing excepted). Their inclusion in this publication does not necessarily constitute endorsement by the editors and ICDVRAT.

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About

ICDVRAT

The ICDVRAT (International Conference on Disability, Virtual Reality, and Associated Technologies) conference series was established in 1996 by Paul Sharkey from the University of Reading, UK. This biennial international event rotates locations worldwide, gathering a research community of over 1,000 members from 35 countries. The community focuses on applying virtual reality (VR) and associated technologies in assessing, treating, and supporting individuals with disabilities, impairments, or support needs. The complete archive of ICDVRAT conferences, including full and short papers, is accessible at `www.icdvrat.com`. ICDVRAT emphasizes end-user involvement in research and actively supports early-career researchers.

ICDVRAT 2024

The **15th ICDVRAT conference** was held in a beautiful venue in the charming city of Prague, offering an ideal setting for both inspiration and engagement. The ICDVRAT 2024 conference was hosted by the Czech Neuropsychopharmacological Society (CNPS) in collaboration with the Third Faculty of Medicine of Charles University in Prague (3FM CU), the National Institute of Mental Health (NIMH), and the Czech Institute of Informatics, Robotics, and Cybernetics at CTU (CIIRC CTU). Attendees were treated to exceptional catering, thoughtfully provided to fuel their minds and keep them energized throughout the intellectually stimulating and intensive days filled with mind-blowing presentations.

The 2024 conference provided a platform for international experts, researchers, developers, and user groups to discuss how advancements in VR and related technologies can benefit individuals with disabilities or mental and physical health challenges. The conference venue in Prague fostered a welcoming and inclusive research community, showcasing cutting-edge research, while placing a strong emphasis on supporting young researchers. This commitment was reflected in the innovative format, where podium sessions combined full presentations with shorter (poster-style) presentations, organized by thematic topics rather than the traditional format of separate podium and poster sessions.

The event featured three **keynote speeches**: **Mariano Alcañiz** introduced virtual humans in context of cognitive assessment and social behaviour studies; **Maria T. Schultheis** examined emerging technologies such as VR and neuroimaging in clinical applications and **Mónica Spínola**, winner of the *Penny Standen Best Early Career Paper Award 2022*, focused in her presentation on

VR and wearable technologies for realistic neuropsychological assessment.

Following a rigorous peer-review process, 67 papers were selected for presentations (podium or poster). These were organized into 14 thematic sessions covering topics such as *Education, Autism, Exposure Therapy, Pain & Palliative Care, Rehabilitation, Cognition, Emotions, Relaxation & Nature, Sexology, and Design Ideas*. The conference also included a special CYBER section presented during the 1st day, featuring lectures from students and supervisors of the *Cyberspace, Behaviour, and e-Therapy (CYBER)* Erasmus Mundus Master's program. The conference featured an Industry Panel on "Virtual Reality in Mental Health and Rehabilitation: Trends, Challenges, and Preventing Entropy," moderated by Skip Rizzo from the University of Southern California, exploring key developments and future directions in the field. An additional session offered opportunity to showcase informal demonstrations and exhibits by companies and research institutions in a relaxed and interactive atmosphere.

Acknowledgements

The Conference Chairs extend their gratitude to all organizations and individuals whose efforts made ICDVRAT 2024 a success. The Czech Institute of Informatics, Robotics, and Cybernetics at CTU graciously hosted the conference in their state-of-the-art venue, providing an inspiring setting for the event. The Czech Neuropsychopharmacological Society played a central role in organizing the conference and covering logistical and financial responsibilities. Additionally, the Third Faculty of Medicine of Charles University in Prague and the National Institute of Mental Health provided significant financial support and full organizational support throughout the event, ensuring its smooth execution. Additional appreciation goes to the Programme Committee for their guidance on the conference format and review process, the authors for their valuable contributions, the members of the Organizing Committee for their dedication that, together with the students, provided vital support throughout the event. Special thanks are extended to the sponsoring companies and demonstrating attendees who showcased their innovative products and solutions, further enriching the conference experience. ICDVRAT 2024 organizers hope attendees found the event both engaging and inspiring and warmly invite feedback to enhance future editions.

Iveta Fajnerova, Pedro Gamito and David J Brown

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Conference Program

Presentation Types

- Keynote presentation (60 mins)
- Standard Podium Presentation (15 min)
- Short Poster Presentation (8 min)
- CYBER Presentations (12 min)
- CYBER Poster Presentations (5 min)
- Pitch Presentation (5 mins)

First day – Tuesday, September 3

		page no.
08:00	**Registration opens**	
08:45 – 09:00	**Conference opening** *Chair: Iveta Fajnerová*	
09:00 – 12:30	**Cyberspace, Behaviour and e-Therapy (CYBER) – Part 1** *Chair: Iveta Fajnerová*	
	Suriia Akhmetova & Misgana Desalegne - *VR-based training for improvement of positive body image: A Pilot Study*	169
	Urme Bose & Bryan Hilanga - *An individual longitudinal follow-up exploratory study of neurophysiological reactions among adults during psychometric testing*	172
	Ling Zeng & Maria Hashmi - *Multisensory Integration and Embodiment: A Virtual Reality-Based Study*	175
	Laura Valentina Lesmes Castañeda & Selin Saglam - *Gamification of a VR Task to Modify Attentional Bias Towards Body Parts Related to Weight*	179
	Wu Panzifan & Maria Castro - *Exposure therapy in Virtual Reality for children and adolescents with selective mutism: A usability pilot study*	182
	Coffee break	
10:45 – 12:30	**Cyberspace, Behaviour and e-Therapy (CYBER) – Part 2** *Chair: Nick Shopland*	

		Prince Paul Appiah - *Predicting Dropout at an Innovative Tech-focused Vocational Education Program using Machine Learning*	185
		Ilia Kulagin & Daniel Velez Marin - *Exploring Verbal Speech Patterns to assess Attachment Style and tendencies towards Anxiety and Depression*	188
		Javad Modaresi & Rafael Paulino - *Avatar-Enabled Virtual Therapist Application for Cognitive Rehabilitation Intervention in Traumatic Brain Injury and Post-Stroke Patients*	191
		Sadia Maqsood - *Cybersecurity Assessment and Training Simulator In Virtual Reality for Workplace Employees*	194
		Fernanda Lima Pimentel & Sandip Bhusal - *Assessing Oxygenation Changes using fNIRS in a Time-Pressure Task*	196
		Oluwatobiloba Sodade & Yusuf Sani - *Psychology of Frailty and Prediction of Fall among Elderly People Living in French Nursing Homes*	199
10:45 – 12:30		**Lunch (Included)**	
12:30 – 13:30		**Welcome session** *Chairs: Iveta Fajnerová, Jiří Horáček, Lenka Lhotská*	
14:00 – 15:00	★	**Keynote talk: Professor Maria T. Schultheis** *Chair: Bonnie Connor*	21
		Technology & Cognition": Examining new trends and opportunities	
15:00 – 17:00		**Session 1: VR exposure – Trauma** *Chair: Albert Rizzo*	
		Michael Roy - *Computer Monitor versus Augmented Reality: Expanding 3MDR Therapy for PTSD: A Randomized Controlled Trial (CARE4PTSD)*	24
		Albert Rizzo - *The Virtual Ukraine Project: Trauma Therapy in Warzones with Virtual Reality*	27
		Coffee break	
		Soledad Quero - *Overcoming traditional exposure treatments: Preliminary results from a Randomized Controlled Trial evaluating the efficacy of Projection-Based Augmented Reality Exposure Treatment for cockroach phobia*	30
		Soledad Quero - *Enhancing exposure therapy effectiveness: projection-based augmented reality for specific cockroach phobia treatment compared to traditional treatment regarding stimuli variability*	33
		Markéta Jablonská - *Design and Evaluation of Virtual Environments for Exposure Therapy of Aviophobia: Early Feasibility Study*	36
		Barbora Darmová - *Evaluating Virtual Scenarios through the Lens of the Contrast Avoidance Model in the Context of Generalized Anxiety Disorder Treatment*	39

17:00 – 18:00	**Cyberspace, Behaviour and e-Therapy (CYBER) – Poster session** *Chairs: Matthew Harris & Michal Sedlák*	
	Kátia dos Santos Estevães & Abigya Melese - *Transforming perspectives: the impact of virtual embodiment on attitudes and responses to gender-based harassment in the metaverse*	202
	Vaishali Goyal & Gustavo Menegon - *The temporal neural dynamics of aesthetic appreciation for visual art*	205
	Nina Belousova, Mariam Barseguyan & Vladimir Zyablov - *Psychological Impact of Breast Cancer and Premature Menopause: Digital Intervention Approach*	208
	Miltiadis Gialousis & Diogo Gomes - *Psychological Trait Assessment Prior to Therapeutic Sessions using Open-Ended Questions*	211
	David Felipe Vega Villa & Vaihbav Mehra - *Can an LLM-equipped Multimodal Chatbot adapted to psychological techniques improve Mental Wellbeing? A preliminary study description*	213
	Bruna Filipa Augusto da Silva, Jana Subirana & Amir Ansari - *Enhancing Personality Assessment: From Self-Reported Questionnaires to Deep Learning Predictions*	216
	Jiayao Chen & Suvechhaya Shrestha - *Enhancing Emotional Connection and Engagement in Long-Distance Relationships: A Comparative Study of Virtual Reality and Video Calls*	219
	Esra Bayısın & Asmar Khalilli - *Using artificial intelligence to model cognitive load and adapt challenging tasks during immersions in virtual reality: Phase 1 – a literature review and study protocol for people diagnosed with schizophrenia*	222

Second day – Wednesday, September 4

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	🗣	Isaac Lee - *Can an LLM AI-Augmented ADI-R Improve Diagnostic Pathways and Educational Outcomes for Autistic Individuals?*	49
	🗣	William Farr - *External Fine Motor Markers of Neurodivergence: Pilot Results of the TangiBall*	53
	🗣	Sean Haddick - *Through The Eyes of An Autistic Child: The Role of Technology and Autistic Researchers in Developing Interventions*	56
	🗣	Pascal Meital - *Online Course for Autistic Adults: Usability Study and Participatory Design*	58
10:20 – 10:50		**Coffee break**	
10:50 – 11:30		**Session 4: Autism – Social Skills & Public Transport** *Chair: William Farr*	
	🗣	Ali Adjorlu - *Virtual Station: Virtual Reality as a Bridge to Independence in Public Transportation for Autistic Youth*	61
	💬	Emil Rosenlund Høeg - *Enhancing Social Skills in Autism Spectrum Disorder: A Virtual Reality Intervention for Educational Settings*	63
	💬	Sean Haddick - Metahumans: A Framework for Assessment and Feedback of Social-Emotional Reciprocity	65
11:30 - 12:10		**Session 5: VR exposure – Design implementations** *Chair: James Lewis*	
	🗣	Muhammad Arifur Rahman - *Optimizing VRET: EEG data for ML Models with Real-Time Biofeedback*	42
	🗣	Martina Janíková - *Virtual environment for exposure therapy of obsessive-compulsive disorder enriched with olfactory stimuli: A pilot study*	45
12:10 – 13:10		**Lunch (Included)**	
13:10 – 14:10	★	**Keynote talk: Mónica Spínola (Penny Standen Best Early Career Paper Award Winner 2022)** Chair: Iveta Fajnerová & David Brown	22
		Functional Neuropsychological Assessment: past, present and future	
14:10 – 15:30		**Session 6: Pain & Palliative** *Chair: Sara Ventura*	
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	🗣	Martin Zielina - *Virtual Reality in Burn Treatment: A Comparative Study of High and Low Immersion Approaches on Pain and Anxiety Relief*	72

	Alexander Moreno - *Preliminary results of a systematic review of the use of virtual reality in palliative care*	74
	Carolyn Thomas - *Existential Biophilic VR Therapy – Developing a Protocol for Care Settings*	77
15:30 – 16:00	**Coffee break**	
16:00 – 17:10	**Session 7: Cognition & Spatial Navigation** *Chairs: Cecilia Sik-Lanyi & Renáta Cserjési*	
	Suhani Dheer - *Beyond Diagnosis: The Cognitive Demands of Stopping and Turning Behaviors Among Drivers With and Without Multiple Sclerosis and Implications for Driving Safety*	81
	Matthew Harris - *Exploring the Potential of Using a Virtual Spatial Navigation Task to Measure Cognitive Decline in Adults with Intellectual Disabilities*	84
	Kathryn N. Devlin - *Virtual Reality Driving Simulation May Enhance the Prediction of Real-World Unsafe Driving*	87
	Mochammad Hannats Hanafi Ichsan - *Navigation in 3D Virtual Environment for Older Adults*	90
17:10 – 18:00	**Session 8: Emotions** *Chair: Sean Haddick*	
	Alex Sumich - *Beneficial effects on subjective mood and brain function of biophilic quality in university environments shown in virtual reality*	106
	Jiří Pešek - *Assessing emotional memory in VR*	109
	Raissa de Oliveira Negrao - *Exploring Emotional Responses to Virtual Reality Environments in Younger Adults*	111
19:30 – 23:00	Social evening & dinner	

Third day – Thursday, September 5

09:00 – 10:15		**Session 9: Education** *Chair: David Brown*	
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	💬	Thomas Hughes-Roberts - *Enabling Creativity through Game Making for the Socially Marginalised: Co-Designing a Game Making Toolkit*	118
	💬	Teresa Souto - *What happened after ethical decision-making training went virtual: some features about VREthics Application*	121
	🗣	Adam Novotník - *Method of Loci and PEG system in VR as learning method for patients with ADHD*	123
	🗣	Cecilia Sik-Lanyi - *Modelling realistic avatars for the "P-game" negotiation game*	126
10:15 – 10:45		**Coffee break**	
10:45 – 12:00		**Session 10: Rehabilitation** *Chair: Pedro Gamito*	
	💬	Ian Male - *What stops therapists from using virtual reality in paediatric acquired brain injury upper limb rehabilitation?*	130
	💬	Emil Rosenlund Høeg - *Exploring therapists' technology acceptance of virtual reality bike-based rehabilitation: A longitudinal study*	133
	💬	Philip Breedon - *Development of an immersive Virtual Reality (VR) system to improve the quality of rehabilitation for paediatric Ataxia Telangiectasia (A-T) patients*	135
	💬	Gianluca Sorrento - *Conditions for inducing freezing of gait in Parkinson's disease freezers on a split-belt treadmill in a virtual environment*	138
12:00 – 13:00		**Lunch (included)**	
13:00 – 14:00	★	**Keynote talk: Professor Mariano Alcañiz** *Chair: Pedro Gamito*	20
		Could Embodied Conversational Agents Be the Future for Assessment and Interventions in Clinical Psychology?	
14:00 – 14:50		**Session 11: Design Ideas** *Chair: Emil Rosenlund Høeg*	
	💬	Sharon Mozgai - *Virtual Humans in Mobile Health (mHealth) Applications: Designing for increased user-engagement and adherence*	142
	🗣	Michal Sedlák - *Feasibility of using OCD exposure therapy application with VR omnidirectional treadmill: A study protocol*	144
	🗣	Tereza Langová - *Virtual Reality Games for Lying Patients*	147

	Hanan Namrouti - *Comparison Between 2D and 3D Icons as Menus in Virtual Reality Assessing the Usability of the Menus and User Satisfaction*	150
14:50 – 15:20	**Coffee break**	
15:20 – 16:00	**Session 12: Sexology** *Chair: Iveta Fajnerová*	
	Ali Adjorlu - *Virtual Sex Therapy: A virtual Psychotherapy Intervention to Help Individuals with Sexual Dysfunction Difficulties*	154
	Ondřej Vaníček - *Female sexual response to audiovisual stimuli in 2D/3D modality and first/third person perspective*	156
16:00 – 17:00	**Company panel discussion** *Moderator: Albert Rizzo*	
	Amir Bozorgzadeh (CEO) - VirtuLeap	
	Giorgio Koppehele (Founder and CEO) - Magic Horizons	
	Stephane Bouchard (President and CEO) - In Virtuo	
	Jan Hrdlička (Co-Founder and CEO) - ComGuide	
	Gareth Walkom (Founder) - withVR	
17:00 – 19:00	**Company presentations & demos with catering** *Chairs: Ali Adjorlu & Iveta Fajnerová*	
	Bogusława Łysakowska-Będek (Technomex) - *X Visio PRO - Therapy in Virtual Reality*	
	Marie Němcová (VR LIFE s.r.o.) - *VR Vitalis Pro*	
	Gareth Walkom (withVR) - *Therapy withVR Research withVR*	
	Martin Zielina & Zbyněk Pohořelský (VRSPACE & 2MF Charles University) - *VR burns*	
	Jan Hrdlička & Jiří Wild (ComGuide) - *Virtual Reality for Practicing Difficult Conversations in Healthcare – self-experience workshop*	
	Petr Hořejší & Matěj Dvořák & Jiří Podlipný (FME UWB & FMP Chales University) - *Risk Environment Simulator (RES©) - a virtual reality serious game on the principle of cue-exposure therapy (CET) for the treatment of alcohol use disorders (AUD)*	
	Giorgio Koppehele & Suna Koppehele (Magic Horizons) - *Magic Horizons - a unique One Stop solution for Mental Health in Virtual Reality: Calming, anxiety and pain distraction for patients - stress reduction for the staff*	
	Artur Sychov (Somnium Space) - *VR1 PCVR headset & Social VR Platform*	
	Lenka Lhotská (CIIRC CTU) - *Natural Human-Robot Interaction*	
	Karina Zamrazilova & Michal Vavrecka (CIIRC CTU) - *Natural Human-Robot Interaction*	
	Iveta Fajnerová (VR centre NIMH, 3MF Charles Uni) - *Virtual Reality for psychotherapy in anxiety disorders and OCD*	

Fourth day – Friday, September 6

09:00 – 10:00		**Session 13: Cognition** *Chair: Orly Lahav*	
	🗣	Kinga Nedda Pete - *Immersive virtual reality experiences for the improvement of attention in post-COVID-19 condition*	93
	🗣	Soma Zsebi - *The assessment of the cognitive profile of elderly individuals using Virtual Reality: A comparison between experienced and inexperienced users*	96
	💬	James Lewis - *The use of the Meta Quest as a tool for ADHD screening through a self administered immersive test of attention and activity*	99
	💬	Karolína Zuzánková - *Virtual environment aiming to train cognitive flexibility in patients with Obsessive – Compulsive Disorder*	102
10:00 – 10:20		**Coffee break**	
10:20 – 11:20		**Session 14: Relaxation & Nature** *Chair: Mufti Mahmud*	
	🗣	Lukáš Hejtmánek - *It's Not All About the Graphics: Finding Calm in Stylized Digital Forests*	160
	🗣	Ágnes Karolina Bakk - *Designing Nature Simulated VR Application for Hospitalized Seniors*	163
	🗣	Patrícia Szabó - *Design virtual reality games that instruct proper breathing techniques with dynamically changing virtual environment*	166
11:30 – 12:00		**Coffee break / small lunch**	
12:00 – 13:00		**Best paper award ceremony and closing remarks** *Chairs: Iveta Fajnerová, David Brown & Paul Sharkey*	
13:00 – 14:00		**Cyberspace, Behaviour and e-Therapy (CYBER) – Diploma ceremony** *Chair: Pedro Gamito*	
14:00		**Goodbye ceremony**	

Keynote Speakers

Mariano Alcañiz: Could Embodied Conversational Agents Be the Future for Assessment and Interventions in Clinical Psychology?

In this talk, I will introduce Virtual Humans (VH) as a powerful tool for studying and characterizing various aspects of human cognition within controlled virtual environments. VH can aid in understanding cognitive processes such as decision-making, problem-solving, and social behaviour through behavioural studies. They also serve as standardized testing platforms for assessing cognitive functions like memory, attention, and language processing. Moreover, VH can simulate human behaviour and emotions, enabling investigations into social cognition and how individuals perceive and respond to emotions and social cues in virtual interactions. Throughout the talk, I will provide examples of VH applications in human cognition assessment, presenting research projects and their results. Finally, I will discuss potential future implications of VH in this field.

This Keynote lecture is supported by the project DigiWell - Research of Excellence on Digital Technologies and Wellbeing CZ.02.01.01/00/22_008/0004583, which is co-financed by the European Union.

Maria T Schultheis: "Technology & Cognition": Examining new trends and opportunities

New technology trends continue to grow rapidly and they offer the potential to change the way we understand brain functioning and brain-behaviour interactions. The clinical application of these technologies continues to require the understanding of both the benefits and limitations of integrating these novel methodologies to the needs of the population served. Established technologies, such as virtual reality and neuroimaging can provide examples of the transition from the lab to the clinic. Other emerging technologies, such as neuromodulation and brain-computer interface devices offer new opportunities for brain-behaviour specialists. This workshop will offer an overview of key lessons learned in the clinical translation of technologies and discuss important considerations for novel technologies that offer new opportunities.

This Keynote lecture is supported by the project DigiWell - Research of Excellence on Digital Technologies and Wellbeing CZ.02.01.01/00/22_008/0004583, which is co-financed by the European Union.

Mónica Spínola: Functional Neuropsychological Assessment: past, present and future

Penny Standen Best Early Career Paper Award Winner 2022

Over the last years, a paradigm shift in neuropsychological assessment has been observed: from a localisationist perspective to one focused on predicting everyday function. In numerous clinical disorders, cognitive deficits lead to compromises in functional abilities. However, current assessment instruments fail to be representative of real-world abilities, not allowing the prediction of the ability to perform activities of daily living.

Technological solutions, such as virtual reality (VR) and wearable technologies, seem to be promising approaches in neuropsychological assessment, allowing the simulation of real-life situations (through VR) and real-time assessment of physiological measures (e.g., heart rate) that relate to cognition (e.g., cognitive workload).

We will explore the development of innovative instruments that capture the advantages of performance-based metrics in real environments (through virtual simulations) and of objective information about the person's internal state (through physiological measures).

Abstracts

Exposure Therapy

The abstracts explore the evolving landscape of exposure therapy through the integration of virtual and augmented reality technologies. Studies highlight the advantages of AR over traditional screen-based exposure for PTSD treatment, with applications extending to war zones using VR for trauma therapy. Researchers are also evaluating the efficacy of projection-based AR for phobia treatment, particularly cockroach phobia, showing how increased stimuli variety can enhance results compared to conventional methods. VR is being utilized to treat various anxiety-related conditions, including aviophobia, generalized anxiety disorder, and OCD, with research focusing on creating realistic virtual environments that incorporate sensory enhancements like olfactory stimuli. Additionally, the use of EEG data and machine learning aims to optimize virtual reality exposure therapy (VRET) by providing real-time biofeedback, allowing for more personalised and adaptive treatment. These studies underscore the potential of VR and AR to revolutionise exposure therapy by creating immersive, flexible, and more effective interventions tailored to individual psychological needs.

Computer Monitor versus Augmented Reality: Expanding 3MDR Therapy for PTSD: A Randomized Controlled Trial (CARE4PTSD)

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ABSTRACT

This paper reviews results of our successful first study involving the novel Multi-modular Memory Desensitization and Reconsolidation (3MDR) "walk and talk" PTSD therapy, and discusses the intent, design and initial progress regarding our second study. Prior to our first study, there had been publications, reporting results with 3MDR in Dutch and British veterans, while our study was unique in being the first to address military personnel with both PTSD and TBI, the first to include significant numbers of women (50%), and in demonstrating that the eye movement element of 3MDR added significant benefit, by randomizing participants to either receive this element or not. Our current effort is intended to prove that 3MDR can be delivered much less expensively, with comparable efficacy.

1. INTRODUCTION

PTSD is more common and difficult to treat in military service members (SMs) than civilians. Prolonged Exposure (PE) and Cognitive Processing Therapy (CPT) are best-evidence therapies, and recently touted as first-line therapies in the U.S. Veterans Affairs/Department of Defense Clinical Practice Guidelines. However, when compared head-to-head in veterans in the largest PTSD interventional trial to date (910 participants), PE and CPT respectively had dropout rates of 55.8% and 46.6%, and loss of diagnosis (CAPS-5 decline of at least 10 to <25 and no longer meeting criteria for PTSD) rates of only 40.4 and 28.2%. More palatable and effective treatments are needed for SMs and veterans. Multi-modular Memory Desensitization and Reconsolidation (3MDR) is a novel "walk and talk" PTSD therapy involving cognitive therapy with self-selected trauma-related music and images displayed in a virtual environment (VE), during ambulation, initially developed for and conducted in the Computer Assisted Rehabilitation Environment (CAREN). Three 3MDR randomized controlled trials (RCTs) have been published using this approach, in Dutch, British, and US SMs. The first 2 enrolled almost solely male veterans with treatment-resistant PTSD, with modest response and dropout rates. In our pilot study of 20 US SMs with PTSD and mTBI, 10 males and 10 females received 3MDR with randomization to with/without an eye movement (EM) task. Of 4 (20%) dropouts, all before exposure sessions, 3 were due to the COVID pandemic. We saw clinically and statistically significant drops in PCL-5, from 52.0 (46.3, 57.7) at baseline to 33.6 (24.3, 42.9) post-intervention, with a more significant response in those who were randomized to receive the EM component. Women had higher a higher completion rate and greater magnitude of improvement than men, though the differences were not statistically significant. However, the CAREN is produced by a Dutch company, Motek, and it costs more than $1 million (US) to build, so it is only available in a handful of locations scattered around the world, and a less expensive delivery mechanism than the CAREN is needed in order to be able to make 3MDR more widely available. CARE4PTSD aims to show that 3MDR can be delivered with comparable success via augmented reality head-mounted display (AR-HMD) or even by a computer monitor.

2. METHODS

The current RCT seeks 60 SMs with PTSD (PCL-5 $\geq$34, confirmed by CAPS-5) at USU/WRNMMC. All participants receive 3MDR, but are randomized 1:1 to delivery via either AR-HMD (Microsoft Hololens2, cost: $3500 US, Figure 1) or a 34-inch curved screen high-resolution computer gaming monitor (Dell, cost: $400 US, Figure 2), in a study powered and designed to establish equivalence for the two delivery methods. The therapy encompasses 10-14 sessions: 3 preparatory, 6-10 intervention, 1 consolidation. In the preparatory sessions, the

therapist and participant select at least 2 songs and 14 pictures to use in the VE. Intervention sessions begin with a song to bring them back to the time of their trauma. They then approach a traumatic image until it looms before them, as the focus of therapy; they spend 5-15 minutes talking about each picture (why they chose it, what it represents to them, how it makes them feel to look at and talk about it, etc.). The therapist identifies key words expressed by the participant (often feelings such as anger, guilt or shame), and at the culmination of the discussion, asks the participant to read the words aloud before they fade away. This is repeated for up to 7 images, each followed by a 30-second-long EM task that features a red ball crisscrossing the screen, superimposed over the picture, with numbers in white font that change each time the ball reaches the screen margin; the participant must recite the numbers aloud as they change. A second song brings them back to the present to end the session. An assessment with the PCL-5 after session 6, and again after session 8, guides determinations about whether to end the intervention or proceed with additional sessions; those with resolution of PTSD and concurrence between participant and therapist may stop at either time point, while those with unresolved symptoms continue. The primary outcome is change in CAPS-5 and PCL-5 scores from pre- to post-intervention, with further assessments at 3 and 6 months to assess for the durability of the response achieved.

Figure 1: *Microsoft Hololens 2 Augmented Reality Head-Mounted Display*

Figure 2: *Dell 34-inch curved screen high-resolution computer gaming monitor*

3. RESULTS

CARE4PTSD was originally designed as a non-inferiority study comparing delivery via AR-HMD versus delivery in the CAREN, and our completion of initial participants with this design suggested excellent efficacy with the AR-HMD. In fact, completers in both arms had dramatic improvement in symptoms and resolution of PTSD. However, the engineer required to operate the CAREN departed and has not been replaced, leading to a modification in study design to the equivalence trial, comparing delivery with the AR-HMD versus delivery via computer monitor, as described. Institutional review board approval for the modified design has been obtained, the staff have been trained, and enrollment of participants has been initiated with the new design. Preliminary results from this comparison will be available by the time of the meeting, and will be presented.

4. CONCLUSIONS

3MDR is a novel, well-received and highly effective therapy for PTSD. Alternative modes of delivery in lieu of the prohibitively expensive CAREN have the potential to markedly improve the availability of 3MDR, ideally with comparable efficacy. After demonstrating that the comparatively inexpensive Microsoft Hololens2 AR-HMD is feasible and effective, we will report on how well an even less expensive computer monitor delivery fares in comparison to the AR-HMD.

Disclaimer: This study is funded by the Uniformed Services University (USU) Center for Rehabilitation Sciences Research, with additional support for its conduct from the Military Traumatic Brain Injury Initiative ($MTBI^2$). The authors have no conflicts of interest to disclose. The views expressed in this presentation are solely those of the presenters and do not necessarily represent those of the Uniformed Services University, Department of Defense, the U.S. government or the Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc, and should not be construed as such.

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The Virtual Ukraine Project: Trauma Therapy in Warzones with Virtual Reality

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ABSTRACT

The "Virtual Ukraine Project," utilizes Virtual Reality (VR) and the Metaverse to address the psychological impacts of the Ukrainian conflict on military personnel and civilians. Leveraging these technologies, the project has four primary initiatives: (1) Adapting the BRAVEMIND VR Exposure Therapy (VRET) system for PTSD treatment to reflect the Ukrainian conflict, creating relevant virtual environments for therapeutic exposure. (2) Employing a digital version of Sandtray therapy for Ukrainian children affected by Adverse Childhood Experiences, allowing for narrative play and emotional expression. (3) Developing a metaverse-enabled social support application, facilitating clinician-driven and peer-supported group processes for displaced individuals, offering a platform for emotional support and shared experiences. (4) Integrating "The Sanctuary," a VR application for mindfulness, meditation and relaxation activities, serving as a supplementary tool for stress and trauma management. Highlighting VR's potential for immersive therapy, the project aims to provide a comprehensive set of VR tools for mental health care in conflict zones, demonstrating VR's innovative, accessible, and culturally sensitive therapeutic possibilities.

1. INTRODUCTION

The invasion of Ukraine has unleashed a tragic chain of global economic, social, and personal disruptions and will likely lead to severe psychological consequences in both civilians and combatants exposed to this wartime trauma. Against the backdrop of an uncertain future--the devastation of villages and cities, destruction of a national infrastructure, and the death and catastrophic injuries inflicted on civilians--a literal petri dish of traumatic experiences has been created that will have a significant impact on the mental health of the Ukrainian people. Relief organizations have documented the challenges being faced in Ukraine (ICRC, 2024) and discussions have been ongoing by respected experts anticipating a potential epidemic of posttraumatic stress disorder (PTSD) in those exposed to this modern-day holocaust (Bouchard et al., 2023; Bryant et al., 2022). These impacts also need to be considered in the context of a residual PTSD problem resulting from the earlier 2014 Russian assault in the Donbas and Crimea regions of Ukraine (Colborne, 2015).

A critical and urgent issue in this context involves how to provide this population of 40 million people much needed psychological interventions at large scale and with minimal costs. The exploration of clinically oriented VR and Metaverse strategies with documented clinical evidence should be pursued vigorously to determine how they could play a critical role for enhancing the delivery of mental health care.

2. METHODS

The ongoing "Virtual Ukraine" project is currently focused on four unique clinical targets (see Figures 1a-d): (1) Direct Virtual Reality Exposure Therapy (VRET) for trauma-focused PTSD treatment with Ukrainians via the translation of the evidence-based BRAVEMIND (Virtual Iraq/Afghanistan) VRET application (Rizzo et al., 2005, 2010, 2018, 2024) that is now being customized to represent relevant Ukrainian contexts/stimuli. Three scenarios (rural village, urban city, forest combat zone) have been created thus far with early clinical implementation planned for late 2024; (2) Treatment of Adverse Childhood Experiences in Ukrainian child victims of the war that leverages a virtual version of sandtray therapy (Dr. Margaret Lowenfeld Trust, 2017; Virtual Sandtray, 2020). To do this, the Virtual Sandtray (Stone, 2020) is being employed to help children express or represent their trauma narrative within their own self-constructed virtual reality worlds. Currently seeking funding to create more culturally relevant content options; (3) Metaverse-enabled social support worlds that are clinician-facilitated to provide international access (using avatar-based engagement) to groups of people currently living in Ukraine and those who are refugees in other countries (8agora, 2024). A randomized controlled trial to evaluate the efficacy of this approach is currently ongoing and status will be presented at the conference; and (4) A VR-delivered application for teaching mindfulness, meditation, and relaxation strategies as an adjunct to direct trauma-focused treatment or as a tool to generally help manage the stress of living in a wartime context, regardless of treatment participation. The initial system that is being offered is the FireflyVR application (Mann, 2024) referred to as “The Sanctuary”. Funding for language translation is currently being sought. The core aim of the Virtual Ukraine project is to create a “toolbox” of VR applications that can be implemented by our clinical partners in Kyiv at the International Institute of Postgraduate Education (IIPE, 2024) and with other interested collaborators. It is also important to note that since the start of this effort the conflict in Israel and Gaza has also reached crisis proportions and much of what is proposed in this Ukraine-focused project is now being assessed for possible translation for Israeli and Gazan populations.

a. *b.* *c.* *d.*

Figure 1a-d: *Screenshots of BRAVEMIND Ukraine (a), Virtual Sandtray Ukrainian Render (b), Ukraine Metaverse World (c), The Sanctuary (d).*

3. DISCUSSION

This talk will present the development status and state of the research on component elements of the Virtual Ukraine Project. However, it's crucial to recognize and anticipate potential challenges for the implementation of this work and that will also be discussed in this talk. The integration of VR in clinical settings, particularly in war zones or for populations affected by conflict, presents unique problems and considerations. Technical and accessibility challenges can limit implementation of even the best evidence-based clinical approaches. In conflict zones, access to the necessary technology and infrastructure for VR interventions may be limited. This includes not only the VR hardware and software, but also reliable internet access for metaverse-based interventions and updates to VR content. There may also be a steep learning curve associated with using VR technologies, especially among populations unfamiliar with such tools. Acceptance and comfort levels with VR can vary, potentially affecting engagement and the therapeutic alliance between clinicians and patients. This points to the need for a clinician training program designed to optimize clinician implementation skills. These pragmatic challenges may seem less of an issue in a relatively modern western society like Ukraine, but it is hard to predict how the ravages of war can have such impact outside of some of the more urban population centers closer to the battle lines where the needs may be most critical. Another challenge involves the customization needed to create highly personalized therapeutic VR experiences. At this point, all of the VR components in this project need to be modified for cultural and geographic relevance, but the funding has lagged behind the inspiration. Fundraising is ongoing to support the unique development costs required to create VR environments that accurately reflect the needs of a critical mass of the Ukraine population who have been exposed to a wide variety of trauma experiences. Ethical considerations and research issues are also at play here (as they really are in *any* setting). Ensuring informed consent, understanding the risks, and having protocols for managing adverse reactions are essential for the ethical and professionally informed use of clinical VR. Finally, some level of effort is also needed to document and aggregate

clinical use data to assess efficacy and to understand/address implementation challenges, as well as to inform the evolution of relevant VR clinical system content and treatment approaches in an iterative process. These challenges are anticipated by the authors of this work, and driven by their passion for the cause, solutions are being developed.

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Appendix A – Video Links

The Virtual Ukraine PTSD Exposure Therapy Project – Prototype Video July 2023, https://www.youtube.com/watch?v=jL2mFoJzkoo

Medicinal Media, May 1, 2023, VR for PTSD with Intro to Virtual Ukraine Project. https://www.youtube.com/watch?v=R9NJCUtELOQ

Ukraine VRET City Highrise Attack video (in development), October 2023, https://youtu.be/Sua6a7PlOd4

CNN Technology for Good, October 3, 2020, Iraq War Veteran confronts trauma through virtual reality. https://www.youtube.com/watch?v=44ymmQ1kdZw

Ukraine Metaverse Promo Video with 2nd Author: https://www.youtube.com/watch?v=0QMZmS8-DIM

Spherical World from Kyiv Created for Pilot testing: https://youtu.be/DMvZKqVs1ok

Metaverse Pilot Test Interactions: https://www.youtube.com/watch?v=ozUDSh-mYPo

Firefly VR Sanctuary Video: https://youtu.be/6FvsKpkmpfM

Overcoming traditional exposure treatments: Preliminary results from a Randomized Controlled Trial evaluating the efficacy of Projection-Based Augmented Reality Exposure Treatment for cockroach phobia

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ABSTRACT

In vivo exposure treatment (IVET), although effective, has limitations related to the availability and acceptability of phobic stimuli. Augmented reality (AR) offers multiple options that can potentially improve treatment efficiency and acceptance. This study investigates the effectiveness of a projection-based AR exposure treatment (P-ARET) compared to IVET for cockroach phobia. The results showed that both P-ARET and IVET significantly improved symptoms compared to a waitlist control group, with benefits sustained over time. However, although no significant differences were found between the active conditions, P-ARET obtained better scores in terms of participants' experience.

1. INTRODUCTION

In vivo exposure therapy (IVET) has been established as the best treatment option for specific phobias (SP), with a strong evidence base (Nathan & Gorman, 2015). However, low acceptance rates and high dropout rates pose significant challenges to its implementation (Olatunji et a., 2009). Furthermore, among the low number of people who experience SP and actively seek treatment, only 0.8% receive an appropriate intervention for their problem (Mackenzie et al., 2012). For a few years now, the integration of technologies such as augmented reality (AR) in psychological treatments has provided an alternative to face these challenges. Several studies have explored its potential in conducting exposure therapies, particularly in the treatment of arachnophobia and cockroach phobia, with encouraging results (Botella et al., 2005; Botella et al., 2010; Botella et al., 2016). Overall, the findings from these studies suggest that AR exposure treatment (ARET) is comparable in effectiveness to IVET. Furthermore, patients undergoing ARET tend to perceive the treatment as less aversive and report similar levels of satisfaction compared to those receiving IVET (Botella et al., 2016). While the ARET system shows greater patient acceptance, potentially reducing dropout rates, a major limitation of the systems used in these studies is the use of an AR system with a head-mounted display. This setup resulted in a mixed reality environment that compromised both naturalness and comfort levels. Projection-based AR exposure therapy (P-ARET; Wrzesien et al., 2013) provides some advantages over more traditional augmented reality systems. Compared to previous ARET systems, P-ARET offers the possibility of presenting animals in a natural and non-intrusive environment, without requiring users to use any additional devices. This feature promotes unobstructed communication between patient and therapist, as well as a more realistic interaction with stimuli, resulting in a more natural therapeutic situation. This study aims to present preliminary results from a randomized controlled trial (RCT) assessing the effectiveness and efficiency of the P-ARET system for treating cockroach phobia compared to IVET and waitlist control group.

2. METHOD

A three-arm simple blind RCT approved by the Ethics Committee of the Universitat Jaume I (CD/64/2019) is being conducted (NCT04563390). For the preliminary results presented in this work, we use data from 49 participants diagnosed with cockroach phobia, assessed before, after, and at 1-, 6-, and 12-month follow-ups. Participants were randomly assigned to: 1) P-ARET (n=17); 2) IVET (n=12); and 3) waiting-list control group

(n=20). The DSM-IV Anxiety Disorders Interview Schedule (ADIS-IV; Di Nardo, Brown, & Barlow, 1994), the Behavioral Avoidance Test (BAT; Öst, Salkovskis, & Hellstrom's, 1991) and the AR adaptation of the BAT were used as primary outcome measures. In addition, the Cockroach Fear Questionnaire (FCQ; adapted from Szymanski and O'Donohue, 1995) and the Cockroach Beliefs Questionnaires (CBQ; adapted from Arnz et al., 1993) were included as secondary outcomes. Finally, expectations and opinion questionnaires (adapted from Brokovec and Nau, 1972) were also analyzed. Both active treatment conditions followed the guidelines of "One-Session treatment" proposed by Öst et al. (1991). This treatment is composed by the following components: exposure, modelling, cognitive challenge, and reinforcement. For the P-ARET group, all available system options were utilized to vary the stimuli. Different types of cockroaches, along with variations in their number and size, were used during the exposure session. Figure 1 illustrates an example of the P-ARET system. In contrast, for the IVET group, the same real cockroach, contained within a translucent urn, was used throughout the exposure session.

Figure 1. *Example of the P-ARET system.*

3. RESULTS

The mean age of the sample was 38.5 years (SD=11.93) and the majority were women (89.8%). Linear mixed model analyses revealed a significant Time factor, showing significant reductions in all primary and secondary outcomes from before to after treatment in both active conditions, which was not found in the waitlist control group (significant Group*Time factor, all *p's =.000*). A significant Group factor was also found between both treatment conditions and the waiting list group, but the comparisons between both active conditions were not significant for any of the primary and secondary variables after treatment. Furthermore, these results were maintained throughout all 3 follow-up assessments, with no significant differences found between both active groups in any of the primary or secondary variables evaluated. However, regarding the experience of the participants with the treatments, significant differences in both expectations and opinion were found before and after treatment. Results showed that P-ARET group considered their treatment option as less aversive both before (p=0,005) and after (p=0,047) treatment compared to the IVET group.

4. DISCUSSION

This study presents preliminary results of an RCT focused on evaluating the effectiveness and efficiency of the P-ARET system for the treatment of cockroach phobia compared to IVET and a waiting list condition. The overall results indicate that both active conditions were effective compared to the waiting list condition in reducing clinical symptoms of cockroach phobia. Furthermore, the results seem to indicate that both treatment conditions were effective after treatment and in maintaining results up to 12 months later, without any condition being clearly superior to the other in terms of effectiveness. However, the P-ARET was evaluated as less aversive, in the same line as found in previous studies with other AR systems (Botella et a., 2016), which could encourage more people to decide to undergo this treatment, thus helping to overcome problems associated with the acceptability and availability of traditional treatments (Olatinji et al., 2009) and, ultimately, reach more people who need treatment.

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Enhancing exposure therapy effectiveness: projection-based augmented reality for specific cockroach phobia treatment compared to traditional treatment regarding stimuli variability

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ABSTRACT

Although in vivo exposure is the preferred treatment for specific phobia, its limitations regarding the availability and acceptability of phobic stimuli prompt exploration of the potential of other alternatives to improve exposure therapy. This study examines the stimuli variability offered by projection-based augmented reality exposure versus in vivo exposure and a wait-list group in a sample of patients diagnosed with cockroach phobia. Results show that both active treatments significantly reduced phobia symptoms compared to the control and maintained the improvements over time. However, the variability of the stimulus offered by augmented reality was not a determining factor of effectiveness.

1. INTRODUCTION

Specific phobia (SP) stands out as one of the most prevalent anxiety disorders. The main treatment for this problem remains in vivo exposure therapy (IVET), although it has limitations in terms of availability and acceptability of phobic stimuli (Olatunji et al., 2009). Augmented reality (AR) can be an alternative that can help to overcome these problems associated with traditional treatment, being able to offer multiple different stimuli (and versions of it) without leaving the clinic. According to Craske et al. (2014), some strategies such as "variability" (stimuli, duration, intensity, contexts, etc.) can have a positive effect in terms of fear renewal and generalization of results. Specifically, the variability of the stimuli during exposure showed positive results in terms of spontaneous recovery in samples with fear of spiders (Rowe & Craske, 1998) and heights (Lang & Craske, 2000). In this line, projection-based AR exposure therapy (P-ARET) allows presentation of animals in a natural and non-intrusive environment without the need to use a head-mounted display (see Wrzesien et al., 2013, for a detailed explanation of the system). Additionally, P-ARET can display different versions of the same stimulus and change the number and size. The aim of the present work is to explore the effects of the variation of the phobic stimulus offered during the exposure therapy for cockroach phobia, comparing two treatment conditions: P-ARET group (multiple and virtual stimuli) and IVET group (single real stimulus), with a waiting-list control group (WL).

2. METHODS

The data presented in this study are part of a randomized controlled trial approved by the Ethics Committee of the Universitat Jaume I (CD/64/2019) and registered in the ClinicalTrials.gov database (NCT04563390). Participants (N=49) were randomly assigned to three experimental conditions: P-ARET (n=17), IVET (n=10), waiting-list control group (n=17). Five assessment moments were included (before and after treatment and at follow-up at 1, 6 and 12 months) using an ad hoc 10-item Likert questionnaire that evaluates SP symptoms. Specifically, the assessed items were the following: I1- *How scared would you be if you ran into a cockroach?;* I2- *To what extent would you avoid encountering a cockroach?;* I3- *To what extent do you think the cockroach is dangerous to you?;* I4- *To what extent do you feel capable of dealing with a cockroach of a different colour, size and shape?;* I5- *To what extent do you feel capable of dealing with several cockroaches?.*

Both interventions followed the "one session treatment" guidelines proposed by Öst et al. (1991) whose components include: psychoeducation, exposure, modelling, cognitive challenge, and reinforcement. For the P-ARET group, all available system options were used to vary the stimulus, so that during the exposure session different types of cockroaches were used, as well as their number and size. Figure 1 depicts an example of the P-ARET system. For the IVET group, the same real cockroach (inside a translucent urn) was used during the exposure session.

Figure 1. *Example of the P-ARET system.*

3. RESULTS

A total of 44 participants diagnosed with cockroach phobia took part of the study. The mean age of the sample was 38.07 (SD=12,22) and it was made up mostly of women (88,6%). Linear mixed models analyses were carried out. Figure 2 shows the graphics of the results for each measured item in each measurement moment by group. Regarding pre-treatment results, no differences were observed between the three groups in any of the 5 items evaluated. Regarding pre-post treatment comparisons, analyses showed a significant Time factor in all items (all *p's* = .000). Post-hoc analyses showed significant reductions in both active conditions, which was not found in the WL group. A significant Group factor was found in items 1, 2, 4 and 5 (all *p's* = .000). Post-hoc comparisons revealed significant differences between both active conditions and WL group, no significant differences were found between the two active conditions. A significant interaction (Time*Group) was found in items 1, 2, 3 (all *p's* = .000) and 5 (*p* = .003), which post-hoc comparisons confirmed, in all cases, that differences in time were significant only at post-treatment and only between each of the active conditions and the WL control group, with the comparisons between the active groups not being significant at any time. Regarding the follow-up results (where only the two active groups were involved), linear mixed models analyses revealed similar results in all items. In this case, no significant factor or interaction were found throughout the three follow-up periods in any of the items.

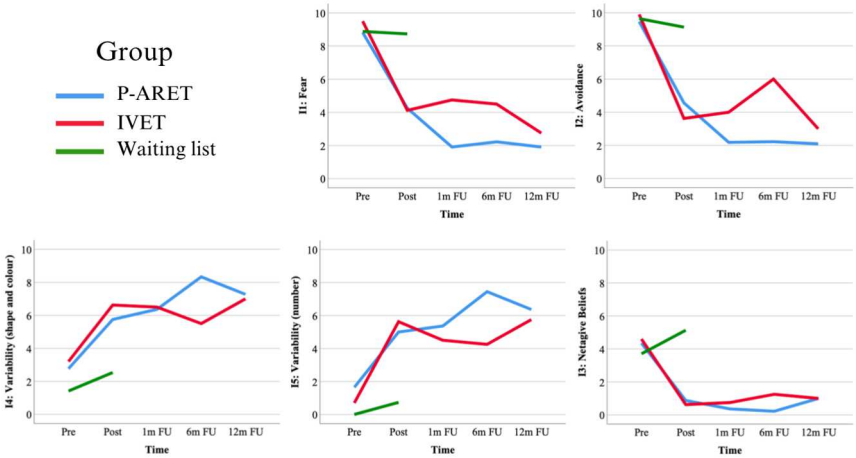

Figure 2. *Results of each measured item troughout time by group.*

4. DISCUSSION

This study assessed the effects of stimulus variability during exposure therapy by comparing two active treatment groups, where one group underwent exposure to a single real cockroach, while the other group utilized all the possibilities (size, colour, shape, and number of cockroaches) offered by a projection-based augmented reality system, compared with a waiting list control group. The results showed that both active treatment conditions significantly reduced SP symptomatology, a change not observed in the control group, suggesting that both

treatment conditions were effective. In addition, these results were maintained over time up to 12 months later. These results are in line with prior evidence of AR effectivity (Botella et al., 2016), in which no differences were reported between IVET and AR groups. However, no significant differences were found in any of the measures between both treatment groups, including those items focused on assessing stimuli variability. Previous research focusing on stimulus variability reported positive results in terms of fear renewal, favouring variability over a single stimulus (Rowe & Craske, 1998; Lang & Craske, 2000). However, in these works the stimuli used were all of the same nature (i.e., all real stimuli), while in the present work, two conditions have been compared with stimuli of a different nature each (i.e., virtual versus real) and this could have affected the results. It could be that when it comes to real stimulus, a real cockroach could be comparable to multiple virtual cockroaches, so these results regarding variability should be taken with caution. In conclusion, despite the results regarding variability, the P-ARET system has shown comparable efficacy to IVET in reducing phobic symptoms, which is in line with previous evidence in the field (Botella et al., 2016). Moreover, authors also reported that patients who received the AR condition showed better results in terms of opinion and experience, which helps to overcome the barriers associated with the low acceptability and accessibility of traditional treatments (Olatunji et al., 2000). Future research with larger sample sizes, more specific assessment measures of the fear renewal and generalization and comparing similar conditions (i.e., both virtual stimuli conditions) might help to clarify how stimulus variability enhances AR exposure therapy effectiveness.

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Design and Evaluation of Virtual Environments for Exposure Therapy of Aviophobia: Early Feasibility Study

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ABSTRACT

Aviophobia is a type of specific phobia characterized by a persistent fear of flying negatively affecting people's professional and social life. This study aims to evaluate a newly developed virtual environment for exposure therapy of aviophobia using a comparison of subjective anxiety ratings between an experimental and a control group. The main focus is on the usability of the environment and its capability to induce anxiety in people with aviophobia. The preliminary results show a great potential of the tested virtual environment in inducing anxiety in people with the fear of flying compared to the healthy control group.

1. INTRODUCTION

Aviophobia or the fear of flying (FoF) is a specific phobia characterized by persistent anxiety during or in anticipation of flying on an airplane, negatively affecting professional and social life, preventing individuals from travelling for work or visiting family and friends (Clark, 2016). Treatment of FoF usually consists of medication and/or cognitive behavioral therapy (CBT), including systematic desensitization or exposure therapy (e.g. listening to or looking at airplanes, spending time in a stationary plane, a flight simulation, etc.). However, performing in vivo exposures for FoF can be problematic due to the limited availability or high costs of practice situations. Virtual reality-based exposure therapy (VRET), already proven to be an efficient tool in phobia treatment (Ribé-Viñes et al., 2023), represents a useful and more accessible alternative that can address these limitations and enhance CBT efficacy. Some virtual environments (VE) for VRET of aviophobia have already been created. Nevertheless, most of them are in the form of self-help mobile app-based treatments or 360° videos, allowing only viewing, but no interaction in the environment, with limited possibility of graduating the exposure based on the patient's individual needs (Cardos et al., 2017). The main aim of this validation study is to examine the feasibility of the created virtual scenario for aviophobia comparing differences in subjective rating during single-session exposure to VR simulation between the experimental and the healthy control group.

2. METHODS

In this project, VE for exposure therapy of FoF (Figure 1a & Figure 1b) was designed (as part of a larger virtual city *VRETcity* that we have developed for phobia treatment in cooperation with the Czech Technical University) based on situations suggested by the Flight Anxiety Modality Questionnaire (FAM; Nousi et al., 2008). The virtual scenario lasts about 30 minutes and includes taking the subway to the airport, going through security, waiting at the gate, boarding the plane, taking off and landing with authentic visual and sound effects (for detailed description see Table 1). The study was conducted in three phases using: 1) VE without avatars, 2) VE with avatars (passengers, airport staff), 3) VE with additional motion synchronised with visual and auditory cues during the exposure. The VE was tested by an experimental and a healthy control group, both groups going through the same

single-session scenario (Table 1 & Table 2). The virtual scenario was presented in a VR headset HTC vive Pro, using one controller to teleport through the VE. The participants are instructed to look out of the window during the whole flight if possible. SUDS (Subjective Unit of Distress Scale) rating of distress level (1-10) was recorded in selected steps of the scenario (see Table 1 and Figure 2).

Table 1: *Individual steps of the virtual exposure scenario*

1- Starting point near the subway station (baseline)	8- Airplane door closing
2- Taking the subway to the airport (2 stations)	9- Safety instructions and departure announcement*
3- Entering the airport (first look around)*	10- Departure (movement around the runway)*
4- Security check (going to the 2nd floor)	11- Takeoff*
5- Waiting at the gate (sitting by the window for 3 min)*	12- Stabilization (for 3 min)*
6- Boarding (looking out of the tunnel for 30 s.)	13- Landing announcement (plane starts to land)*
7- Sitting (3rd row, bý the window)*	14- Getting off the plane (back to the gate)*

**scenario steps with asterisk (*) are visualised in Figure 2 by the indicated number*

Participants were recruited to an experimental group (phobic subjects n=60) or a control group (healthy controls n=8) based on the criteria for specific phobia:

- **DSM-V criteria** (fear out of proportion to the actual danger; situation is actively avoided or endured with intense anxiety; fear, anxiety, or avoidance causes clinically significant distress or impairment in important areas of functioning; fear, anxiety, or avoidance is persistent, lasting for 6 months or more)
- **Flight Anxiety Situations Questionnaire** (FAS; cut-off score for phobia under 56)
- **Flight Anxiety Modality Questionnaire** (FAM; cut-off score for phobia under 25)

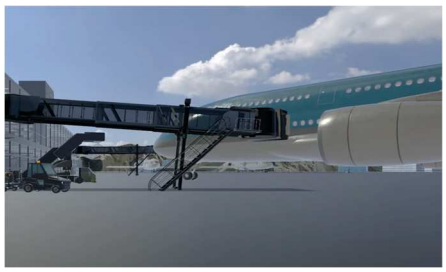

Figure 1a *Illustration of the created VE (outside)*

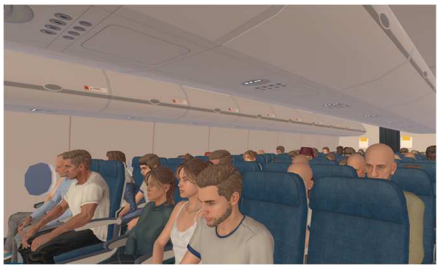

Figure 1b *Illustration of the created VE (user's view)*

3. RESULTS

Table 2: *Data summary*

Group	**Gender** (female/male)	**Age** (yrs)	**reported FoF** (yrs)	**FAS** (mean)	**FAM** (mean)	**STAI Pre/Post**
Phobic (N=60)	F=49/M=11	38	14.8 (SD 7.8)	107.2 (SD 23.1)	55.8 (SD 13.3)	12.6/11.8 t(59)=1.63,p>0.05
Control (N=8)	F=5 / M=3	31	0	41.6 (SD 6.9)	22.3 (SD 3.4)	11.3/9.5 t(7)=2.20, p>0.05
Phobic vs. Control	-	-	-	t(66)=7.92, p<0.01	t(66)=7.06, p<0.01	t(66)=1.09, p>0.05 / t(66)=1.62, p>0.05

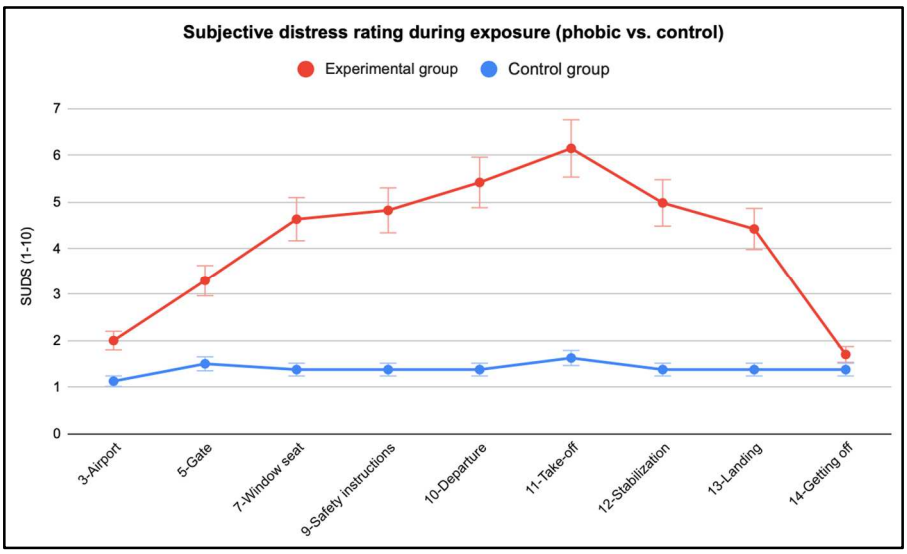

Figure 2 Average *SUDS ratings for selected steps of the scenario (experimental vs. control group) (Note. Error bars represent standard errors)*

4. DISCUSSION

The preliminary results show great potential of the VE in inducing anxiety in people with FoF. The main limitation is the unbalanced sample, lacking participants in the control group. A detailed description of the virtual environment and the data analysis including comparison between different phases of the study with an enlarged sample will be presented at the conference. This study will be followed by a clinical study on the effectiveness of the VRET scenario in the treatment of aviophobia. The main advantage of the created scenario is the possibility of gradual, individualized exposure in a VE controlled by a professional therapist. The addition of virtual avatars or motion synchronised with visual and auditory cues during exposure might improve the efficacy of VRET for FOF, but further research is still needed.

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Evaluating Virtual Scenarios through the Lens of the Contrast Avoidance Model in the Context of Generalized Anxiety Disorder Treatment

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ABSTRACT

This study explores the application of the Contrast Avoidance Model (CAM) within virtual reality exposure therapy (VRET) for treating generalized anxiety disorder (GAD). Recognizing GAD's pervasive impact and the limitations of traditional cognitive-behavioral therapy (CBT), this research aims to design, implement, and evaluate CAM-based intervention that addresses negative contrast sensitivity in GAD patients. We hypothesize that exposure to controlled, discomfort-evoking VR scenarios, coupled with relaxation, can enhance patients' coping mechanisms and reduce anxiety symptoms (Newman et al., 2011). This study zeroes in on evaluating VR scenarios to confirm they trigger negative emotions in GAD patients, crucial for their use in the proposed treatment.

1. INTRODUCTION

Generalized anxiety disorder (GAD) is characterized by excessive worry and tension that significantly impairs an individual's daily functioning and overall quality of life (Stein et al., 2015). Despite advances in psychotherapeutic treatments such as cognitive-behavioral therapy (CBT), approximately 50% of GAD patients experience persistent symptoms or relapse (Fisher, 2006; Hunot et al., 2007). **The Contrast Avoidance Model (CAM)** offers a novel perspective, suggesting that GAD sufferers engage in worry to minimize the emotional impact of future negative events thus avoiding sharp emotional contrasts (Kim et al., 2022). This model proposes that worry helps to maintain a constant state of negative emotional arousal, thereby preventing the jarring effect of sudden negative emotions (Llera & Newman, 2014). According to this model, by constantly worrying, individuals with GAD attempt to avoid the distress associated with unexpected emotional changes that they find particularly threatening (Kim et al., 2022; Llera & Newman, 2014).

Our research aims to develop and evaluate a protocol for CAM-based **virtual reality exposure therapy (VRET)** using a virtual reality (VR) headset to display realistic stimuli. VRET's consistent structure, ease of use, and potential for gradual exposure make it an ideal candidate for this type of intervention. By first inducing a state of relaxation followed by triggering scenarios, the approach aims to help patients directly confront and process their fears of contrasting emotions, potentially reducing the avoidance behaviors central to GAD (Llera et al., 2014). This method allows for the controlled and safe experience of sharp emotional contrasts, providing a realistic yet manageable environment for exposure therapy (Carlson, 2023). In the following text, we focus on the design and evaluation of VR scenarios intended for the exposure component of VRET, with the goal of validating their efficacy in eliciting the desired response in the GAD population.

2. METHODS

2.1. Study Design and Participants

The study consists of two phases. First, an online questionnaire will be administered to both GAD patients and therapists to assess subjective reaction to 30 visual stimuli identified through a systematic review. Examples include **prison, witnessing violence, natural disaster, dark spooky forest**, and **overcrowded subway** (Figure 1). Two illustrative images per scenario, generated by the artificial intelligence (AI) Stable Diffusion v2.1, will be presented to each participant. These visuals, rendered in black and white to minimize the influence of color, will

be paired with brief textual descriptions in a questionnaire to assess their emotion-inducing potential. This phase will target 15 experienced therapists from the Czech CBT Association and aims to enroll at least 25 volunteers diagnosed with GAD. The sample size was determined by a power analysis based on our pilot results to ensure that the intraclass correlation coefficients (ICC) reached the desired value of 0.75.

Figure 1 *AI-generated visuals of sample scenarios created using model Stable Diffusion v2.1.*

2.2. Selection and Evaluation of VR Scenarios

This section outlines the methods used to select and evaluate the VR scenarios for the study to ensure their effectiveness in inducing the emotional contrasts necessary for therapeutic intervention.

2.2.1. Selection of Stimuli.

Clinical professionals will assess the relevance and generalizability of the scenarios to GAD population, while GAD patients will provide ratings of their emotional responses to them. The selection of scenarios for further evaluation will be based on the 5 highest rated stimuli from the questionnaire phase. Reliability will be assessed using intraclass correlation coefficients (ICC) to determine good consensus among participants. Statistical analysis will include the weighted sum method of multiple criteria decision analysis (MCDA), maximizing means, minimizing standard deviations, and using ICCs as weights to ensure reliable scoring.

2.2.2. Evaluation of VR Environments.

Selected scenarios will be recreated as virtual environments to be displayed using a VR headset (Figure 2). Each VR scenario is designed to be brief and will feature realistic auditory and visual elements to enhance immersion. Prior to testing the scenarios in a clinical population, a pilot study will be conducted with a subclinical population of up to 10 participants who self-identify as mild to moderate anxious. The protocol will be the same as for the clinical population, with the exception of the initial clinical interview.

The subsequent evaluation of these scenarios will involve 25 GAD patients, confirmed by an initial interview, excluding any with epilepsy. Participants will be immersed in a single VR session lasting no longer than 45 minutes using the Meta Quest 2 headset. During this session, physiological correlates such as heart rate and respiratory rate will be measured using specialized wearables and headset's internal sensors. This comprehensive approach aims to gather both subjective and objective data to validate the effectiveness of the VR scenarios in inducing the emotional contrasts necessary for therapeutic intervention.

Figure 2 *AI-generated visual of a crowded elevator (left) vs. the same scenario in VR (right).*

2.3. Measurements and Scales

During the questionnaire phase, the GAD-7 scale will initially be used to ensure that participants' anxiety levels are consistent with moderate GAD (scores >10 out of 21). GAD patients and therapists will rate their responses to the scenarios on a Likert scale from 1 to 10. The top 5 highest-rated stimuli will be selected for further evaluation. Participants will be included based on the GAD-7 scores above 5 for the subclinical VR pilot study. For the clinical population portion (with GAD-7 scores > 10), a diagnosis of GAD will be confirmed during an initial interview using the Beck Anxiety Inventory (BAI).

Both clinical and subclinical participants' responses to VR scenarios will be monitored using the Vernier Go Direct Respiration Belt to measure heart rate, respiratory rate, and heart rate variability (HRV) - key indicators of emotional and sympathetic activity - as well as physiological responses recorded by the headset, such as head and hand movements, gyroscope, accelerometer, and sound intensity. The impact of the VR scenarios will be assessed through both physiological measures and participant feedback, utilizing the Self-Assessment Manikin (SAM) for emotional valence, arousal, and dominance, and the Subjective Units of Distress Scale (SUDS) to quantify emotional response to the VR scenarios.

3. RESULTS

Our pilot results from a previous study indicate moderate reliability of assessment with ICC values ranging from 0.65 to 0.74 ($p < .001$) in GAD patients. The pilot study questionnaire also revealed low consensus among therapists regarding scenario applicability (ICCs 0.41 to 0.46). Top anxiety-provoking scenarios were identified, including "prison" and "witnessing violence," based on their impact and consistency of ratings (mean 8.07 - 6.07; SD 1.94 - 2.79; on a Likert scale of 1-10). Building on these initial findings, the current study aims to administer a new questionnaire to a larger sample. Once the scenarios with the highest impact are identified, their effectiveness in eliciting responses will be validated in subclinical participants and GAD patients using physiological measures and subjective feedback while immersed in VR. The data set from the Meta Quest 2 headset and the readings from the Vernier Go Direct Respiration Belt will provide a comprehensive view of the emotional states induced by the VR scenarios. Preliminary data on the final selection, as well as the effectiveness of these scenarios in eliciting targeted negative states in the subclinical population, will be shared through the conference poster presentation.

4. DISCUSSION

The validation of VR scenarios as effective triggers of negative emotions marks an important step forward in our trajectory. The implications of these findings are twofold. First, the confirmation of scenario validity may support the potential of VR as a possible treatment medium for GAD, offering a novel way to engage GAD patients in exposure therapy without the logistical and ethical constraints of the real world. Second, the effectiveness of these scenarios in eliciting negative emotions suggests that VR can be tailored to mimic real-life situations closely enough to elicit genuine emotional responses, thereby enhancing the realism and applicability of this therapeutic intervention. Moving forward, our focus will shift to integrating these validated scenarios into a comprehensive VRET program. The next phases of our research will explore the therapeutic efficacy of these scenarios in systematically desensitizing patients to their fears, with the goal of reducing GAD symptoms through repeated and controlled exposure to emotional contrasts.

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Optimizing VRET: EEG data for ML Models with Real-Time Biofeedback

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ABSTRACT

The research paper investigates the integration of machine learning (ML) and biofeedback mechanisms in Virtual Reality Exposure Therapy (VRET) for managing anxiety and stress-related disorders from electroencephalogram (EEG) data. It explores the utilization of EEG data obtained from a 32-Channel brain-computer interface (BCI) in creating personalized interventions, highlighting the potential of real-time biofeedback for stress management. The paper presents a novel ML-driven biofeedback pipeline, leveraging EEG data. The study's outcomes could refine mental health technology by incorporating ML models for the biofeedback for personalized interventions.

1. INTRODUCTION

The cutting-edge Virtual Reality Exposure Therapy (VRET) systems offer immersive, controlled environments where individuals can confront anxiety-inducing stimuli in a safe, controlled manner. They provide a realistic yet manageable platform for exposure, allowing gradual desensitization and skill-building. VRET systems offer scalability, accessibility, and customization, catering to diverse user needs. Additionally, they can integrate biofeedback mechanisms, enhancing effectiveness by providing real-time physiological data for personalized therapeutic interventions and stress management strategies and psychological disorders Premkumar et al. (2021), Rahman et al. (2022, 2023).

In our research paper Rahman et al. (2023), we presented a novel approach to VRET by incorporating biofeedback mechanisms. We delineate a comprehensive exploration of utilizing EEG for heart rate (HR) and heart rate variability (HRV) signals in VRET to manage anxiety and stress-related disorders. The process involves data acquisition using emotive EPOC flex, followed by feature extraction and statistical analysis of HR and HRV. Integration of biofeedback into VRET sessions involved monitoring heart rate and cortical arousal levels in real-time, providing feedback through a virtual environment.

In the research Rahman et al. (2023), we pointed out the challenges and future research directions, including the need for ML-driven real-time biofeedback analysis, variability in VRET sessions, optimal electrode placement, haptic feedback integration, and data collection from diverse experimental conditions. The study highlights the importance of accurate detection of distress-related arousal levels and its potential applications in managing anxiety and stress across various populations. In the paper Rahman et al. (2023), we calculated the threshold for different stimuli based on some mechanistic models where our target was to set up the pipeline for real-time biofeedback.

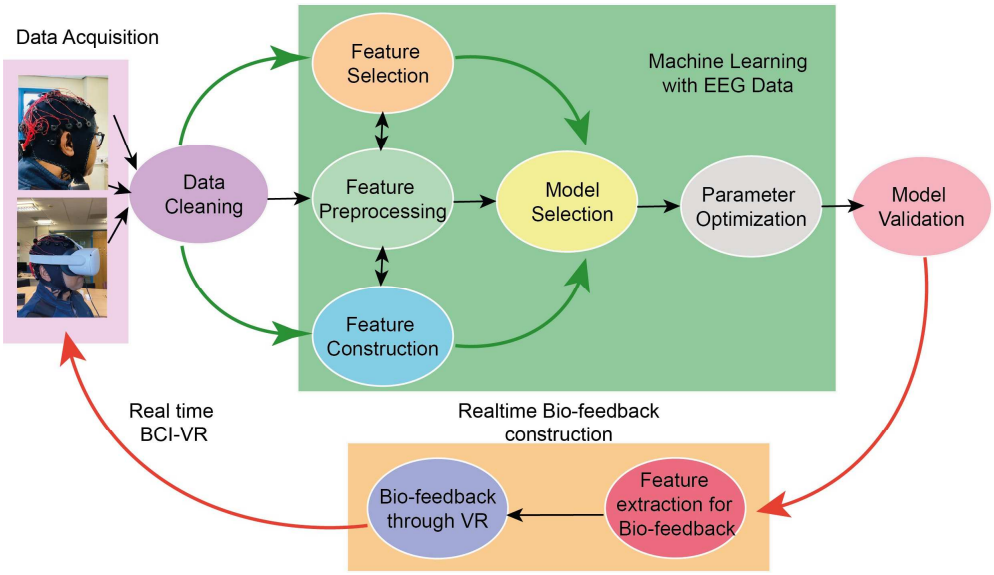

Figure 1: *The proposed machine learning pipeline for real-time biofeedback construction and optimization from the EEG data.*

There is a need to explore deeper into the refinement and optimization of VRET protocols, including the development of immersive environments, interactive scenarios, and personalized interventions tailored to specific anxiety and stress-related disorders. This could involve investigating novel techniques for enhancing the effectiveness and accessibility of VRET across diverse populations and clinical settings.

Further research could explore the integration of advanced machine learning algorithms and real-time data analytics to enable more accurate and personalized assessment of distress-related arousal levels with higher precision. This may involve the development of predictive models, algorithms, and digital platforms capable of analyzing multimodal physiological data streams and behavioural metrics to provide timely feedback and support for individuals undergoing therapy.

2. METHODOLOGY

Here in this paper, we want to carry forward the ongoing research by generating ML-driven biofeedback for VRET, where the ML models will play a crucial role in optimizing and personalizing biofeedback based on EEG data we have collected from participants. We have presented a pipeline in Figure 1. The ML models will analyze patterns and trends from the EEG signals to identify individualized markers of stress, anxiety, or other psychological states. By leveraging advanced algorithms, ML models will adapt in real time, tailoring the biofeedback interventions to each participant's unique needs and responses. This personalized approach enhances the effectiveness of real-time biofeedback therapy, ensuring that individuals receive targeted interventions that resonate with their specific physiological and psychological profiles, ultimately leading to improved stress management and mental well-being.

Future research could focus on expanding the scope of biofeedback integration beyond traditional physiological measures to incorporate novel modalities and sensors, such as wearable devices, ambient sensors, and affective computing technologies. This could facilitate more comprehensive monitoring and intervention strategies that address the complex interplay between psychological states, environmental factors, and individual well-being.

Overall, the evolution of research in these areas holds the potential to revolutionize mental health care delivery, empower individuals in managing their emotional and psychological well-being, and pave the way for innovative approaches to addressing the global burden of anxiety and stress-related disorders.

3. DISCUSSION

Our proposed research activity will lay the foundation for further collaboration and expanded funding opportunities by demonstrating the efficacy of integrating machine learning and biofeedback in VRET by producing high-impact research papers. With successful outcomes and established methodologies, it becomes a compelling prospect for interdisciplinary collaborations with experts in psychology, neuroscience, and technology.

These collaborations can attract larger funding opportunities from governmental agencies, private foundations, and international research consortia aiming to advance mental health interventions.

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Virtual environment for exposure therapy of obsessive-compulsive disorder enriched with olfactory stimuli: A pilot study

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ABSTRACT

Obsessive-compulsive disorder is a neuropsychiatric condition with exposure and response prevention as the most common psychotherapeutic treatment. Virtual reality exposure therapy (VRET) has been recently established as a new method that enables simulation of a real-life situation in a safe, controlled environment. This study focuses on testing VRET enriched with olfactory stimuli.

1. INTRODUCTION

Obsessive-compulsive disorder (OCD) is a neuropsychiatric condition characterised by obsessions, which are intrusive and unwanted thoughts, images, or urges that elicit a feeling of discomfort or anxiety. To reduce the distress caused by obsessions, OCD patients perform compulsions: repetitive and ritualised behaviours or mental acts that provide short-term relief but reinforce the obsessive-compulsive pattern in the long run. Therefore, the most common psychotherapeutic treatment for OCD, exposure and response prevention (E/RP), targets obsessive-compulsive cycle by exposure to the feared stimuli or situation while simultaneously averting compulsive acts or avoidant behaviour (Law & Boisseau, 2019).

Apart from standard exposure techniques: imaginary and in vivo, virtual reality exposure therapy (VRET) has been recently established as a third option that augments the standard procedures with simulation of a real-life situation in a safe, controlled environment. Virtual house environment "OCD house" has been developed in our lab (Fajnerová et al., 2023) and this study aims at testing VRET in the "OCD house" enriched with olfactory stimuli. There is robust evidence showing that olfactory stimuli are particularly salient to trigger both positive and negative emotions (Warrenburg, 2005). As such, olfactory stimuli might significantly influence the perception of exposure stimuli in OCD patients, increase the feeling of presence in the virtual environment and therefore enhance the overall therapeutic effect of VRET.

2. METHODS

The recruited OCD patients (n = 6) and healthy control subjects (n = 9) underwent one session of exposure in the virtual house environment with and without olfactory stimuli. Patients underwent standardised scenarios relevant to their symptom subtype (contamination/cleaning or fear of harm/checking) and participants in the control group were randomly assigned to the cleaning or checking condition. Two neutral (e.g. standing under a tree) and two aversive scenarios (e.g. cleaning floor contaminated with urine) were used in each condition. All participants first underwent the scenarios without the olfactory stimuli and then again with added olfactory stimuli. Olfactory stimuli were delivered with commercially available home aroma diffuser with adjustable speed and remote control (Otello electronic diffuser). During the exposure, participants rated their anxiety and the need for compulsion/avoidance on the 10-point Likert scale (1-10). After the session participants filled the questionnaires focused on olfactory perception, realism, immersion and presence in VR.

3. RESULTS

OCD patients rated the exposure situations as more provoking in means of anxiety and compulsion/avoidance compared to healthy controls. The olfactory stimuli increased the perceived anxiety and need for compulsive action/avoidance in both groups; however, the OCD group rated the scenarios accompanied with olfactory stimuli as more distressing than the control group. Furthermore, there was a difference between neutral stimuli and aversive (OCD symptoms provoking) stimuli (see Figure 1). Participants also reported that added olfactory stimuli (especially aversive) increased realism of virtual scenarios and immersion in the virtual reality (ratings of aversive stimuli on 10-point scale: realism: *Md* = 8, *SD* = 2.87; immersion: *Md* = 8, *SD* = 3.6).

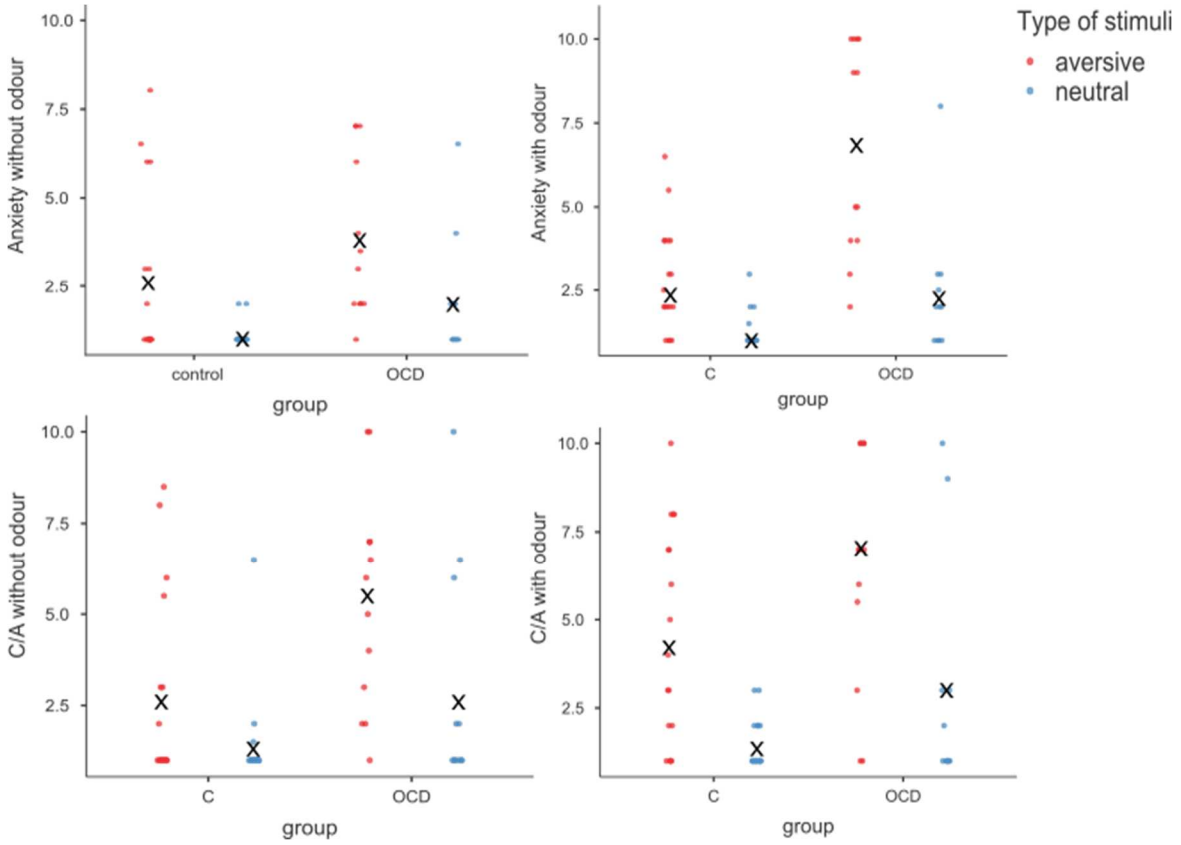

Figure 1: *Preliminary results from VRET scenarios with and without additional olfactory stimuli. Figure shows participants' ratings of anxiety and need for compulsion/avoidance (C/A) on 1-10 Likert scale during either neutral or OCD-symptom provoking (aversive) situations in the VR house,* X *denotes mean.*

4. DISCUSSION

The preliminary data show that olfactory stimuli increased perceived anxiety and need for compulsions in OCD patients during symptom provoking rather than neutral VR scenarios. Furthermore, all participants rated the VR scenarios as more realistic when combined with the olfactory stimuli.

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Autism

The abstracts examine a range of technological innovations to support autistic individuals across diagnostics, education, and skill development. AI is being explored to enhance diagnostic accuracy and streamline pathways for better educational outcomes, potentially improving the assessment process. Research on fine motor skills seeks to identify markers of neurodivergence to aid in assessment. Interventions leverage technology, with VR used to teach independence in navigating public transportation and to improve social skills in educational settings. Insights from autistic researchers are shaping these interventions, ensuring they are relevant and effective. Additionally, studies focus on the usability of online courses for autistic adults, aiming to increase accessibility and participation. Virtual platforms are also being developed to support social-emotional learning, offering a safe space to practice and receive feedback. These studies highlight the potential of AI, VR, and online tools to transform support for autistic individuals, emphasising personalised, accessible, and practical solutions. The abstracts examine a range of technological innovations to support autistic individuals across diagnostics, education, and skill development. AI is being explored to enhance diagnostic accuracy and streamline pathways for better educational outcomes, potentially improving the ADI-R assessment process. Research on fine motor skills seeks to identify markers of neurodivergence to aid in assessment. Interventions leverage technology, with VR used to teach independence in navigating public transportation and to improve social skills in educational settings. Insights from autistic researchers are shaping these interventions, ensuring they are relevant and effective. Additionally, studies focus on the usability of online courses for autistic adults, aiming to increase accessibility and participation. Virtual platforms are also being developed to support social-emotional learning, offering a safe space to practise and receive feedback. These studies highlight the potential of AI, VR, and online tools to transform support for autistic individuals, emphasising personalised, accessible, and practical solutions.

Can an LLM AI-Augmented ADI-R Improve Diagnostic Pathways and Educational Outcomes for Autistic Individuals?

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ABSTRACT

There are several significant issues in Autism diagnostics today including gender, race, and socioeconomic bias and the phenomenon of subjective observational inventories which are exacerbated for individuals with autism without intellectual disability. Even "gold standard" diagnostic tools like the ADI-R suffer from cost, time, accuracy, efficiency, and scalability issues. A promising and emerging area of study within this field is concerned with the applicability of LLM AI. This paper will argue for a theoretical framework surrounding the potential augmentation of the ADI-R using LLM AI to improve both diagnostic pathways and educational outcomes for individuals with autism without intellectual disability.

INTRODUCTION

There are several significant issues with Autism diagnostics today (Taylor et al., 2023), one being the prevalence of gender and race bias in screening and diagnosis (Brickhill et al., 2023; Obeid et al., 2021). Furthermore, contemporary Autism assessments are overly reliant on costly, time-consuming, and subjective observational inventories (Male et al., 2023; Chen et al., 2019; Galliver et al., 2017). Considering the variety and complexity of behavioural symptoms associated with Autism, diagnostics has become an inefficient, inaccurate, and unscalable process (Taylor et al., 2023; Male et al., 2023a;).These concerns were further complicated by definitional changes in DSM-5 (APA, 2013), which decreased assessment and support for individuals with autism without intellectual disability (Volkmar et al., 2021; Bent et al., 2017;). An arguably greater challenge is ensuring that clinical diagnoses demonstrably improve and lead to positive learning outcomes for children with Autism (Odom et al., 2021) by addressing significant differences between clinical and educational approaches which lead to non-integrated Autism care and overlapping diagnostic pathways (Male et al., 2023b, Izuno-Garcia et al., 2022;).

Notwithstanding these issues, the Autism Diagnostic Interview-Revised (ADI-R) is considered one of the "gold standard" diagnostic instruments because of its reliability, consistency, and analytical depth (Wall et al., 2012) even with DSM-5 changes (albeit with lower sensitivity to children with Autism without intellectual disabilities) (Lai et al., 2022). It takes approximately 2.5 hours, is 93 questions long, and consists of an in-person interview with a caregiver of someone with undiagnosed Autism, who is questioned about the person's development and the causes behind ASD-linked behaviours (Lebersfield et al., 2021). The ADI-R has been successfully conducted via telephone and with expanded but tailored question sets (Kim et al., 2013; Ward-King et al., 2010).

An emerging field of study in Autism diagnostics concerns artificial intelligence (Erden et al., 2020), specifically Large Language Model Artificial Intelligence (LLM AI) (Bertacchini et al., 2023). LLM AI specializes in understanding human language (Schueller & Morris, 2023), which is relevant because accurate assessments effectively and precisely communicate to stakeholders and correctly interpret responses (Luallin et al., 2022; Cavus et al., 2021). LLM AI can enhance the ability of clinicians and medical professionals to work with many stakeholders with critical information about the child being assessed (Alowais et al., 2023). While discussed for more than a decade (Wall et al., 2012), accelerating technological advances have catalyzed a rapidly growing literature base (Alam et al., 2023; Megerian et al., 2022).

This proposal sets out whether an LLM AI-augmented ADI-R can improve diagnostic pathways and learning outcomes for children with autism without intellectual disability. While current Autism care practices are service provider-centric and disjointed (Krakowski et al., 2022), an LLM AI-based approach provides a foundation for a dynamic, holistic, and client-centric model (Ostrovsky et al., 2023). LLM AI could continuously measure inputs and modulate support for: initial assessment and lifetime support (deLeyer-Tiarks et al., 2023), cognition (Iannone & Giansanti, 2024), and learning (Pandya et al., 2024). Using LLM AI in Autism diagnostics can help assuage concerns about cultural or gender bias, subjective observational inventories, and clinician subjectivity while transparently and ethically improving diagnostic accuracy, consistency and effectiveness with substantially larger

data sets from more caregivers and stakeholders (Buranova et al., 2022), enhanced respondent objectivity (e.g. the SCQ and the AQ) (Hayes et al., 2022; Möricke et al., 2016) and higher participation rates (Cahyadi et al., 2022). In addition, LLM AI A/B testing (Polonioli et al., 2023) can potentially refine assessment questions continually, prompting the most accurate and contextually relevant responses.

Several efforts to integrate technology with Autism assessment tools (e.g. the M-CHAT, TELE-ASD-PEDS, and ADOS-2) have encountered accuracy, correlation, and resource issues and remain clinician-centric (Dahiya et al., 2021). An LLM AI chatbot system would be child-focused, cost-effective, scalable, and adaptable (Joudar et al., 2022). In addition, neurodevelopmental and other diagnostic assessments like the DAWBA (Amelio et al., 2024) and LLM AI ADI-R are not mutually exclusive approaches. LLM AI ADI-R could broadly and inexpensively pre-screen children significantly reducing the need for more advanced, clinician-driven assessments. In fact, to the extent that other tools are interview or query-based, the adoption of LLM AI as a new interface and engagement modality could be the subject of future research.

METHODOLOGY

The LLM AI ADI-R will be delivered through stakeholder smartphones as a chatbot via popular chat apps like WhatsApp and Telegram. The ADI-R would be conducted by the LLM AI chatbot with the full consent and cooperation of participants and stakeholders in compliance with all applicable local laws and regulations. Data collection would happen in a pilot study and a feasibility trial. As the traditional ADI-R is well established, the pilot study would assess the functional viability of the LLM AI ADI-R's interface, engagement dynamics, and analytic tools. A selected group of 15-30 learners with autism without intellectual disability and their caregivers would use the LLM ADI-R for up to 150 minutes (or 2.5 hours) spread across several short chat sessions, with insights being collected through surveys, interviews, focus groups, and comparative data analysis.

A feasibility trial will compare the LLM AI-delivered ADI-R to the traditional ADI-R. Approximately 70 learners suspected to have autism without intellectual disability and their respective caregivers will be selected. For both studies, gender, race, ethnicity, and socioeconomic diversity will be prioritized. The learners will be randomly placed in either the LLM AI ADI-R group or the conventional ADI-R group. Given the accessibility and interface familiarity of LLM AI ADI-R, up to 10 stakeholders per learner will be invited to participate in the LLM AI ADI-R group. Outcomes will be measured continuously from baseline data collection until the trial's conclusion. Both ADI-R scoring and qualitative participant and stakeholder evaluations will be evaluated to demonstrate the LLM-AI ADI-R's efficacy in improving diagnostic pathways.

EXPECTED RESULTS

This study would have several expected outcomes:

The LLM AI-based ADI-R should meaningfully improve the qualitative results of diagnostic pathways for individuals with autism without intellectual disability. Specifically, the PPV of the LLM AI-based ADI-R should be at least equal to the conventional ADI-R with a higher NPV for learners who are female, of color, or from diverse socioeconomic backgrounds. The chatbot-based assessment process is expected to provide at least the same sensitivity rates as the conventional ADI-R with higher sensitivity rates for learners who are female, of color, or from diverse socioeconomic backgrounds.

Compared to the lengthy conventional clinician-curated ADI-R process, the LLM AI-based ADI-R interviews should be much easier, naturally conversational, intuitive, and engaging for caretakers. High rates of acceptance, adoption, and willingness to continuously interact with the chatbot would support its suitability as a platform and conduit to continually enhance and evolve Autism diagnostic pathways, assessments, and interventions over time.

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External Fine Motor Markers of Neurodivergence: Pilot Results of the TangiBall

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ABSTRACT

At two previous ICDVRAT conferences (2018, 2022) the authors reported on the concept, and then development phase of a tangible toy that could be used to assist in the diagnosis of autism in pre-school children. Here, results of the first round of testing on the intended user group are reported. Results show variation between pre-school neurodivergent and neurotypical populations as predicted in terms of speed and accuracy of movement. Fine motor movement can be a potential biomarker for autism that would be less dependent on observational data, and more objective.

1. INTRODUCTION

Autism is a challenging diagnosis to make in children, especially those who are primary school age and those who are pre-school with an unclear cluster of symptoms. Children who receive diagnoses quickly are generally either severe and with intellectual disability, or extremely clear in presentation (Abrahamson et al., 2021). Original diagnostic descriptors that pre-date both the World Health Organisations International Classification of Disease (ICD), and the United States Diagnostic and Statistical manual of Disorders (DSM) of Grunya Sukhererva in the Soviet Union in the late 1920s suggest that children with autism have additional disorders in motor function as well as in social communication (Sher & Gibson, 2021). These additional areas currently manifest in the manuals as interoceptive, sensory impairment, and even as emotional regulation problems rather than as disorders with origins in divergent proprioceptive and receptor activity (Torres et al., 2018; Torres et al., 2013; Torres & Denisova, 2016). The single biggest problem with autism diagnosis is in the agreement on presentation, and the majority of diagnostic tools have either relatively poor sensitivity or specificity, resulting in a national screening programme in the United Kingdom being repeatedly dismissed (UK National Screening Committee, 2022) . Subjective Observational Inventories (SOIs) e.g., Autism Diagnostic Observation Schedule, result in there being no single clear biomarker for autism (Bokadia, Rai and Torres, 2020) .

2. METHOD

2.1. TangiBall

The TangiBall is an attempt to look at a singular external marker - fine motor activity - to see if this aligns with variation between neurodivergent populations and neurotypical presentation. Fine motor activity in this feasibility pilot study was detected through the insertion and removal of a jack into a hole which is locked into place with a shape indentation (see figure 1). TangiBall is a hub toy of 12 faceplates (see diagrams 1 below). Speed and accuracy of insertion were measured with LEDs, sensors, an SD card, and a microcontroller. Sensor faceplates have a unique shape point on the surface, and correct shape insertion elicits the hub to light-up and then a “reward” sound is played. Accuracy is determined by how easily a child can find the correct insertion faceplate, and speed refers to how fast the peg is inserted into the faceplate once the correct shape is identified. Each input peg provides movement time in milliseconds in real time, and an analogue to digital convert number (ADC) which can be

converted into voltage for data processing. Data was stored in basic .txt format in the SD card within the hub housing. When raw data of time versus voltage is graphed, this produces gradient curves showing insertion, removal actions of the child, as well as activity whilst just holding and turning over the hub.

2.2. Participants

The study was given NHS Research Ethics clearance in February 2022. Children with a diagnosis of autism, or suspected autism were recruited from one single NHS trust in the South of England, after an approach by a known clinician. Information was then passed to the research team to recruit and consent. Five children with autism and five children who have never had any contact with child development services were recruited to the study. Children played with the TangiBall between June 2022 and March 2023 when the project closed. All children played with the TangiBall long enough for there to be a registered result. On average 5 minutes of interactive play produced around 10,000 lines of data.

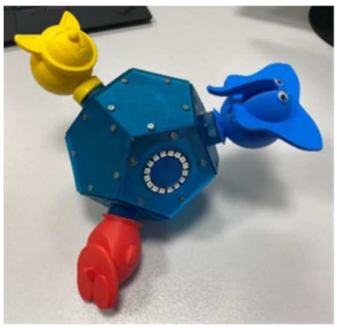

Figure 1 *TangiBall prototype*

3. RESULTS

3.1. Quantitative Findings

Five children with autism and five controls played with the TangiBall between June 2022 and March 2023. Mean age in both groups was Autism, 41.24 months, and Controls, 49 months. Average insertions and removals by children with autism indicated less control than the control group (average voltage Autism, 518v). A child's ability to smoothly insert and extract the tangible peg into the correct hole showed that the autism group were less controlled than the neurotypical group (voltage Autism, 077v, and Control, 0.12v, SD). This is consistent with previous literature. Children with autism also played with the object for a shorter amount of time than control peers overall (width ms average, autism, 5348 milliseconds, SD 8532ms, control 6755ms, SD 6429ms). Autistic children were showing less smooth insertion, and also playing for less time overall. Overall Lempel-Ziv complexity of baseline scores showed variance even when children were just playing with hub and not inserting or removing insertion pieces (autism 0.71, SD, Control 0.69). Even when the hub was not fully engaged with utilising insertion pieces, autistic children showed interest in the hub marginally more than control group children.

4. CONCLUSION

This work aimed to explore the viability, integration and acceptability of data gathered during interactions that are ecologically sound e.g., for children that would most likely be with objects such as toys or during play situations and are potentially clinically useful. Data collected in a smooth and uninterrupted manner whilst engaging with professionals is paramount. Currently, data that could be gathered from children as they interact naturally is only harnessed through recall and observation. The ultimate problem is with subjective observation, and this was an attempt to begin to automate the process. With the rise of the neurodiversity civil rights movement, there is also a clear delineation required between those who are neurodivergent – that is that have a condition that impairs social functioning and requires clinical diagnosis or support, and the neurodiverse, those within the normal distribution in a population.

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Through The Eyes of An Autistic Child: The Role of Technology and Autistic Researchers in Developing Interventions

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ABSTRACT

Children with Autism Spectrum Disorder often attempt to supress certain characteristics associated with the condition (known sometimes as "masking") in order to avoid negative social experiences. When done for a long period of time, this can result in meltdown and burnout, which can come as a surprise to caregivers, and often they report struggles in being able to manage these episodes. In this paper, we outline the results of preliminary research, including structured interview and thematic analysis thereof, with the intent to create a Virtual Reality intervention to aid caregivers in anticipating and managing meltdowns and burnout.

1. INTRODUCTION

Autism is a heterogeneous condition clinically characterised by observable social and communication challenges, and repetitive and restricted behaviours and interests (American Psychiatric Association, 2022). These characteristics however may be habitually suppressed or hidden by autistic children to avoid negative social experiences such as being mocked for being different, leading to internal conflict and stress (Howe et al., 2023). Many caregivers and most teachers are not aware of this process. They would only notice behavioural problems, meltdowns and burnout, which are in fact the cumulative consequences when an autistic child could no longer suppress or control themselves (Chapman et al., 2022). Understanding this process and its different consequences depending on whether stress is noticed and dealt with by caregivers and teachers will help them learn to anticipate and prevent behavioural problems, meltdowns and burnout in autistic children. This learning effect should be mutually beneficial to both adults and autistic children as well as their relationships.

Virtual reality offers an immersive and interactive experience that allows end users to feel the presence of the virtual body and attempt to control actions in the digital space in real time. Although the process of suppressing and hiding the authentic self to internal conflict and stress is covert, it may be understood with the help of virtual reality by allowing end users to take the perspectives of an autistic child. Pervious studies showed that taking the perspective of an autistic child via virtual reality could promote empathy, helping intentions and positive attitudes towards autistic children (Camilleri et al., 2017; Koniou et al., 2023; Sarge et al., 2020). There has also been studies using virtual reality to facilitate skills acquisition in autistic children (Kandalaft et al., 2013). However, there has not been any studies using virtual reality to facilitate perspective taking and skills acquisition in caregivers and teachers of autistic children. Simulated scenarios of real-life situations that can be repeated and accommodate different experiences depending on end users' choices of actions may allow caregivers and teachers of autistic children to acquire different perspectives, skills and strategies that may be beneficial to their interaction with autistic children. Therefore, this project co-designed a virtual environment experience with three different stakeholder groups to facilitate adults' understanding of autistic children's everyday experience.

2. APPROACH

A series of three semi structured open ended focus group discussions were conducted with participants from diverse backgrounds. The participants consisted of three groups of stakeholders: (1) autistic adults who self-reported as having a diagnosis of autism spectrum disorder (ASD); (2) autistic parents who self-reported as having a diagnosis of ASD and having a child who also has a diagnosis of ASD; and (3) parents who self-reported as having a child who has a diagnosis of ASD. All three groups had 4 participants.

Common eligibility criteria across the three groups included: (1) aged 18 years or older; (2) English speaking; (3) comfortable to participate in online discussion and have access to the internet.

Based on the above thematic analysis, the research team will develop and deliver an interactive script. This script will then be translated into a fully realised Virtual Reality application, to be developed in Unreal Engine, with the utilisation of their Metahuman Creator and Animator framework where appropriate. Appropriate technologies, such as motion captured acting, will also be utilised where appropriate and feasible.

3. RESULTS

Reflexive thematic analysis with an inductive approach was used to analyse the qualitative data using the six step method described by Braun and Clark (2012): (1) familiarizing oneself with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) refining and naming themes, and (6) writing up the analysis. The data analysis generated three main themes and multiple subthemes, as follows:

1. Universal lack of understanding and acceptance
    a. Impact on the Child
    b. Impact on the Parents
2. Universal Need for Awareness and Understanding
    a. Positive impacts thereof
    b. Understanding Autism
    c. Need for a collaborative approach
3. Preferences for the Style of the VR experience
    a. Hearing inner thoughts of the child
    b. Hearing changes in breathing
    c. Demonstrating variabilities over stereotypes
    d. Presenting autism-specific understanding and strategies

We are currently continuing with designing and preparing the virtual environments, before continuing with acceptance testing amongst prospective users of the application, as well as having the experience be potentially reviewed by the co-design team. The primary developer of the experience has a confirmed diagnosis of ASD as well, and has been involved in the co-design sessions – though they are naturally also taking care to only complete the experience as specified. Nonetheless, they are working closely with the remainder of the team to ensure that the experience is as beneficial to the end users as possible.

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Online Course for Autistic Adults: Usability Study and Participatory Design

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ABSTRACT

This paper explores the development process of an online course for autistic adults. Three studies were conducted: usability study, participatory design study, and pilot evaluation study. Key findings emphasize the importance of customization of the presentation of information, clarity in instruction delivery, mitigation of distractions, and motivation enhancement during possible challenges. Insights highlight the need to accommodate unique perceptual traits, adapt instructions, foster a clear learning environment, and address possible challenges sensitively. These findings inform the design of effective online courses tailored for autistic adults.

1. INTRODUCTION

As part of the development process for an online learning course designed to identify and raise awareness of strengths among autistic adults, three studies were conducted: a usability study, a participatory design study, and a pilot study. These investigations were undertaken to ensure that both the program content and interface were adapted to the specific needs of autistic adults (Oswal, 2019). The goals of the usability study were twofold: to test whether users could navigate the interface independently and to adjust the interface design and instructional descriptions to better suit the communication and sensory preferences of autistic adults. The participatory design study then aimed to evaluate the design components within the Moodle interface used in the Good-Word (Mila Tova) course and to tailor the course content to the unique learning characteristics of autistic adults. Following the implementation of modifications informed by the participatory design study, the pilot study was conducted. The primary objective of this final phase was to assess the technical functionality of the complete course and the participants' experiences during the course.

2. METHODS

2.1. Study 1: Usability Study–Design principles in an online course for autistic adults

Three autistic adults participated in this study, which focused on evaluating a prototype interface for an online course: Participant 1: 55-year-old woman, PhD student; Participant 2: 55-year-old man, secondary education; and Participant 3: 37-year-old woman, master's degree. The online course prototype was constructed using the Figma website (https://www.figma.com) and comprised six interfaces (see, for example, Fig. 1). Subsequently, interviews were conducted to elicit feedback on interaction with the interface. The data analysis involved a thematic review of the interviews, guided by the conceptual framework of Universal Design for Learning (UDL) outlined by CAST (2018).

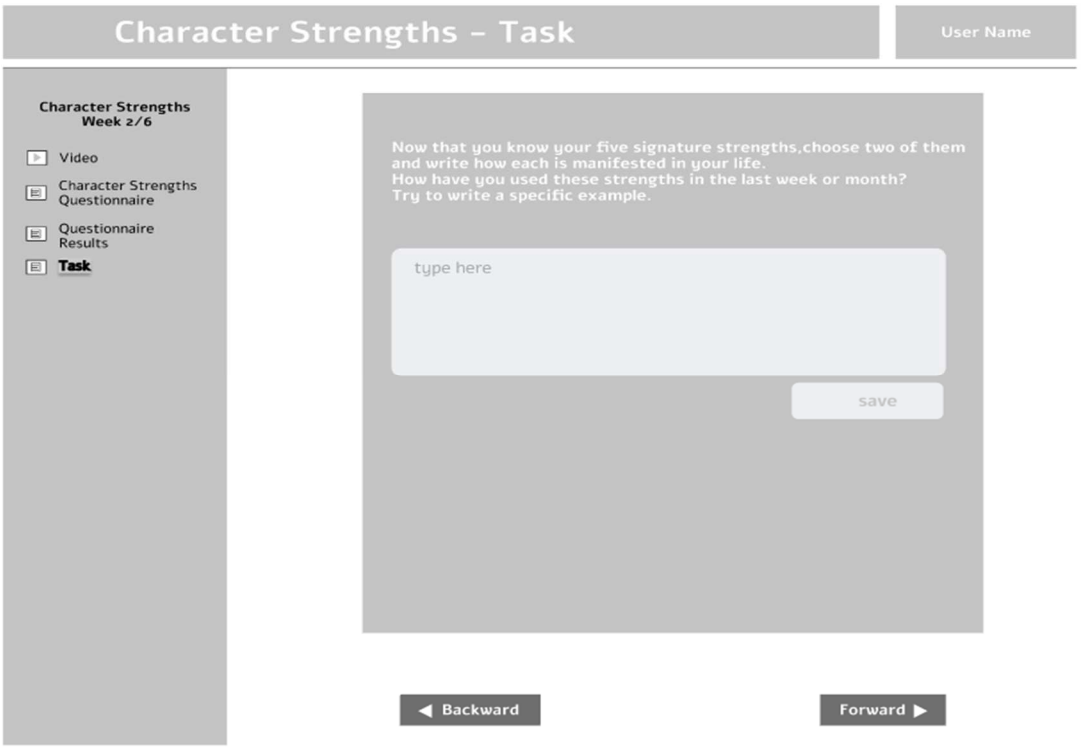

Figure 1 *The character strength task interface.*

2.2. Study 2: Participatory design in Moodle

Two participants from the initial study continued in the follow-up study, which focused on evaluating an online course on the Moodle platform. The course comprised eight study units and a summarization unit. Within each unit, participants examined the activities presented, including questionnaires, diary, and tasks. Participants were encouraged to pinpoint challenges, sources of confusion, or potential improvements. All data collected from the interviews then underwent thematic analysis, guided by the conceptual framework of UDL (CAST, 2018).

2.3. Study 3: Complete course pilot study

A 29-year-old autistic woman with a bachelor's degree participated in the pilot study, following the complete online course on Moodle. The participant engaged independently with the course materials for two months. An interview then examined her experience with the course. The data analysis consisted of thematically reviewing the interview, guided by the UDL framework (CAST, 2018).

3. RESULTS

3.1. Study 1: Usability Study–Design principles in an online course for autistic adults

Following the CAST (2018) framework of UDL, we found three main categories in the data analysis: (1) offer ways of customizing the display of information: participants addressed aspects such as font size, font colours, and background colours; (2) clarify vocabulary and symbols: participants raised clarifying questions regarding the instructions and questionnaire content; and (3) minimize threats and distractions: some participants mentioned experiencing uncertainty in certain interface areas.

3.2. Study 2: Participatory design in the Moodle system

Following the UDL framework (CAST, 2018), six primary categories emerged from the data analysis: (1) offer ways of customizing the display of information: participants articulated the necessity for visual adjustments in design to better suit their preferences; (2) clarify vocabulary and symbols: participants highlighted the ambiguity of instructions in certain questionnaires or tasks, emphasizing the need for unambiguous and clear guidelines; (3) use multiple media for communication: participants expressed a desire for diverse expression methods throughout the course; (4) optimize relevance, value, and authenticity: participants emphasized the importance of content

relevance for autistic women and their personal experiences within the course; (5) minimize threats and distractions: participants expressed the need for clarifications in various task components and program aspects to enhance clarity and mitigate feelings of pressure and anxiety; and (6) promote expectations and beliefs that optimize motivation: participants emphasized the need for additional instructions to enhance learning motivation in challenging tasks or questionnaires.

3.3. Study 3: A pilot on the complete course

Using the UDL framework (CAST, 2018) two primary categories emerged from the data analysis: (1) minimize threats and distractions: the participant highlighted factors that elicited a sense of threat, such as malfunctions on the Moodle website and questionnaire time constraints and (2) activate or supply background knowledge: the participant expressed a need for clarifications or explanations connecting various parts of the course.

4. DISCUSSION

The three outlined studies aimed to adapt the Good-Word (Mila Tova) online course for use by autistic adults. Key findings from these studies, significant for the development of online courses for this population, include:

1. The unique perceptual characteristics of autistic adults must be recognized. Various studies highlight distinct visual and auditory perception traits among autistic adults (Parmar et al., 2021; Sturrock et al., 2022). Consequently, it is crucial to offer options for text size, colour, background, audio speed, etc., to accommodate these differences.

2. Providing clear and direct instructions with concrete examples is important. Autistic individuals often have unique communication characteristics that may affect how they understand verbal instructions. Therefore, it is essential to customize instructions in a way that will contribute to their optimal understanding.

3. Reducing threats and distractions is essential for creating a safe and clear learning environment, which can help alleviate anxiety and improve learning outcomes. Employing strategies like consistent course structure and thorough task preparation are crucial practices in online courses designed for autistic adults.

4. Enhancing motivation for learning and handling challenging tasks. It is crucial to address tasks that may pose a challenge and to motivate individuals to respond to the best of their ability without feeling evaluated based on their performance.

In conclusion, these findings reveal insights vital to the development of online courses customized for autistic adults. These current studies are part of broader research that will examine the effects of the online learning course on identification and awareness of strengths for autistic adults. This research will include an additional 30-40 participants.

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Virtual Station: Virtual Reality as a Bridge to Independence in Public Transportation for Autistic Youth

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ABSTRACT

In this paper, we present a virtual reality application designed to prepare autistic children for independent use of public transportation. A virtual subway train station is designed to look similar to a real train station in Copenhagen next to a special education school. This extended abstract describes the VR intervention, the results of an explorative evaluation, and future iterations of the project.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) describes a range of neurodevelopmental conditions that can negatively affect day-to-day living skills, such as independent use of public transportation Lubin & Feeley (2016). These difficulties can reduce the quality of life and independence during childhood and adulthood of autistic individuals.

In Denmark, municipalities collectively spend approximately 1.4 billion DKK annually on the transportation of special needs students to and from schools Children and Youth Administration (2023). Specifically, the Copenhagen municipality alone allocated 78.2 million DKK in 2022 for student transportation, such as taxi services.

In this paper, we present a virtual reality (VR) simulation tailored to prepare autistic children and adolescents for independently using public transportation. The application is designed and evaluated in collaboration with a special education school in Copenhagen.

Figure 1 *Top: Valby train station. Bottom: Virtual Valby train station*

2. THE VR PUBLIC TRANSPORTATION TRAINING APPLICATION

The virtual train station is designed to look similar to "Valby Station," a subway train station next to "Freja Skole", with shops, benches, trash cans, ticket machines, and train departure and arrival information screens all being placed in the same place in the virtual environment as their real-world counterpart (see figure 1 and 2). This is done by

scanning the real station to get accurate size ratios that were then imported to unity. In the virtual station, the user is given the task of locating the train to a specific destination, finding out when the train comes, purchasing a ticket, walking to the correct track, and entering the train. The user can check the current destination using a virtual smartphone at all times (see figure: 2). If the user enters the correct train, the game will change to a victory scene, while entering the wrong train will result in a try again screen.

3. EVALUATION AND RESULTS

An explorative evaluation was conducted on one autistic child at a special education school in Copenhagen. The school is located right next to an S-train station. The participant was a 13-year-old boy who was on the taxi program financed by the municipality due to his inability to take the train. Two teachers conducted the study. After the VR session, one of the teachers followed the child to the real-world s-train station to see whether he was capable of purchasing a ticket and finding the train to his destination. The teacher reported her observations to the authors. At the station, the child went directly to the information screen and told the teacher that there were several trains toward Copenhagen Central Station. He then localized and walked down the to the correct track. After 15-30 seconds, he looks nervous and runs back up to the same information screen to make sure he is on the right track. This is despite the fact that there was also a screen at the track, which he did not use during his VR sessions and ran all the way back to the screen by the station entrance that he used during VR session. After this confirmation, he then used his travel card to "check-in" for his trip as he had done in the VR intervention. According to the teachers, he had not been able to perform these tasks on previous trips to the station. The following week, he went back to using the taxi service.

4. DISCUSSION & CONCLUSION

This explorative study shows the potential to prepare autistic children for daily living skills such as public transportation. The next itteration of the project will include the inside of the train experience, having to pick a spot to sit, talk to the ticket controller, and find out when to get off. A longitudinal study is planned with several students who have difficulties independently using public transportation.

Figure 2 *Left: The smartphone and the travel card. Right: The information screen*

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Enhancing Social Skills in Autism Spectrum Disorder: A Virtual Reality Intervention for Educational Settings

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ABSTRACT

In this paper, we explore the use of a Virtual Reality (VR) environment designed for special education teachers to enhance the social skills of children with Autism Spectrum Disorder (ASD).The effectiveness of this tool was preliminarily evaluated by European teachers during a Learning, Teaching, and Training Event under the Erasmus+ GAMESS project. Initial feedback from the participants, teachers from multiple European countries, indicates a positive attitude towards integrating VR in education, though some reservations about technology use were noted. The findings suggest that VR could be a supportive tool in special education for enhancing learning experiences and social interaction among autistic children.

1. INTRODUCTION

Autism Spectrum Disorder describes a range of neurodevelopmental disorders that can have a negative effect on the social, communication, and everyday living skills of individuals diagnosed with it (Lord et al. (2018)). Challenges with social interaction can negatively affect autistic children's peer interaction and school experience (Keen et al. (2016)). Several studies have shown the potential of using Virtual Reality (VR) interventions as a tool to work with the social and communication skills of autistic children (Bravou et al. (2022)). In this paper, we present a virtual environment designed to be used as a tool for special education teachers to work with the social skills of their students.

2. METHODS

The project involved creating a VR-based classroom consisting of a variety of social activities for teachers to perform with one or more students, with the purpose of training soft skills for autistic children. Upon entering the VR environment, the teacher and children can choose a 3D avatar to represent them visually. They can then enter a virtual classroom in which they can perform social activities together, including drawing on a whiteboard, solving basic math problems, building pizzas, and playing tic-tac-toe. The virtual environment was developed using the Unity3D engine, and the networking was implemented using the Photun Pun plug-in.

Target participants were European teachers attending a Learning, Teaching, and Training Event (LTTA) as part of the Erasmus+ GAMESS project. As part of the event, the virtual classroom was presented and subject to preliminary evaluation by the participating teachers. A questionnaire was developed to evaluate the teachers' views on the VR-tool for autistic individuals. The questionnaire included basic demographic information to describe the participants, followed by open-ended questions about the perceived usefulness, relevance, and their projected intended use of such a tool.

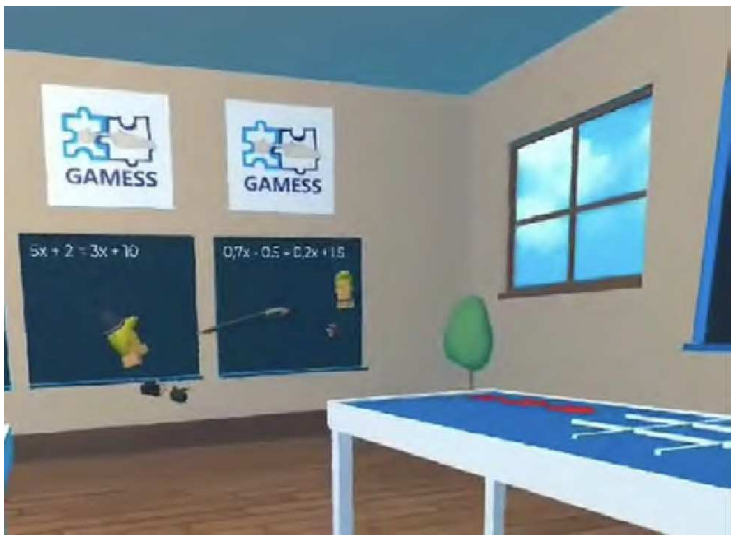

Figure 1 *The virtual classroom*

3. RESULTS

Participants (n=10) from Denmark, Finland, Spain, Croatia, and Cyprus filled out the questionnaire. Respondents were predominantly female (n=9), ranging from 22 to 47 years of age, and with teaching experience spanning 0-20 years. Most respondents (n=7) were familiar with VR, while only one of them had previously used it for teaching. Participants have an overall positive attitude towards incorporating technology into learning environment, stating that it can be a supporting tool that can enhance learning and create exciting experiences. However, the participants also have some concerns when incorporating technology, namely the usage of the technology. Here the participants mentioned that usage could be complicated, as the technology might just be used for fun rather than educational purposes, and cause an undesired dependency on the technology itself.

4. DISCUSSION

The respondents' attitude towards using technology in learning environments was overall positive, with a majority stating that it can be a supporting tool that can enhance learning and create exciting experiences. However, there were also concerns about incorporating technology. Overall participants would consider recommending or use the VR program in the further. They see it as a useful supporting tool for teaching and that it is necessary to teach autistic student modern technology.

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Metahumans: A Framework for Assessment and Feedback of Social Emotional Reciprocity

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ABSTRACT

Current assessment and training in regard to Facial Emotion Expression Recognition (FEER) indicates that deficits in mimicry or mirroring—nonverbal behaviours used for social communication and social interaction—are a major contributing factor to deficiencies in that ability in persons with Autism Spectrum Disorder (ASD) and Alexithymia. This paper proposes a testing and potential training framework that utilises modern games technology, namely High Realism Virtual Humans, combined with live motion capture to encourage and aid in self-assessment of mimicry, proposing that in turn this could address deficits in FEER, and improve quality of life for persons with ASD and alexithymia.

1. INTRODUCTION

According to DSM-5-TR, a diagnosis of autism spectrum disorder (ASD) always necessitates "Deficits in social-emotional reciprocity" and "Deficits in nonverbal communicative behaviours used for social interaction" (APA, 2022). Further, there is a significant amount of evidence to suggest there is a higher prevalence of anxious and depressive disorders, reflected through multiple studies (Hollocks et al., 2018). It is not unreasonable to suggest that this increased prevalence is directly related to the social deficiencies characteristic of ASD, especially since similar results are seen when specifically observing persons with alexithymia, or emotional blindness, a condition with high but not universal co-occurrence with ASD (De Beradis et al., 2008).

More recent studies have investigated the prevalence of mimicry regarding facial expressions and posture. According to Chartrand & Lakin (2011), neurotypical (NT) populations often engage in this mimicry, copying the facial expressions of persons they are nearby and are engaged with without any explicit direction, confirming older theories that these behaviours aid in social-cognitive development. In contrast, other research shows children with ASD do not engage in these behaviours as often and are more likely to not do so at all – and there is evidence to suggest not engaging in these behaviours results in a reduction in empathy and affiliation (Tunçgenç et al., 2023).

There is evidence to suggest that the lack of mimicry and ability to identify emotional expressions emerges from a difficulty in quantifying the emotions that persons with ASD observe. In a study by Tseng et al. (2014), two groups, comprised of those with a confirmed diagnosis of autism and those without, were given a task in which they were to utilise the Circumplex Model of affect (Posner et al, 2005) and rate facial expression images on a 2D scale of valence and arousal. While both groups used the entire span of the scale, persons with ASD typically gave more constrained responses. Although the effect became less severe with age, even when comparing NT to ASD adults, ASD adults were usually more constrained in their responses to valence.

This paper proposes a hybrid testing program that should provide potential users with both assessment and instantaneous feedback, assisted by High Realism Virtual Human technology (via the Unreal Metahumans framework) (Haddick et al, 2022) to potentially train and assess deficiencies in mimicking behaviour and emotional analysis, that can then be refined through codesign to create a useful application for a user group.

2. PROPOSED METHOD

To create the application, a number of Metahuman models will be generated by utilising the Mesh/Capture to Metahuman process available in current releases of Unreal Engine (Epic Games, 2022), creating lifelike models

of volunteer individuals. Then, a series of animations in which the models show an emotional expression will be generated, using naturalised prompts (for example, being shown content that the subject enjoys, or being provided with irritating stimuli, and so on). These models and animations will create the Testing Set.

The application will be personalised for each user by creating a Metahuman Model of the user utilising the same methodology. This will create the user's personal "mirror image".

The testing application will go through, in its first iteration, a three-step process for each test item.

1. Mirroring Phase – The user will be shown the emotional expression in question. Then they will be encouraged to replicate this expression as closely as possible. Their movements will be copied by their mirror image to assist in this process.
2. Original Evaluation – The user will then only be shown the original model, and asked to evaluate it – both on a standard scale of valence and arousal, and by labelling it with one of eight emotional terms (the standard 7 used by Ekman (1992), and neutral)
3. Self-Evaluation – Finally, the user repeats Step 2 with regards to their own duplication.

The outcomes of this self-evaluation methodology (comparing against the "expected" response, either as designated by a psychologist or by the intent of the prompt) may then be supplemented by artificial intelligence (AI) tools. For example, the facial expression provided by both the original model and the participant may be evaluated by an AI algorithm and assigned an emotional label, and a valence/arousal rating. This may then be further supplemented by a simpler algorithm recognising which Facial Action Coding System Action Units (Ekman, 1992) were engaged, and comparing the two in this manner as well, providing instantaneous feedback to the user.

3. RESULTS

The initial phase of testing will focus on proof of concept, verifying that the tool is useful, either to assess or train, and identifying the persons with which the application will be the most helpful. Once the tool has been verified as safe and useable by testing with Final Year Computer Science student volunteers studying at Nottingham Trent University, the application will be provided to a wider range of users. The relative results of these students, both in regard to their present performance on the application and the relative increase in performance as the test continues, will be used to inform decisions in regard to who to approach to involve in the codesign of later versions of this application.

In the long term, the goal is to co-design an application which can be utilised to assist in the development of both emotional mimicry and the quantification of emotional expression, and investigate if an improved understanding of these aspects aids in the development of social relationships, and in the very long term, investigating if this reduces the prevalence of Anxious and Depressive Disorders in persons with ASD and/or Alexithymia.

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Pain & Palliative care

The session on Pain and Palliative Care explored the innovative use of VR to enhance patient comfort, manage pain, and reduce anxiety. Research presented included trials on VR interventions for children with life-limiting conditions, showing reduced anxiety through immersive experiences. Comparative studies in burns treatment highlighted the benefits of high-immersion VR in providing pain relief. A systematic review underscored the diverse applications of VR in palliative care, emphasising its adaptability for personalised treatment. Additionally, biophilic VR therapy was introduced, focusing on nature-inspired environments to alleviate existential distress and enhance emotional well-being in care settings. Overall, VR shows significant promise in improving quality of life in palliative care contexts.

The use of experiential VR to minimize anxiety in children with life limiting condition: A Randomized Control Trial

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ABSTRACT

This randomized controlled study involved children (N = 18, ages 10-18) with hemato-oncological or gastroenterological conditions. They were assigned to two groups: one receiving experiential VR intervention and the other, a video intervention followed by VR. Anxiety, pain, and fear levels were assessed before and after the interventions. The findings suggest that VR is effective in reducing anxiety. Moreover, the VR is favoured over video distraction among participants who have experienced both interventions. Most children found distraction helpful and expressed willingness to use VR repeatedly.

1. INTRODUCTION

Children with life-limiting illnesses often have to face frequent hospital stays and many uncomfortable procedures as part of their treatment. All of this can lead to increased levels of anxiety and, as a result, impaired mental well-being (Barker et al. 2019). To alleviate these issues, non-pharmacological interventions like immersive virtual reality (VR) are being explored alongside conventional treatments (Dingley et al., 2021). Immersive virtual reality is a type of computer-generated environment that creates a realistic impression that the person is actually in a virtual world (Eijlers et al., 2019). The use of VR in the paediatric population has been shown to be an effective anxiety-reducing intervention for a wide range of medical procedures (e.g. Eijlers et al., 2019). Most of the randomised controlled trials published so far compare VR with standard care, a situation where the patient receives standard medical care without additional intervention methods e.g. (Gerceker et al., 2021). This limitation is reflected in the presented study by comparison with another intervention method explored in other studies (e.g. Tennant et al.,2020). Additionally, the ethical impact on participants who would not have received the VR intervention was considered by ensuring all participants experienced the VR intervention in the second session.

The aim of this study was to assess the effectiveness of VR intervention compared to other distraction method in the form of a video with experiential topics corresponding to VR programs, e.g. ocean world, travel to Antarctica etc.

H1: VR intervention is an effective distraction method for reducing anxiety/pain/fear levels.

H2: VR intervention is more effective than the video distraction method in reducing anxiety/pain/fear levels.

2. METHODS

The presented research project was designed as a randomized control study using pre and post measurement of observed constructs: anxiety, pain, and fear. Participants (N = 18, age 10-18) with hemato-oncological or gastroenterological conditions were recruited by opportunity sampling. These conditions, hemato-oncological and gastroenterological, were selected because they are life-limiting and require extensive, ongoing medical treatment. This makes the affected children suitable candidates for the interventions. The mean age of the sample was 14.39 years (*SD* = 2.20). In total, 8 girls and 10 boys participated in the study. The kids were randomly assigned to an experimental group with experiential VR intervention (two sessions +14d apart, based on the medical plan of the child) or a control group with Video intervention followed by VR intervention in the 2nd session. The protocol lasted approximately 35 minutes, 10 min. for the pre-questionnaire, followed by 10-15 minutes of VR or Video distraction intervention, and after that there was post-questionnaire for 8 min. The protocol was carried out during chemotherapy in hemato-oncology patients and infusion administration in gastroenterology patients. Children's level of fear and pain were measured by Children Fear Scale (CFS, 1-item visual scale), Child Medical Fear Scale (CMFS, 17 items questionnaire), and Wong-Baker Faces Scale for pain (1-item visual scale). Scale measuring anxiety in children (Czech "SAD-R", 17 items questionnaire) was used to observe the level of anxiety before and after the intervention. Furthermore, Simulation Sickness Questionnaire (SSQ) and non-standardized items focusing on the previous experience with VR, and subjectively perceived levels of fun, immersion, and ability to concentrate were also evaluated after the intervention. The research was approved by the Ethics Committee of the University Hospital in Motol (EK - 667/22).

3. RESULTS

A total of 18 children were enrolled of whom 15 finished the whole study with 2 sessions (three could not participate in the second session because of a changed medical plan). Due to the characteristics of the sample (e.g. small sample and non-normal distribution), non-parametric statistical methods such as Wilcoxon signed-rank test and the Mann-Whitney U test were used for data analysis.

The main results of the study suggest that: 1) VR is an effective distraction method for alleviating anxiety in pediatric population, no significant changes were found in fear and pain (see Table 1.), 2) children benefited similarly from Immersive VR and a video intervention, with no significant differences in child outcomes (Anxiety: $Mdn = 17$ (for exp. group), $Mdn = 20.5$ (for control group), $U = 41.50$, $p = 0.572$, $r = 0.038$, Fear: $Mdn = 0$ (for both exp. and control group), $U = 39.00$, $p = 0.468$, $r = -0.025$, Pain: $Mdn = 0$ (for both exp. and control group), $U = 42.50$, $p = 0.622$, $r = 0.063$), 3) VR intervention ($Mdn = 3.00$) was rated as more enjoyable compared to video distraction ($Mdn = 2.00$) by participants who experienced both interventions, $z = -1.826$, $p = 0.036$, $r = -1.00$.

Other important results show that the majority of children in the study: a) wanted to be distracted during the medical procedure (91 %), b) believed that the distraction helped alleviate their anxiety during the procedure (73 %), c) would like to use VR repeatedly (88 %), and d) rated the system as easy to use (96 %).

Table1. Wilcoxon signed-rank test comparing the amount of anxiety, fear and pain before and after the intervention procedure in the experimental group in both sessions.

Measure	Session	Pre M (SD)	Post M (SD)	W	z	p	r
Anxiety	**VR1**	**26.9 (14.12)**	**24.2 (14.22)**	**39.00**	**1.955**	**0.028**	**0.773**
	VR2	**17.9 (15.32)**	**16.6 (14.29)**	**10.00**	**1.826**	**0.049**	**1.000**
Fear	VR1	0.40 (0.52)	0.10 (0.32)	6.00	1.604	0.074	1.000
	VR2	0.43 (0.53)	0.29 (0.4 9)	4.00	0.535	0.386	0.333
Pain	VR1	0.70 (0.82)	0.50 (0.71)	10.00	0.674	0.286	0.333
	VR2	0.86 (0.90)	0.57 (0.79)	3.00	1.342	0.173	1.000

Note. Measure column shows the three components of distress – anxiety measured by Scale Measuring Anxiety in Children - Short Version, fear measured by Children Fear Scale, and pain measured by Wong-Baker Faces Visual Analog Scale.

a)VR group had VR distraction intervention in the first session as well as in the second session.

4. DISCUSSION

The study investigated the effectiveness of using VR as a distraction intervention compared to passive video viewing. Video and VR differ as distraction interventions beyond interaction. Video engages visual and auditory senses on a flat screen, whereas VR offers a deeply immersive, multi-sensory experience that can evoke stronger emotional responses and enhance distraction effectiveness. The results of the study outline that VR has proved to be an effective method for alleviating anxiety. Children gain comparable benefits from immersive VR experiences and video intervention. Children with experience of passive video viewing rated VR as more entertaining. Interestingly, children had difficulty distinguishing between the immersive nature of VR and the enjoyment derived from the experience itself. Several limitations were noted, including a small sample size, unexpectedly high engagement with the video intervention among the control group, potential bias in self-assessment due to social desirability, and the narrow age range (10 and older) of participants. Future research could benefit from including younger children to broaden these findings. This study underscores the importance of distraction for children undergoing medical procedures, with VR serving not only to fulfil their desire for distraction but also to mitigate negative psychological effects associated with such procedures. The findings provide valuable insights for further exploration in this area of research.

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Virtual Reality in Burn Treatment: A Comparative Study to High and Low Immersion Approaches on Pain and Anxiety Relief

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ABSTRACT

Virtual Reality (VR) interventions have emerged as a significant tool in medical treatments, particularly in reducing pain and anxiety during burn dressing changes. This study examines the effects of different VR immersion levels on pain (NPRS), anxiety (BSPAS), and presence (IPQ) during these procedures. We recruited 67 adult participants and randomly assigned them to either an experimental or a control group. The experimental group was subjected to a high-immersion VR environment known as Cold River, whereas the control group was exposed to a low-immersion environment featuring static images. Additionally, both groups underwent a dressing session without any VR intervention in a randomized design. Our findings indicate that VR, regardless of immersion level, significantly reduced pain and anxiety as compared to the non-VR condition.

1. INTRODUCTION

Pain is an unpleasant sensory and emotional experience that is often associated with tissue damage, whether actual or potential. A significant number of burn injury participants are subjected to repeated painful treatments (i.e., procedural pain) like wound debridement, dressing changes, and limb mobility exercises (Phelan et al., 2023). Intense acute pain during a participant's hospitalization can hint at subsequent psychological challenges post-discharge.

Virtual reality (VR) has been found to be a potent tool in alleviating both acute and chronic pain, as highlighted by recent studies (Georgescu et al., 2020). Studies indicate that the primary cause of pain relief in participants undergoing wound care is distraction (He et al., 2022). The efficacy of VR in reducing pain and anxiety in participants, has been proven (Farzan et al., 2023).

Consequently, our hypotheses for examining adult participants are:

H1: Participants experience lower levels of pain and anxiety when VR is utilized compared to the non-VR condition.

H2: The reduction in pain and anxiety occurs regardless of whether high- or low-immersion VR is employed.

H3: High-immersion VR is more effective at reducing pain and anxiety levels than low-immersion VR.

Beyond the stated hypotheses, we compare subjective ratings of presence, immersion, and interactivity in high- or low-immersion VR participant groups.

2. METHODS

We enrolled 67 adult participants from the University Hospital Královské Vinohrady in Prague, dividing them based on their informed consent order into experimental and control groups. Participant demographics showed an age range of 18 to 74 years, with an average age of 46.46 (SD = 14.61). The mean duration of the VR experience was 17.26 minutes (SD = 7.22). We used the HTC Vive Pro EYE HMD. Each participant underwent two dressing sessions, with a segment of each incorporating immersive VR. The experimental group was subjected to a high-

immersion VR environment known as Cold River, whereas the control group was exposed to a low-immersion environment featuring static images. Additionally, both groups underwent a dressing session without any VR intervention. We employed a repeated-measures crossover design.

3. RESULTS

Our findings indicate that the use of VR, regardless of immersion level, resulted in a significant decrease in pain $t(198) = 4.88$, $p < .001$, $\delta_T = .46$ and anxiety $t(198) = 5.15$, $p < .001$, $\delta_T = .45$ as compared to the non-VR condition. Notably, while there was no substantial difference in pain $t(197) = 0.03$, $p = .979$ or anxiety $t(197) = 0.89$, $p = .375$ between the two VR immersion types, the high-immersion environment amplified the sense of presence, encompassing general presence, spatial presence, and involvement.

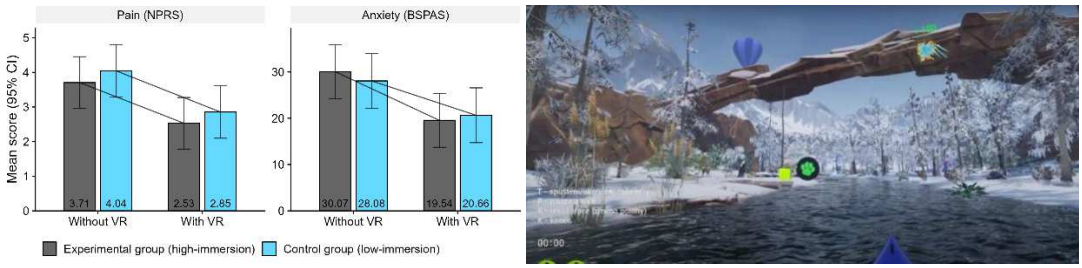

Figure 1 and 2 Investigating pain and anxiety in low and high-immersive VR environments versus non-VR using the Cold River app (see www.vrburns.eu for more information)

4. DISCUSSION

Virtual reality proves to be a valuable tool in reducing pain and anxiety associated with dressing changes in participants. It's particularly noteworthy that, while there was no significant difference in pain or anxiety levels between the two VR immersion settings, the high-immersion environment enhanced the sense of presence, including aspects of general presence, spatial presence, and involvement. This suggests that, beyond the general benefits of virtual reality in alleviating pain and anxiety, the degree of immersion can further enhance the participant's experience during medical procedures.

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Preliminary results of a systematic review of the use of virtual reality in palliative care

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ABSTRACT

Virtual reality (vr) has shown its potential in a variety of clinical applications. This systematic review aims to analyze vr studies conducted in pediatric, adult, and geriatric palliative care. Using covidence software, the screening process included 1005 records. After the independent review of the records, only 40 studies met the inclusion criteria. The preliminary findings before the final extraction process indicate that vr is a flourishing field in palliative care. The studies will be reviewed in the context of outcome measures and the type of vr intervention used, evaluating its feasibility, acceptability, and clinical efficacy.

Keywords: Virtual reality; Palliative care; Pediatric; Adult; Geriatric; Pain; Anxiety

1. INTRODUCTION

Virtual reality (VR) is a technology that has proven its effectiveness in the management of somatic and psychological symptoms in different health conditions (Martin, 2022). With increasing portability and affordability, VR has been used to reduce pain, depression, and anxiety (Mo, 2022). In palliative care, studies have addressed its usability, feasibility, acceptability, likeability, preferences, and perceived benefits with few to no adverse reactions (Moloney, 2023). The objective of this study is to systematically review the evidence of VR in pediatric, adult, and geriatric palliative care.

2. METHODS

The systematic review was conducted in five databases including Embase, Web of Science, MEDLINE, CINAHL, and PsycINFO (PROSPERO registration number CRD42024522413). Studies were selected with the following eligibility criteria: a) studies conducted in children, adults, or older adults, b) any life-limiting disease requiring palliative care, c) studies with family caregivers, individuals in palliative care, healthcare professionals, or palliative care staff, d) the use of immersive, semi-immersive or immersive VR, e) training or therapeutic purposes in palliative care, f) qualitative, quantitative, or mixed studies, and g) studies conducted at home, in the laboratory, or a hospital setting. The authors rejected studies based on exclusion criteria: a) studies in non-

palliative care services (e.g., surgery, non-terminal medical illness, dentistry, among others), b) studies not using VR technology, c) opinion papers, d) letters to the editor, e) conference abstracts, f) reviews, and g) descriptions of a VR technology not tested in a real setting. The search was performed from inception to November 2023.

3. RESULTS

A total of 1005 studies were identified and classified using COVIDENCE software (*Embase* = 450; *Web of Science* = 217; *MEDLINE* = 175; *CINAHL* = 101; *PsycINFO* = 62). A total of 349 studies were duplicates, of which 20 were identified manually and 329 by COVIDENCE. Of the remaining 656, 68 studies were retained for extraction following title and abstract screening by two independent reviewers. After full-text screening, 28 records were excluded mostly because they corresponded to conference abstracts. Of the 28 abstracts excluded, 42.9 % corresponded to the use of VR for chronic health conditions (e.g., Parkinson's Disease and Dementia), 28.6% to VR interventions for adults in palliative care, 21.4% to the use of VR to train medical students or healthcare professionals, 3.6% to VR interventions for family caregivers of individuals in palliative care, and 3.6% to VR interventions for children in palliative care. Most of the abstracts excluded and published in the proceedings of scientific conferences (n = 28) comes from the United Kingdom (32.1%) or other European countries (32.1%), the United States of America (25%), Canada (7.1%), or other countries (3.6%). At the final stage, a total of 40 studies were retained for the final extraction phase. The review process is depicted in Figure 1.

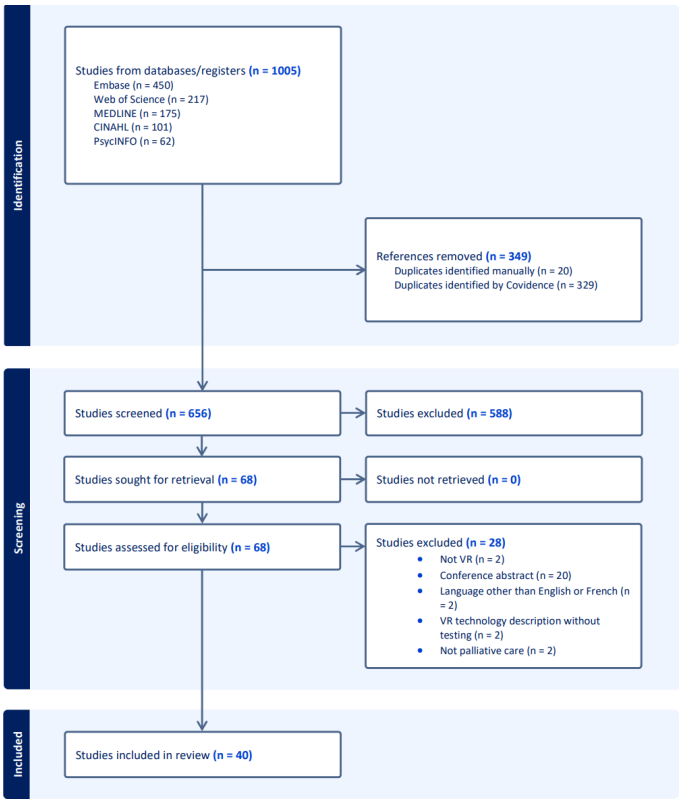

Figure 1 *PRISMA flowchart*

4. DISCUSSION

The use of VR in palliative care is growing and we anticipate that with more affordable and portable VR technologies, VR-based interventions will become increasingly used in end-of-life care. When we take into account the emerging research based on the abstracts that are published in the proceedings of scientific conferences, Europe seems to be leading the interest in developing VR interventions for both palliative care and chronic diseases. These preliminary results suggest that VR is an active research field in European countries. When we complete the data extraction and analysis of the remaining 40 records, we will be able to map the state of the art of VR in palliative care and we will be able to provide specific recommendations in this specific area of VR.

5. CONCLUSION

The preliminary results obtained will allow the scientific community to gain a deeper understanding of the efficacy of VR as a valid, safe, and useful non-pharmacological intervention for palliative care in children, teenagers, adults, and older adults. For each of the 40 records, the independent extraction will include the general publication data (i.e., author, year, and title), study design, objectives, setting, participants (e.g., sample size, mean age, sex, ethnicity, diagnosis, disease duration, demographic information for control groups (when available), VR intervention (i.e., name of the VR application, technical information, subjective and objective level of immersion, the number of VR sessions and frequency, length of each VR session, and VR overall mean duration), outcome measures, results, user acceptance, adverse effects, generalization, and the general conclusion. A narrative synthesis will be performed based on the categories of data extraction as follows: a) By population (i.e., pediatric, adult, or geriatric), b) by the final use of the VR technology (i.e., education, treatment, health promotion, entertainment), and by context (i.e., hospital, laboratory, or home setting). The systematic review of the remaining 40 studies meeting the inclusion criteria will also help to document the quality of the evidence and its use for therapeutic or training purposes in palliative care.

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Existential Biophilic VR Therapy – Developing a Protocol for Care Settings

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ABSTRACT

An intervention protocol to assess health and wellbeing from biophilic Virtual Reality interventions, was elaborated to include existential theories identified from a scoping review. Additionally, a pilot study in care facilities was employed to assess the protocol's feasibility. To comprehensively assess health and wellbeing outcomes for care home residents and individuals at end-of-life care, existential theories must be integrated. Meaning and purpose in life, agency, presence, legacy, and flow, are essential considerations for VR interventions in care settings and for maximising health and wellbeing outcomes. Finally, from the pilot study, existential aspects can effortlessly integrate within VR interventions, from the content creation to the research methods selection.

1. INTRODUCTION

Individuals in care facilities lack contact with the outside world, which is further compromised due to physical and sensory impairments. Additionally, existential, and spiritual distress become more prominent as human beings age, identified as common topics of discussion during therapeutic sessions (Suri, 2010). Hence, interventions which maximise health and wellbeing in care facilities are necessary for individuals at end of life (EOL). However, according to the Health Research Analysis Report (2018), EOL care is the least funded research area. VR biophilic interventions are essential for connecting people to the outside world when inaccessible.

Biophilia is defined as an innate affiliation to nature, as humans have evolved around it for most of their evolutionary history. Biophilia in the built environment fosters connections to nature through design applications to maximise health and wellbeing (Thomas, Xing 2021, Xing et al. 2024). Furthermore, a protocol founded on existential theories is required to maximise health and wellbeing outcomes from biophilic VR interventions. According to Frankle, life can still retain meaning even in difficult times, "the tragic triad: pain, death, and guilt" (Frankle, 2004, p. 139), and states: "a human being is not one in pursuit of happiness but rather in search for a reason to become happy" (Frankle, 2004, p. 140). Residents in care facilities and individuals at EOL require meaningful interventions, despite disabilities and sensory impairments.

The aim of the research was to develop a biophilic VR intervention protocol to include existential aspects identified from the scoping review. The objective was to assess the protocol's feasibility through a pilot study. Existential theories relate to meaning and purpose in life, presence (i.e. being in the now, flow) (Suri 2010), agency (i.e. lack of control in life) (Engelen et al. 2022) and legacy (impact) (Grewe 2017), which can readily be integrated within any VR intervention.

2. METHODS

Key themes identified from the literature and the pilot study will inform the final protocol for the main project. The scoping review on existential therapy and biophilia employed the ROSES protocol (Reporting Standards for Systematic Evidence Synthesis) to maintain transparency and reproducibility (Haddaway et al. 2018). Database searches included the Web of Science and Scopus in November 2023. As biophilic "Existential Therapy for Ageing Care" and "Biophilic Person Centred Therapy" received zero results; search terms were broken down into key terms "Existential Therapy" or "Humanistic Therapy" or "Biophilic Care Homes" and "Biophilic Care." 99 articles

were identified, and duplicates removed. Progressive steps were implemented to select the most suitable studies: exclusion criteria were applied to include studies from 2005 onwards, focused on both men and women and above 65+ age group or at EOL. A pilot study was employed to assess the protocol's feasibility, seven participants across two care facilities were invited to take part in a VR Biophilic Intervention.

3. INITIAL FINDINGS

The scoping review provided insights into key themes and concepts for a final protocol in preparation for the main PhD project. To inform the pilot study, thematic analysis was employed for the scoping review on Biophilic Existential Therapy, where 29 articles were analysed and categorised. Emerging themes included: meaning and purpose, agency, presence, and legacy. The findings from the scoping review revealed existential and spiritual distress are recognised as a major concern for individuals in care facilities (Van Der Vaart & Van Oudenaarden, 2018; Kellehear & Garrido, 2023). Additionally, presence has been employed as a powerful technique in existential therapy. Furthermore, VR content should reflect personal preferences to maximise effectiveness (Huang & Yang, 2022; King, 2023). Finally, VR interventions in care facilities which aim to assess impacts on health and wellbeing comprehensively, must include existential aspects within their study procedure.

The pilot study procedure included an initial managerial team meeting, an open day, and the creation of a Nature Preference Profile to inform the content, followed by two VR interventions in each facility. Personalised content provided meaning and purpose, and presence was reflected in the content creation through locality and time. As VR is highly immersive, it scores strongly for presence. Throughout the pilot study procedure, presence was key; active listening is required to create authentic and meaningful interactions. Focus groups can provide an ideal setting for participants to share ideas. Both legacy and agency can be included at all stages of a study (from personalised content to focus group discussions). Flow was observed in participants during the VR interventions, future research should include a flow questionnaire to assess the participant's engagement.

4. CONCLUSION AND FUTURE RESEARCH

This study identified key themes for the inclusion of existential aspects in VR interventions. A biophilic intervention protocol which includes existential aspects provides a comprehensive approach for its application in care facilities. Meaning and purpose, agency, presence, and legacy can readily be integrated within any study procedure or protocol, to maximise health and wellbeing. From content creation to the research methods employed, progressive steps enable participants to track developments in the study. Individuals from the 80+ age category, need to share their thoughts and have impact (legacy) in their lives. Finally, a focus group was identified as being a suitable research method in creating impact, improve acknowledgement and agency by enabling decision making. As VR is effective in replicating life like scenes (presence), when based on preferences it can enable flow states. Immersive technologies should assess engagement as part of the design process of all VR interventions in care facilities. Future research should focus on micro-flow activities and life satisfaction in care facilities (Csikszentmihalyi. 1988. p146). Adaptive learning systems based on the flow model have been developed to maintain the state of flow and reduce boredom in people with intellectual disabilities (Standen et al. 2020). Biophilic VR interventions should be assessed for engagement through a flow questionnaire. The protocol informed by the scoping review and the pilot study, will be employed as part of the main PhD project.

Schools of Art and Design, Arts and Humanities and Architecture, Design and the Built Environment Research Ethics Committee (AADH REC). Ethics application number: 1557295

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Cognition

The session on Cognition highlighted various studies leveraging VR for assessing and enhancing cognitive functions across diverse populations. Presentations covered the use of VR driving simulations to assess cognitive demands and predict driving risks, including for those with conditions like Multiple Sclerosis. Researchers explored tasks in virtual environments to measure cognitive decline in adults with intellectual disabilities and improve spatial navigation in older adults. The potential of immersive VR experiences was noted for enhancing attention in post-COVID-19 patients, while VR assessments helped profile cognitive abilities in elderly individuals. Tools like Meta Quest were tested for ADHD screening, and VR environments were developed for training cognitive flexibility in patients with Obsessive-Compulsive Disorder. Overall, the session showcased VR's versatile role in cognitive assessment, training, and rehabilitation.

Beyond Diagnosis: The Cognitive Demands of Stopping and Turning Behaviors Among Drivers With and Without Multiple Sclerosis and Implications for Driving Safety

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ABSTRACT

This study investigates the impact of multiple sclerosis (MS) and specific cognitive/motor functions on virtual reality-simulated driving behaviors, namely stopping and turning behavior, which are common sources of collisions. Findings suggest that while individuals with and without MS generally exhibit similar driving behaviors, subtle differences exist, especially for left-turns and complex intersections. Various cognitive/motor domains, including visuospatial ability and psychomotor speed, significantly influence driving behaviors across both groups. These findings emphasize the importance of taking cognitive and motor abilities into consideration when evaluating driving capability, underscoring road safety and independence for people with MS and the general population.

1. INTRODUCTION

Driving is a crucial everyday activity for many individuals, providing them with transportation, freedom, and even a means of living. Driving is also a challenging and dangerous activity that can be compromised by neurologic conditions that affect cognitive and motor function, such as multiple sclerosis (MS). Road collisions, which tend to occur at intersections involving stops and turns, are more common among people with MS (Schultheis et al., 2002). However, the precise impact of MS-related cognitive decline on intersection driving behaviors remains uncertain.

Virtual reality driving simulators (VRDS) are an invaluable tool for evaluating driving capacity and its cognitive demands. They enable safe, objective, and precise assessment of challenging driving situations (Schultheis et al., 2007). Moreover, VRDS performance is related to MS symptom severity (Raphail et al., 2020) and directly observed real-world driving behaviors (Devlin et al., 2024). This study used VRDS to

Aim 1: Investigate differences in stopping and turning behavior between adults with and without MS.

Aim 2: Identify cognitive/motor correlates of stopping and turning behaviors.

Aim 3: Assess whether MS influences these correlates.

2. METHODS

Participants were 85 adult drivers ages 21-60 (79.5% women, 64.8% White), including 48 people with MS (PwMS) and 37 healthy controls (HCs). Each participant underwent neuropsychological assessments evaluating driving-relevant domains: cognitive and motor speed (Symbol Digit Modalities Test, Trail Making Test A), executive functioning (Trail Making Test B), auditory working memory (Paced Auditory Serial-Addition Test), visuospatial attention (Useful Field of View), and visuospatial ability (Motor-free Visual Perception Test). Participants also completed a VRDS drive (Raphail et al., 2020), which included various driving scenarios involving right and left turns, as well as stop sign intersections with varying cognitive demands (high, medium, low). Stopping metrics included failing to stop, minimum speed, distance from the stop line, and wait time. Turning metrics included lane position, speed, braking, and acceleration before, during, and after the turn. Statistical analyses were as follows: **Aim 1:** ANOVA, Mann-Whitney U, chi-square, and Fisher exact tests were used to investigate differences in stopping and turning behaviors between PwMS and HCs. **Aim 2:** Pearson and Spearman correlations were used to identify cognitive and motor correlates associated with stopping and turning behaviors.

Aim 3: Linear and logistic regression analyses were used to assess the impact of MS on these identified correlates. Namely, cognitive/motor measures, MS status, and their interaction were entered as predictors of stopping and turning behaviors.

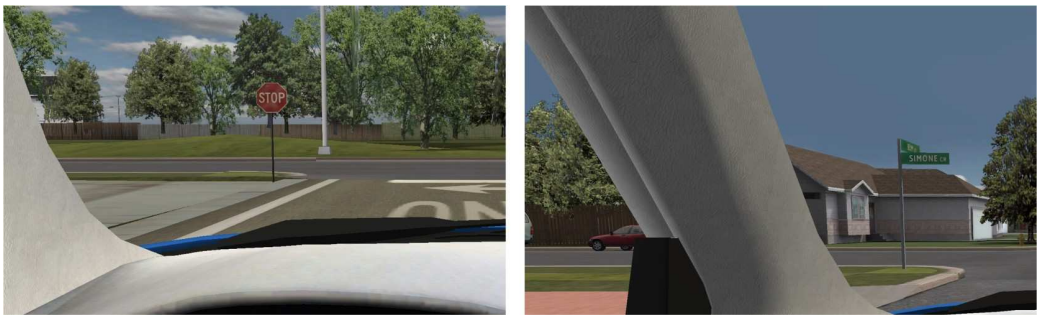

Figure 1 *Image of High Cognitive Complexity Stop and Left Turn in the VRDS.*

3. RESULTS

For Aim 1, group differences in stopping and turning behavior were minimal. HCs executed sharper left turns than PwMS, while PwMS stayed closer to the ideal turn line ($p=0.035$, $\eta^2=.08$). At the high-complexity stop, PwMS trended towards being more likely to stop after the line ($p=0.07$, phi=0.31).

For Aim 2, analyses revealed that weaker abilities in several domains were associated with less safe turning behavior. Namely, weaker visuospatial abilities, visuospatial memory, cognitive/motor speed, and time-based working memory were associated with increased lane position variability, sharper left turns, inappropriately slow speeds, and greater pre-turn acceleration. However, cognitive correlates of stopping behaviors were mixed; cognitive/motor weaknesses were sometimes associated with less safe stopping, and sometimes with safer stopping. Most notably, abnormal complex visual attention was associated with delayed stopping.

Lastly, for aim 3, most associations of cognitive and motor functions with stopping/turning did not differ by MS status. The rare exceptions were as follows: select associations between psychomotor speed/executive function and turning behavior were present only in the MS group, while the HC group drove more safely (e.g., more consistent lane position, faster speed) regardless of these abilities. Conversely, regarding working memory and turning lane position, worse working memory correlated with sharper left turn lane position in the HC group, while individuals with MS exhibited less sharp turns, regardless of working memory.

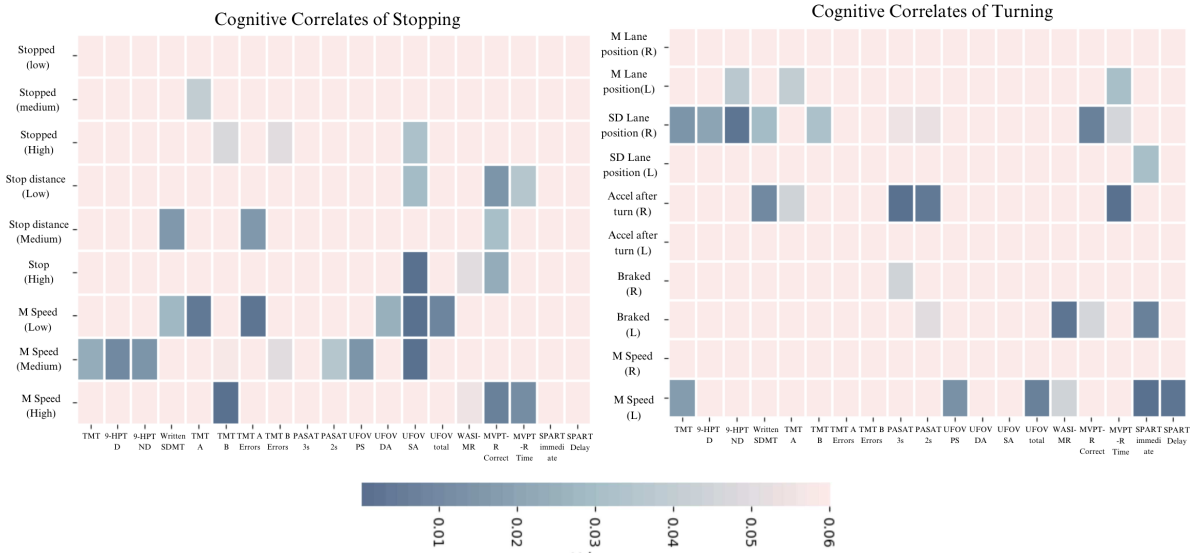

Figure 2 *Heatmap of Correlation Between Stopping and Turning Variables and Neuropsychological Assessments.*

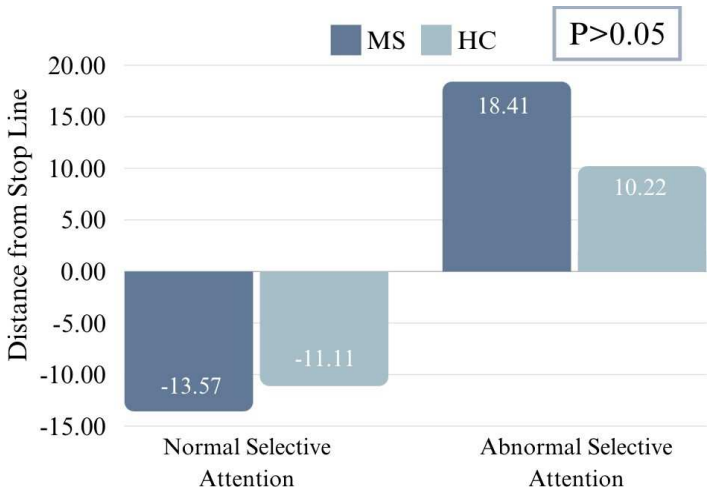

Figure 3 *No significant interaction between MS status X Selective attention: Abnormal selective attention was related to stopping after the line, regardless of MS status.*

4. DISCUSSION

Individuals with multiple sclerosis (PwMS) generally demonstrated similar driving behaviors to healthy controls, especially at challenging intersections. Notably, those with MS tended to approach left turns with increased caution, yet they showed a slight inclination towards less safe stopping at intersections with higher complexity levels. Cognitive and motor functions, including selective visual attention, visuospatial ability, working memory, and psychomotor speed, were found to be significantly linked to stopping and turning behaviors. Importantly, with rare exceptions, these correlations were consistent across both groups, indicating that MS status did not significantly alter the influence of these cognitive and motor factors on driving behaviors. These findings carry important implications for driving evaluations and recommendations, benefiting both individuals with MS and the wider population. The results underscore the importance of assessing cognitive and motor capabilities for driving, rather than solely relying on the diagnostic status of an individual. Assessing these capabilities improves estimating driving risk, enhancing road safety, and promoting independence when it is safe to drive. These results also highlight the value of virtual reality in safely assessing challenging driving scenarios.

While few driving differences were observed in PwMS, it is essential to recognize that this population tends to have mild difficulties and good insight into those difficulties. Findings may vary among other neurological populations, which will be explored in future research.

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Exploring the Potential of Using a Virtual Spatial Navigation Task to Measure Cognitive Decline in Adults with Intellectual Disabilities

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ABSTRACT

Due to its potential to offer a controlled environment for cognitive assessment, Virtual Reality (VR) has the potential to assess spatial navigation skills in those with intellectual disabilities (ID). An immersive virtual environment based on the triangle completion task (TCT) was codesigned and piloted with a research governance group comprising individuals with ID. Preliminary test-retest reliability was examined along with a comparison between the VR-based task and the Montreal Cognitive Assessment Basic (MoCA-B), an established cognitive measure. Eight participants with ID completed the VR task across varying difficulty levels for between 2 and 4 sessions, with their performance assessed for reliability and correlation with MoCA-B scores. Results indicate poor test-retest reliability for the practise mode, while the version of the VR environment with limited visual cues showed better but still insufficient reliability. A weak correlation was observed between participants' performance measures in the virtual environment containing limited visual cues and their MoCA-B scores, demonstrating the potential to use a virtual spatial navigation task in the assessment of cognitive decline for individuals with ID.

1. INTRODUCTION

Those with intellectual disabilities (ID) represent a population that has historically received limited attention in the realm of cognitive decline research. This study aims to address this concern, recognising that individuals with ID may experience cognitive decline earlier, and conditions like mild neurocognitive disorder and dementia are likely underdiagnosed in this population (Sheehan et al., 2014).

Existing tasks designed to assess spatial navigation are largely non-immersive, desktop based systems (Smith et al., 2024). These existing tasks do not involve the use of the vestibular system which is used in real-world navigation. The paper proposes the use of immersive VR as a potential tool to assess spatial navigational skills in individuals with ID. VR is suggested as a technology that could provide a controlled and immersive environment for assessing cognitive abilities. Previous research has highlighted the potential that spatial navigation has in identifying cognitive decline, and a deficit in spatial navigation capacity has been identified as one of the first signs of Alzheimer's disease (Gazova et al., 2012). We have co-designed an immersive virtual environment based on a commonly used test of spatial navigation with a research governance group consisting of people with ID.

This paper presents preliminary test-retest reliability of a VR based spatial navigation task and compares the outcome measures of this task to an existing cognitive measure, the MoCA-B for each participant (Nasreddine et al., 2005), a variant of the MoCA designed for those who are illiterate. This was used as there is no variant of the MoCA specific for those with Intellectual Disabilities. Other cognitive tests for those with Intellectual Disabilities were considered, though many of these are informant measures which are susceptible to informant bias.

2. METHOD

We developed an immersive VR implementation of the TCT, a common assessment method of spatial navigation using the Unity game engine. The hardware used was a Pico Neo 3 pro. Participants completed three difficulty levels with varying visual cues. The TCT was chosen as a basis for this task due to its simplicity and perceived ease of teaching to individuals with ID. In the easiest level (practise mode), participants practised in a virtual kitchen environment by completing a virtual tea-making task. The second level (limited-visual cues mode), and the final version (no visual cues mode) was closest to the conventional TCT in which the participant must navigate a featureless environment. Distance from the target point, the angle of deviation, time taken, and final orientation were recorded for each attempt. These different levels were designed to introduce this navigational task to a group of participants with ID in a graduated way.

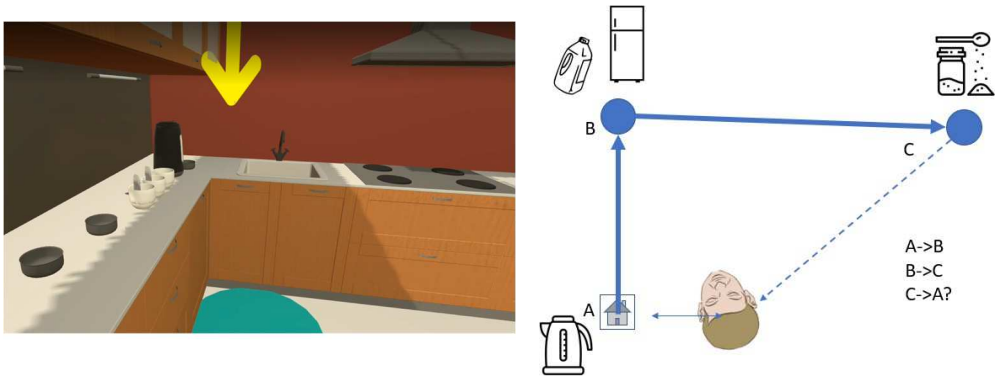

Figure 1: *Screenshot of the Kitchen Environment practice mode (left) and TCT outline (right)*

The distance between the first two points was 2.6m and the distance between the second two was 4.07m. The size of the virtual room was 6mx6m meters. Data collection took place in our VR lab. Researchers were present to ensure the safety of the participants, and only interfered when they were close to colliding with something. The noise in the room was kept to a minimum to avoid providing additional cues that could influence the performance of the task.

Eight participants (aged 21-50) with Down's syndrome, William's syndrome, or severe learning difficulties completed the task. Participants completed all difficulty levels in sequence on the same day. The average time between sessions was 49 days. A few participants completed the set of difficulty levels twice on the same day. Reliability was established with Pearson's correlation coefficient to establish consistency across sessions and the effectiveness of a "parallel form" to control for practice effects. Additionally, we collected MoCA-B scores to explore potential correlations with task performance.

3. RESULTS

Comparing each participant's distance error for the practise mode with the distance error from their following session's attempt at the same difficulty yielded poor test-retest reliability ($r=-0.4396$, $p=0.29$). The angle of deviation was equally poor ($r=-0.356$, $p=0.23$). The limited cues difficulty mode yielded better test-retest reliability for distance error ($r=0.689$, $p=0.0092$), though fairly poor for angle of deviation ($r=0.24$, $p=0.43$). The no visual cues mode was also poor ($r=0.24$, $p=0.43$).

The parallel forms reliability tests also showed poor reliability, and a negative correlation in distance error ($r=-0.71$, $p=0.010$). The angle of deviation was equally poor ($r=-0.44$, $p=0.155$).

The participants' MoCA-B scores demonstrate good test-retest reliability between sessions 1 and 2 ($r=0.88$, $p=0.0036$). Comparing participants' MoCA-B scores to their distance from the final target on the practise mode of the task indicates no correlation ($r=-0.19$, $p=0.5$) and no correlation for the angle of deviation ($r=-0.13$, $p=0.65$). For the limited visual cues mode, distance error appears to correlate negatively with MoCA-B score ($r=-0.77$, $p=0.00087$) and similar in angle of deviation ($r=-0.66$, $p=0.0079$). As lower distance/angle corresponds to a higher performance on the task, this indicates that those who score higher on the MoCA-B, do better on the spatial navigation task. The no-visual cues mode shows a weaker correlation between final distance and MoCA-B score ($r=-0.54$, $p=0.047$) and a slightly stronger correlation with angle of deviation ($r=-0.66$, $p=0.010$).

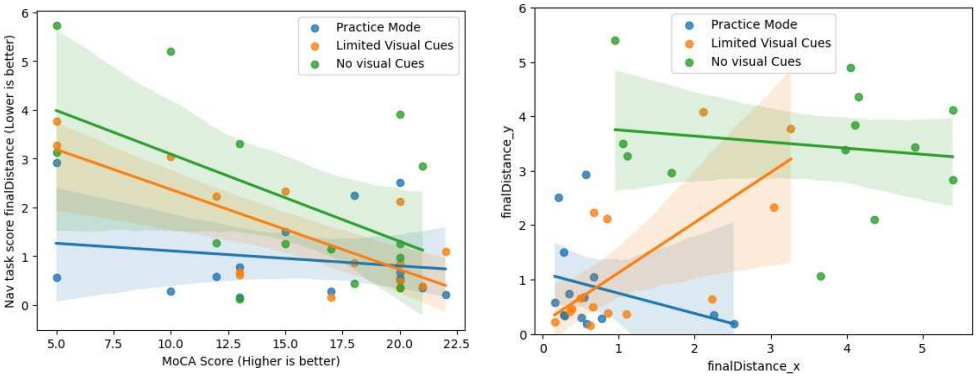

Figure 2: *Test retest reliability (left) and correlation to MoCA-B (right) for each difficulty*

4. DISCUSSION

While previous research found low test-retest reliability in VR versions of the standard TCT (McLaren et al., 2022), the present study introduces an easier task variant presenting limited visual cues. This easier mode showed improved (though still not ideal) reliability compared to the standard version, suggesting it might be more suitable for individuals with ID. Additionally, performance on the limited cues difficulty correlated with MoCA-B scores, demonstrating the potential for this VR TCT to act as a tool to indicate cognitive decline.

Pearson's correlation coefficient overestimates the relationship for small sample sizes, therefore inflated correlations due to sample size require further investigation with a larger group. Additionally, the task was still under development during initial data collection. Further improvements to the task including changes to the instructions for clarity might improve the test-retest reliability.

Future work could include an evaluation of an immersive virtual reality implementation of the Morris Water Maze (Thornberry et al., 2021). This would evaluate allocentric spatial learning using distal cues rather than egocentric path integration. This task has also been widely used to study effects of ageing.

Overall, this research demonstrates the promise of a VR TCT for those with ID, but further testing is needed to confirm its effectiveness as a tool to assess cognitive decline.

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Virtual Reality Driving Simulation May Enhance the Prediction of Real-World Unsafe Driving

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ABSTRACT

Virtual reality driving simulation (VRDS) may provide ecologically valid, objective, sensitive, and challenging measures of driving capacity than can complement existing driving evaluation tools. The present study is among the first to examine the association of VRDS metrics with real-world, naturalistic driving-as-usual. Additionally, this study examined whether these VRDS metrics offer added predictive value beyond traditional neuropsychological tests of driving-relevant cognitive domains. Results demonstrate that VRDS may enhance the prediction of naturalistic driving behaviours above and beyond traditional neuropsychological assessments.

1. INTRODUCTION

Clinical driving evaluations typically include neuropsychological tests, which assess the cognitive capacities that relate to driving risk (Hird et al., 2016), and a behind-the-wheel drive. VRDS can complement such measures by providing information that is objective, sensitive, challenging, and functionally relevant (Schultheis, 2023). While VRDS metrics have been validated in relation to self/informant reports and driver records (Helman & Reed, 2015; Park et al., 2007), research on their relation to directly observed naturalistic driving behaviours is in its infancy. Furthermore, the added value of VRDS over traditional driving evaluation methods is unknown. The present study examined the ability of VRDS performance to predict naturalistic risky driving behaviours during driving-as-usual in healthy adult drivers, and its added value beyond neuropsychological measures.

2. METHODS

Twenty-five neurologically healthy adult drivers (ages 23-61, 68% women) were recruited from the general community. They completed neuropsychological (NP) testing and a VRDS drive. The NP assessment measured cognitive domains known to be relevant to driving, namely basic and complex attention (WAIS-IV Digit Span, Useful Field of View), processing speed and executive function (Symbol Digit Modalities Test, Trail Making Test A and B, Stroop Colour Word Test, NAB Mazes), visuospatial abilities (MVPT-4), and visuospatial memory (10/36 Spatial Recall Test). Both raw and demographically adjusted scores were examined.

The VRDS drive was completed on the Drexel University Driving Simulator, custom-developed by Digital Media Works Incorporated in collaboration with the study's senior author. The simulator displays a preprogrammed driving environment on an ultrawide curved monitor to provide an immersive driving experience (Figure 1). The driver provides input using a steering column, turn signals, and foot pedals adapted from a real vehicle. The simulator simultaneously tracks those raw inputs along with multiple other metrics, including vehicle speed, lane position, and target object distances. The drive was adapted from previous studies using this simulator (Graefe et al., 2013; Guinosso et al., 2016; Patrick et al., 2020) and included driving on a straight rural road with and without external distractor tasks (verbal judgment/memory, coin sorting) and four driving challenge scenarios: following a truck on a highway, stopping for a school bus, reacting to a child running into a residential street to retrieve a ball, and reacting to a car pulling into a commercial street (Figure 1). VRDS measures included speed, lane position, lane busts, and challenge-specific measures (e.g., distance from target, time to react to target).

Figure 1 *Virtual reality driving simulator (VRDS) equipment setup and driving scenarios.*

Participants then completed 28 days of naturalistic driving-as-usual with an in-vehicle video telematics platform (Lytx) that detected potential risky driving events through a combination of accelerometer, global positioning system (GPS), and video data. Unsafe driving behaviours were coded through a combination of automated procedures and manual review by trained coders. These behaviours are a comprehensive set of well-established predictors of crash risk and injury risk in the categories of traffic violations (e.g., speeding > 10 mph above the limit, failing to stop at a stop sign or red light), fundamentals (e.g., unsafe following distance of < 4 seconds, unsafe lane change), awareness errors (e.g., late response, lack of mirror use), distractions (e.g., cell phone use, eating/drinking), driver conduct (e.g., drowsy, aggressive), and other concerns (e.g., seatbelt non-use/misuse). The primary naturalistic driving measure was the number of unsafe driving behaviours per hour driven.

We conducted bivariate Pearson or Spearman correlations of unsafe driving behaviours per hour with each NP and VRDS measure. Correlations in the medium range or larger ($r > .3$) were entered into subsequent regression analysis. To reduce redundancy, if multiple measures from the same NP test or VRDS challenge were highly collinear ($r > .7$), the one with the strongest correlation with naturalistic driving was entered in regression analysis. Finally, a hierarchical linear regression was conducted to examine the independent and shared contributions of NP and VRDS measures in the prediction of naturalistic unsafe driving behaviours. NP measures were entered in the first step, VRDS measures were entered in the second, and NP measures were removed in the third.

3. RESULTS

VRDS measures that exhibited a medium or larger correlation with real-world unsafe driving behaviours (Table 1) included lane position on the straight rural road, several truck following measures, time to resume in the child-ball task, and stopping in the car pullout task. The latter two associations were not statistically significant. Drivers who veered left of the ideal centre of the lane on a straight rural road during the simulated drive engaged in a significantly higher number of real-world unsafe driving behaviours, as did drivers who drove more slowly, more inconsistently, and farther behind the truck during the simulated truck-following task. Rural road lane position and average truck following speed were entered in subsequent regression analysis.

Table 1: *VRDS measures correlated (r > .3) with real-world driving behaviours.*

VRDS measure	*r*	*p*
Rural road: lane position (without external task)	-.47	.020
Truck following: average speed	-.50	.013
Truck following: SD speed	.49	.014
Truck following: average distance from truck	.45	.028
Truck following: SD distance from truck	.48	.018
Child-ball: time to resume	.31	.139
Car pullout: stopping	-.32	.132

NP measures that exhibited a medium or larger correlation with real-world unsafe driving behaviours (Table 2) included two auditory working memory measures (Digit Span Sequencing) and three visuospatial memory measures (10/36 Spatial Recall Test). Better performance in auditory working memory or visuospatial memory was associated with a higher number of real-world unsafe driving behaviours, though these correlations were not statistically significant. Digit Span Sequencing age-adjusted scaled score and 10/36 Spatial Recall Test immediate recall raw score were entered in subsequent regression analysis.

Table 2: *Neuropsychological measures correlated (r > .3) with real-world driving behaviours.*

Neuropsychological measure	*r*	*p*
Digit Span Sequencing raw	.38	.062
Digit Span Sequencing scaled	.39	.054
10/36 Spatial Recall Test immediate recall raw	.37	.068
10/36 Spatial Recall Test immediate recall scaled	.33	.105
10/36 Spatial Recall Test delayed recall scaled	.30	.144

In a hierarchical regression analysis, VRDS metrics alone explained a large and significant proportion of variance in real-world unsafe driving behaviours (p = .007, R^2_{adj} = 32%). By comparison, NP measures alone explained a small and non-significant proportion of variance (p = .142, R^2_{adj} = 9%). Together, VRDS and NP measures explained 33% of the variance in driving behaviours (p = .019), 8% of which was shared. VRDS metrics uniquely explained 24% (p = .021), while NP measures uniquely explained only 1% (p = .329).

4. DISCUSSION

Virtual-reality-simulated driving performance provides unique, ecologically valid information about real-world unsafe driving behaviours and may enhance predictive value beyond traditional neuropsychological measures. Furthermore, the present findings challenge the typical directional interpretation of neuropsychological tests as indicators of driving capacity; that is, worse performance is generally interpreted to mean worse driving capacity, yet in this study worse performance was related to fewer risky driving behaviours. These novel findings provide preliminary support for incorporating VRDS assessment when evaluating driving capacity. In addition to the ecological validity demonstrated here, strengths of this VRDS system include its balance of portability and similarity to real vehicles. Limitations of VRDS include simulator sickness and the potential influence of computer/gaming familiarity; that said, these should be balanced against the limitations of neuropsychological tests, which include lower ecological validity, the influence of education and culture, and the need for extensive administration training. As statistical power in the present study is limited by the small sample size, future research will expand these investigations to larger samples and clinical populations, such as acquired brain injury. Identifying novel approaches for improving prediction of driving capacity can optimize the balance of safety and independence in people affected by brain injury or illness.

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Navigation in 3D Virtual Environment for Older Adults

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ABSTRACT

Navigation is one of the main components in Virtual Reality (VR)/Virtual Environment (VE) or desktop VR. The interaction model in desktop VR comprises standard computer peripherals such as a monitor, keyboard, and mouse. Navigation techniques using mouse and monitor coordinates can be used as a navigation base model. Currently, older adults can still be productive by utilizing desktop VR. Various jobs/skill development in training or administration can be done so that older adults remain productive. To help older adults work, simplified VR navigation can reduce confusion and increase learnability. This pilot study proposes three forms of navigation in 3D VE that can be offered to improve navigation techniques in desktop VR based on design possibilities.

1. INTRODUCTION

The current development of Virtual Reality (VR) / Virtual Environment (VE), including desktop VR, extends beyond serious games, demonstrating excellent job and skill development in all age groups, especially older adults. Desktop VR systems offer an immersive experience that can be used for cognitive training, focusing on specific cognitive domains such as memory, attention, problem-solving, and motor control (Brugada-Ramentol et al., 2022). These systems facilitate various jobs and skill development activities, helping older adults remain productive (Bibby, 2023). Around 15% of the global population, or 1 billion individuals, suffer from disabling conditions, with over 46% of older adults and 250 million experiencing moderate to severe disabilities (*Ageing and Disability | United Nations Enable*, n.d.).

Desktop VR has various advantages, including a better learning experience, accessibility, cognitive stimulation, adaptability, less physical effort, and psychological benefits. The computer mouse is an effective navigation tool in desktop VR. It enables users to control different components of their computers and interact with virtual items. In this context, the computer mouse is a valuable navigation tool for desktop VR (Seibert & Shafer, 2018). Similarly, in the MaxWhere application, the mouse can be a powerful navigation tool (Berki, 2020). Navigation is a critical component of realistic and engaging VR experiences. The design of navigation, including moving, turning, and rotating, is crucial to improving the user experience (Li et al., 2023). Based on these, this study proposes a navigation design within a desktop VR to help older adults remain productive. This pilot project will investigate multiple mouse navigation possibilities based on computer mouse possibilities. The study in this research will be a foundation for future research development, implementation, and further analysis.

2. RESEARCH METHOD

This research focused on designing the navigation methods that can be implemented using first-person shooter (FPS) user mode in desktop VR. The first mode is *Click-based navigation*: This mode utilizes the right click and moving the mouse following the y-axis to rotate the camera, while the middle click and moving the mouse with the x-axis for forward and backward movement and y-axis for moving right and left, as illustrated in Figure 1 (a). The second navigation type is *Combinational mouse-screen navigation*: In this mode, the camera can rotate right and left if the cursor is directed at the Screen Edge (SE), depending on SE-Right for rotating right and SE-Left for

rotating left. SE-Top and SE-Bottom for forward and backward movement direction, as illustrated in Figure 1 (b). The third/last navigation type is *Cursor Fix navigation*. In this navigation mode, the cursor does not move and is fixed in the center of the screen. If we move the mouse with the y-axis, the camera will move back and forth, and if we move the mouse with the x-axis, the camera will be rotated left and right, as illustrated in Figure 1 (c).

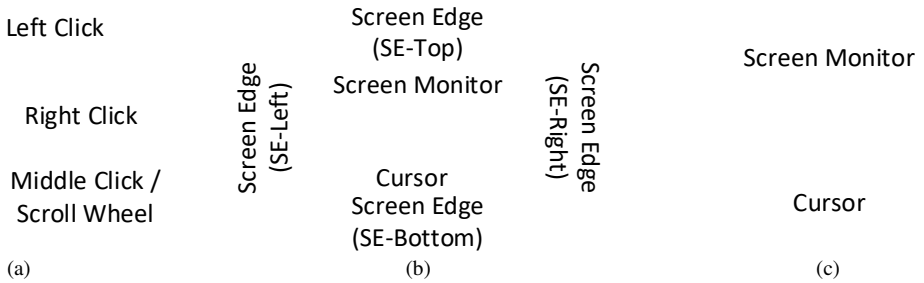
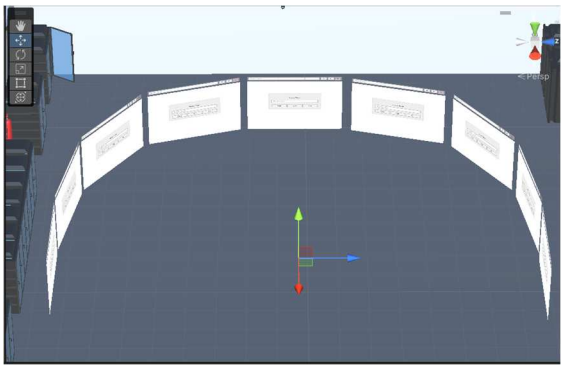


Figure 1 *Navigation Mode: (a) Click-based navigation; (b) Combinational mouse-screen navigation; (c) Cursor Fix navigation.*

3. RESEARCH DIRECTION

This research is at the pre-elimination stage, and the design of the navigation control stage is also underway. The navigation design will be implemented on multi-browser VE. Multi-browser VE is a VE with several browsers placed in a row. The browser has several standard features, such as URL location and a back-and-forward menu. Another feature provided is the focus view. At the start of use, VE can be seen as a 3D environment as in Figure 2. (a), but users can also focus on just one browser so that the static display is like the 2D view as in Figure 2. (b).



(a) (b)

Figure 2 (a) The Multi-Browser VE, (b) Browser Focus View

Moreover, three navigation modes are provided, which can be done using a standard mouse axis and screen coordinates for user movement. The leading operating system targeted is Windows, while development will be carried out using Unity 2022.3.10f1. The first evaluation technique to assess this navigation at the early stages of development will be using The System Usability Scale (SUS) to measure which navigation design is appropriate to justify the feasibility (Rodríguez Lera et al., 2021). After obtaining results from the SUS with a minimum classification of "good," further studies will be conducted to assess acceptance, user experience, and presence. For each aspect, measurements will be taken using the Technology Acceptance Model (TAM) (Pang & Cheng, 2023), User Experience Questionnaire - short (UEQ-s) (Guertin-Lahoud et al., 2023), and The Igroup Presence Questionnaire (IPQ) (Melo et al., 2023). The aspect measurements provide a comprehensive, efficient, and widely accepted method for assessing usability, user experience, technology acceptance, presence levels, and industry standards.

4. CONCLUSION AND FUTURE WORKS

This initial study proposes click-based navigation, rotational navigation based on mouse-screen navigation, combinational mouse-screen navigation, and cursor fix navigation. This idea will be implemented in a VE or desktop VR for older adults to learn, work, and develop their skills. The research stages after this phase are as

follows: The first stage is the development of the VE. After that, we will conduct studies including usability, acceptability/acceptance, user experience, and presence level. The study aims to give brief design possibilities on desktop VR and research direction of navigation design for older adults.

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Immersive virtual reality experiences for the improvement of attention in post-COVID-19 condition

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ABSTRACT

This study explores the effects of a 6-week immersive virtual reality (VR) cognitive intervention program on attention deficits in individuals with post-COVID-19 condition (PCC). Seventeen adults participated, showing significant improvements in attention, perceived cognitive status, and mood. They presented low levels of cybersickness, high levels of immersion, presence, motivation, enjoyment and usefulness, and optimal difficulty level of VR games. Despite the small sample size, findings suggest that VR-based interventions are promising for managing PCC-related cognitive symptoms.

1. INTRODUCTION

Post-COVID-19 condition (PCC) appears typically 3 months post-SARS-CoV-2 infection, persisting for at least 2 months and is unrelated to other diagnoses (Soriano et al., 2022). Common neuropsychological symptoms include attention deficits, memory issues, executive function impairments and motor coordination problems (Nalbandian et al., 2021, 2023). These impairments affect daily activities and functional independence, necessitating tailored rehabilitative strategies (Nalbandian et al., 2023). The WHO recommends psychological assistance, physical activity, mindfulness, cognitive exercises, education, self-management tactics and the utilization of assistive tools and environmental adjustments (WHO, 2023).

Although VR technology is increasingly utilized in neuropsychological rehabilitation, its benefits and potentials for PCC are under-researched (Ahmadi Marzaleh et al., 2022; Groenveld et al., 2022; Kolbe et al., 2021). This study aims to present findings from a 6-week immersive VR cognitive intervention for PCC.

2. METHODS

2.1. Participants

17 adults (5 males, 12 females; M_{age}=36.82 years, SD_{age}=15.78; $M_{education}$=17.09 years, $SD_{education}$=3.72) with PCC participated without any history of neurological or psychiatric problem prior to COVID-19 infection.

2.2. Materials

Neuropsychological tests included the *D2-R Revised Test* (Brickenkamp et al., 2010) measuring attention and processing speed, the *Perceived Deficits Questionnaire* (PDQ, 1990) evaluating perceived cognitive difficulties, and the *Self-Assessment Manikin* (SAM; Bradley & Lang, 1994) assessing valence and arousal. VR experience was evaluated using the *Simulator Sickness Questionnaire* (SSQ; Kennedy et al., 1993), *Virtual Reality Neuroscience Questionnaire* (VRNQ; Kourtesis et al., 2019), and a self-constructed *VR experience questionnaire* with a 5-point Likert scale (immersion, presence, enjoyment, usefulness, motivation, perceived difficulty). A Meta Quest 2 headset was used.

2.3. Procedure

Participants underwent baseline neuropsychological evaluation, followed by a 6-week immersive VR intervention (1 session/week). Each session included diaphragmatic breathing exercises and cognitive VR games developed by Virtuleap to enhance attention (Brugada-Ramentol et al., 2022). The game consisted of using 2 controllers to hit several figures popping up from an arcade as fast and as accurate as possible. Participants filled out questionnaires pre-and post-sessions. Post-intervention neuropsychological evaluation occurred 9 weeks from baseline.

3. RESULTS

Analysis using paired samples T-tests or Wilcoxon signed-rank tests showed significant improvements in several measures:

D2-R Revised Test: Significant decrease in *accuracy %* ($t[15]=2.43$, $p<.05$, Cohen's $d=0.61$) from baseline ($M=11.48$, $SD=8.17$) to follow-up ($M=7.46$, $SD=5.14$). Significant increase in the *number of processed targets* ($t[15]=-3.62$, $p<.005$, Cohen's $d=-0.9$) from baseline ($M=152.06$, $SD=28.44$) to follow-up ($M=170.88$, $SD=37.37$). Significant increase in *concentration performance* ($t[15]=-4.82$, $p<.001$, Cohen's $d=-1.2$) between baseline ($M=134.31$, $SD=25.51$) and follow-up ($M=158.19$, $SD=36.33$). The pre-post changes of number of errors of omission and number of errors of commission turned out to be insignificant.

PDQ: Significant decrease ($t[16]=3.86$, $p=.001$, Cohen's $d=0.94$) from baseline ($M=33.06$, $SD=13.61$) to follow up ($M=24.65$, $SD=12.38$).

VR Game Scores: Significant improvement ($t[16]=6.88$, $p<.001$, Cohen's $d=-1.67$) between the 1st ($M=12.31$, $SD=3.45$) and last ($M=15.47$, $SD=3.7$) game trials.

SAM Valence and Arousal: Significant increase in *valence* at the 1st session ($t[16]=-3.12$, $p<.005$, Cohen's $d=-0.76$) pre- ($M=7$, $SD=1.46$) and post-session ($M=7.88$, $SD=0.86$), trend of increase in other 4 sessions and no change in one session. Significant increase of *arousal* at the 1st session ($t[16]=-3.12$, $p<.005$, Cohen's $d=-0.76$) in between pre- ($M=4.94$, $SD=1.85$) and post-intervention ($M=5.94$, $SD=2.11$), trend of increase in 3 other sessions and trend of decrease in 2 sessions.

SSQ Scores: Significant decrease ($W=108$, $p<.05$, $r_{rb}=0.59$) at the 1st intervention session pre- ($Mdn=29.92$) and post-session ($Mdn=18.7$). Trend of increase in 3 sessions and a trend of decrease in 2 other sessions.

VR Experience: Perceived immersion ($M=4.63$, $SD=0.42$), perceived presence ($M=4.46$, $SD=0.5$), enjoyment ($M=4.65$, $SD=0.37$), motivation ($M=4.61$, $SD=0.4$), usefulness ($M=4.75$, $SD=0.36$), perceived difficulty ($M=3.02$, $SD=0.64$).

4. DISCUSSION

4.1. Summary of findings

The VR-based intervention significantly improved attention and reduced cognitive complaints in PCC participants. VR game scores improved significantly from the beginning to the end of the program. Emotional valence improved during most sessions, while arousal changes were mixed. Cybersickness symptoms decreased significantly initially, then followed a varied trend. This surprising finding could be rooted in the nature of PCC, where some symptoms are similar to cybersickness symptoms (e.g. light-headedness, headache, difficulty in concentrating…etc.). Since PCC symptoms seem to have a neurocognitive background, the cognitive VR tasks might have contributed to alleviate them.

Participants found the intervention highly immersive, motivating, optimally challenging, enjoyable, and useful, and experienced a high sense of presence. The VR software was shown to be adequate and did not cause significant VR induced symptoms and effects (Kourtesis et al., 2019). Future research should expand the sample size, include control groups and previous history, use and attitude towards digital technology, and explore optimal VR program durations.

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The assessment of the cognitive profile of elderly individuals using Virtual Reality: A comparison between experienced and inexperienced users

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ABSTRACT

Virtual Reality (VR) technology has garnered substantial interest in psychology, particularly in its application to enhance neuropsychological cognitive assessments. By offering tailored environments and integrating realistic measurements, VR presents a promising avenue for advancing clinical procedures. With a global rise in the elderly population, the pursuit of healthy aging has become paramount, emphasizing the preservation of cognitive abilities crucial for maintaining quality of life and autonomy. Spatial memory decline, an early indicator of cognitive decline in aging, underscores the importance of accurate assessment methodologies. The Corsi-Block Tapping Task, a conventional method for evaluating spatial memory, has been augmented by VR technology, providing a dynamic platform to assess cognitive function. However, concerns persist regarding older individuals' familiarity and attitudes towards VR technology, potentially influencing performance outcomes. To address this gap, we aim to investigate the attitudes and experiences of elderly participants (aged 65 and older) towards VR-based cognitive assessments. Utilizing the VR Corsi Task, participants will undergo cognitive testing alongside traditional Corsi-Block Tapping Task assessments. Additionally, participants will complete self-reported questionnaires assessing technology familiarity, user experience, and emotional states. We anticipate that participants with prior VR experience and positive attitudes towards technology will exhibit enhanced performance in the VR Corsi Task. This study contributes to understanding the feasibility and validity of VR technology in assessing cognitive function among older adults, shedding light on the potential benefits and challenges of integrating VR into neuropsychological evaluations.

1. INTRODUCTION

Virtual Reality (VR) has emerged as a captivating and cutting-edge technology that has attracted considerable interest within the realm of psychology, specifically in its utilization to augment clinical procedures like neuropsychological cognitive assessment (Tan et al., 2019; Liu et al., 2020). The use of VR in neuropsychological evaluation provides a crucial advantage in its ability to be tailored to individual needs, facilitating the incorporation of measurements in a realistic environment. Furthermore, it combines the benefits of online assessments, including reaction time measurements, automatic feedback, and decreased errors (Parsons, 2015).

One key neuropsychological condition is healthy aging, as the global increase in the elderly population has led to a rise in the exploration and advocacy for healthy aging. A key focus in this endeavor is the preservation of cognitive abilities, which greatly influences the quality of life and autonomy of older individuals (Sánchez-Izquierdo & Fernández-Ballesteros, 2021). While cognitive impairment has typically been assessed in clinical terms, new studies propose a more intricate relationship between aging and cognition along a spectrum, prompting a reassessment of traditional evaluation techniques, which VR solutions can take advantage of (Murman, 2015; Zaninotto et al., 2018).

Spatial memory decline serves as an early indicator of cognitive decline in aging, often preceding more noticeable cognitive impairments (Wang et al., 2017). This decline can impact various everyday tasks, including

navigation, remembering locations, and spatial orientation (Colombo et al., 2017). The Corsi-Block Tapping Task is a widely employed method for assessing spatial memory (Kessels et al., 2000). It involves individuals reproducing a sequence of spatial locations presented in a random order, which they have to either reproduce in the same order (forward condition) or in reverse order (backwards condition). Performance on this task reflects an individual's ability to encode, maintain, and retrieve spatial information, providing valuable insights into spatial memory function. Early diagnosis of spatial memory decline is crucial as it allows for timely interventions and strategies to mitigate further cognitive deterioration (Vlček, 2011; Rosenbaum et al., 2012). By identifying subtle changes in spatial memory early on, interventions such as cognitive training, lifestyle modifications, and pharmacological interventions can be implemented to support cognitive health and potentially delay or prevent more severe cognitive decline associated with aging.

In a prior study, we created a VR iteration of the Corsi-Block Tapping Task (VR Corsi Task) to test the cognitive abilities of young, healthy participants in a fully immersive VR environment (Zsebi et al., 2023). However, we overlooked whether these participants had any familiarity with VR or their overall attitudes towards cognitive assessments in a virtual environment. While this factor may not have been significant for younger participants, it could be more relevant when considering older individuals who typically have less experience and enthusiasm for emerging technologies (Benoit et al., 2015). This factor, however, is important to be clear about since attitudes and experience highly influence performance on neuropsychological tests which is even more important when it comes to testing with high-tech equipment.

To evaluate this possible concern, we aim to test 30 elderly individuals (aged 65 and older) using the VR Corsi Task in a fully immersive VR environment. Throughout the data collection process, our participants will be asked to complete the System Usability Scale (SUS), the User Experience Questionnaire (UEQ), and our own Likert-scale questions designed to assess participants' previous experiences and attitudes towards technology and VR. We also measure the Cybersickness In Virtual Reality Questionnaire (CSQ-VR) to explore participants' potential physical symptoms during VR session, mainly related to motion sickness. For comparing elderly data, we also collected young participants' data (age between 18-29 years) and compare both questionnaire data and performance.

2. METHODS

Our data collection procedure will commence by capturing demographic details of participants, after which they will respond to a questionnaire rating their current emotional state on a 1-5 Likert scale. Following this, participants will undertake the Corsi-Block Tapping Task and the VR Corsi Task with an Oculus Quest 2 head-mounted device in a randomized manner with the experimenter's support. Upon completion, participants will once again complete the emotional state questionnaire, followed by the UEQ and SUS questionnaires. Data collection in the above mentioned method has already started with currently 10 pieces of data which we plan to expand in the following two months. As for young participants', the full dataset has already been collected.

In order to evaluate the validity of our data, we will compare participants' performance in both forward and backward conditions for each task. We expect to see a significant difference in scores between the backward and forward conditions. If our data is deemed reliable through this analysis, we will then use linear regression models to investigate how self-reported questionnaire scores may influence performance outcomes. We anticipate that participants with higher scores in previous VR experience, SUS, UEQ and CUE will exhibit better performance in the VR Corsi Task, but not in the Classical Corsi-Block Tapping Task.

3. EARLY RESULTS

Our young sample has achieved an average of 5.364 on the VR Corsi Task's forward condition and an average of 4.909 on the backward condition. Their average UEQ score was 96, which is very high, their SUS score average was 25.93, and CSQ-VR average score was 10.41. As the elderly data collection is still ongoing, no results of them can be currently interpreted.

4. CONCLUSION

If our anticipation turns out true, a reassessment of the implementation of the task becomes relevant, since it will reveal that subjective attitudes and/or previous experience and/or user experience significantly influences performance in VR tasks. This result would indicate a need for greater caution when it comes to implementing neuropsychological tasks in VR. In this case, for further studies about VR implementations, we'd recommend

utilizing complex neuropsychological pre-testing with “classical” tools and making comparison analyses between them and VR performance.

If our hypothesis won’t turn out true, it will imply a greater potential for VR devices as the performance on these devices won’t significantly depend on such factors, revealing the potential usability of VR for neuropsychological testing. Although in this case, we’d still recommend neuropsychological pre-testing, however, further and more innovative software may be created.

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The use of the Meta Quest as a tool for ADHD screening through a self administered immersive test of attention and activity

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ABSTRACT

We investigated the potential of a VR self-diagnosis tool for ADHD based on the Qb-test. The VR app iinterpreted the Qb-test's features into an immersive format and captured comparable key diagnostic metrics. An ADHD psychologist confirmed its potential for self-screening and earlier diagnosis. Future studies will address data limitations and assess the tool's effectiveness through clinical trials. This project advances VR's use in ADHD awareness and diagnosis and access to support.

1. INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a prevalent neurodevelopmental disorder characterized by inattention, hyperactivity, and impulsivity (American Psychiatric Association, 2022). It is estimated to affect approximately 7.6% of children and adolescents and often persists into adulthood (Salari et al, 2023). Timely diagnosis of ADHD is essential for accessing appropriate treatment modalities, including medication and behavioural interventions, which can significantly improve quality of life [Sonuga-Barke et al., 2013]. Traditional diagnostic methods for ADHD typically involve a combination of clinical interviews, parent and teacher reports, and continuous performance tests (CPTs) (Bradley et al 2024). CPTs are objective assessments that measure a patient's ability to sustain attention and respond to specific stimuli presented visually or (Edwards et al, 2007). One commonly used CPT is the Qb-test, which requires participants to continuously monitor a stream of rapidly presented geometric shapes and respond only to target stimuli (Hult et al 2015). However, traditional diagnostic methods for ADHD can be time-consuming and resource-intensive. Additionally, subjective assessments based on interviews and reports may be susceptible to bias or inconsistencies. There is a growing interest in exploring the potential of virtual reality (VR) technology to enhance the accessibility and effectiveness of ADHD diagnosis. VR offers a unique immersive environment that can be used to create engaging and standardized CPTs potentially comparable to traditional methods (Jiang et al 2019).This project reports on the development and evaluation of a VR-based self-diagnosis tool replicating the core functionalities of the Qb-test. The project adheres to a VR stage 1 development model, prioritizing user experience and expert feedback over large-scale quantitative (Birckhead, 2019). The primary objective was to assess the feasibility of developing a VR version of the Qb-test and gather expert insights to inform future iterations of the application.

2. METHODS

The Meta Quest (formerly Oculus Quest) was chosen due to its high level of ownership and its affordability compared to high-end VR headsets, promoting user accessibility. Additionally, the standalone nature of the Meta Quest eliminates the need for a PC connection, simplifying user experience and setup. Finally, Unreal Engine, the project's development tool, offers strong mobile optimization, ensuring optimal performance on the Meta Quest's mobile hardware. The VR application was designed to closely replicate the core functionalities of the Qb-test. The VR application mimicked the Qb-test by presenting users with geometric shapes (squares and spheres) in a virtual environment for a set duration (200ms) with controlled intervals (2 seconds). Target stimuli (25%) matched the previous shape, adhering to the original Qb-test parameters for performance comparison (Hult, 2015). User interactions were tracked throughout the test, including omission and commission errors, head movements potentially indicating focus or distraction, reaction speed to targets, and anticipatory responses. Following completion, the application provided visual feedback through graphs similar to the Qb-test, displaying user performance metrics such as errors, reaction time, and head movement data.

Following a stage 1 VR development model, [Birckhead, 2019], a psychologist specializing in ADHD test accessibility was recruited for an in-person, semi-structured interview. The interview assessed the VR application's intuitiveness, user experience, and potential for ADHD diagnosis. Key areas explored included clarity of instructions, user interface design, test engagement, post-test information, authenticity compared to the Qb-test, and potential impact on the ADHD diagnosis pipeline, particularly for self-diagnosis.

3. RESULTS

The expert interview with the psychologist yielded valuable insights that will inform future iterations of the VR application. From an iterative design perspective it was suggested instructional videos should be added alongside written instructions. The psychologist also recommended improvements to the user interface, including adjusting the virtual table position for better start button visibility and incorporating clearer visual cues. Additionally, the post-test information should be enhanced with explanations alongside graphs to aid interpretation and provide links to relevant resources.

The interview also addressed the core project goals. The psychologist confirmed the VR application's ability to capture the Qb-test's core functionalities and faithfully replicate the testing experience. While acknowledging limitations as a standalone diagnostic tool, the psychologist highlighted its potential to improve access to ADHD diagnosis, particularly for demographics familiar with VR technology. They emphasized the application's role as a self-screening tool and facilitator for earlier professional evaluation, not a replacement for diagnosis.

4. DISCUSSION

This project successfully built a basic VR version of the Qb-test, replicating core functionalities like stimulus presentation, target ratio, and user interaction tracking. An expert evaluation provided valuable user experience and effectiveness insights. Aligning with a stage 1 VR development model [Bos et al., 2018], qualitative evaluation through an expert interview prioritized user experience over large-scale testing. This allows for iterative development based on the psychologist's feedback before broader user studies. The project suggests VR's potential for engaging and accessible self-diagnosis tools for ADHD. VR's immersive environment can create a controlled testing space replicating traditional CPTs. The current application lacks a robust data export solution for users to share results with healthcare professionals. Potential solutions include a companion mobile app, cloud storage integration, or refined email functionality within Unreal Engine. Future work should address these limitations and conduct a clinical trial. This would allow for a more comprehensive evaluation of the VR application's ability to replicate the original test and establish its validity as a self-diagnosis tool. This project represents a significant step forward in exploring VR for ADHD self-diagnosis. The development of the foundational VR Qb-test application and expert feedback demonstrate the approach's feasibility and promise. Ultimately, this project contributes to research exploring VR's potential for improving ADHD diagnosis and empowering individuals to seek appropriate care

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Virtual environment aiming to train cognitive flexibility in patients with Obsessive – Compulsive Disorder

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ABSTRACT

Obsessive-compulsive disorder (OCD) is characterized by obsessions (intrusive thoughts) and compulsions (ritualized behavior). Patients with OCD can also have impairments in cognitive flexibility (CF), which may result in a decreased ability to shift between mental processes and adapt their behavioural response to environmental changes. To target the CF impairments we created virtual reality (VR)-based cognitive training methods (VRCT). This study aims to evaluate this method as a potentially valuable addition to cognitive behavioural therapy (CBT) and to present preliminary data on the feasibility of the training.

1. INTRODUCTION

Obsessive-compulsive disorder (OCD) is a persistent psychiatric condition with a variety of symptoms. It is defined by obsessions, intrusive thoughts eliciting anxiety, and compulsions; repetitive actions providing temporary relief. Individuals suffering from OCD may experience difficulties in cognitive flexibility (CF, Dajani and Uddin 2015), leading to a reduced capacity to transition between cognitive processes and adjust their actions in response to changing circumstances. Consequently, they often engage in repetitive behaviors even when they are irrelevant. Recent neuropsychological evaluations indicate that CF is compromised in OCD patients, as evidenced by challenges in tasks such as reversal, attentional set-shifting, task-switching paradigms, and inhibitory control (Gruner and Pittenger 2017). It seems beneficial to target specifically cognitive flexibility in training to ameliorate inflexibility in patients with OCD (Zuzankova and Fajnerova 2023). OCD is usually treated by Cognitive Behavioral Therapy (CBT) and medication. At the National Institute of Mental Health (Czech Republic), the standard CBT group program for hospitalized OCD patients is currently enhanced by integrating virtual reality-based cognitive training (VRCT) aimed at CF. We hypothesise this approach could potentially enhance CF abilities and alleviate symptom severity. We expect patients who undergo VRCT together with the standard CBT program to perform better in tests of CF at the end of the treatment.

2. METHODS

The recruited inpatients (see Table 1) undergo 4-5 sessions of VRCT, once per week, in VR with a head-mounted display (HMD) technology using an HTC Vive headset. Each training session lasts about 30 minutes. Before the first and last VRCT, we assess participants' symptom severity using the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS) and CF with Cognitive flexibility inventory and cognitive tests battery (see Table 1). The control group solely attending group CBT programs without VR intervention during their inpatient stay in the institute is now being recruited (n = 3, not reported).

Table 1: *Description of procedure and test methods used*

Description	Before and after the whole treatment	Before and after each VRCT	After the second VRCT
3 cognitive tasks with increasing difficulty (see Fig.1): 1.Flies - Selective Attention & Set-shifting 2.Shooting range - Inhibitory control 3. Castle - Reversal episodic memory learning	STAI-T, hierarchy of fears, cognitive flexibility inventory (CFI), Stroop test, Verbal Fluency, Trail Making Test, Go/No-go task, Berg Card Sorting Test	current anxiety level (STAI-6)	SSQ (simulator sickness questionnaire), IPQ (igroup presence questionnaire) and SUS (Slater-Usoh-Steed questionnaire)

The environment for cognitive training is located in a virtual city environment and present buildings (see Fig.1, or VRcity system website: www.vrmesto.cz). In each session, the participants undergo the same sequence of tasks, with each task being divided into three levels. The difficulty of the tasks increases between the sessions and within each session as well. The first task **"Flies"** aims at the attentional set-shifting paradigm and strategy adaptation. The person training has the assignment to hit all the flies that will appear (sit) in front of them as fast as possible. In this task, the places the flies can fly to, their speed, number, and behaviour (walking or not, to be disturbed or not) change with increasing task difficulty. The second task **"Shooting range"** aims at inhibitory control and reversal learning. The task is based on the go/no-go paradigm, and the participants shoot paper animals in an amusement park. The difficulty increases with changes in the number of targets presented, speed, and environmental cues. Third is an episodic memory task **"Castle"** game aimed at reversal learning, with the goal being to remember object identity (what), original location (where) and order (when) of the acquired objects that are shown to the participants beforehand.

Figure 1: *Illustration of the virtual environments visualized in the tasks for cognitive flexibility training*

3. RESULTS

So far the preliminary measures of cognitive flexibility assessed before and after VRCT do not show any effects of the CF training (see Table 2, Wilcoxon rank tests were performed).

Table 2: *Results of Wilcoxon rank tests within-subject comparisons of Pre/Post treatment assessments*

	CFI	TMT A	TMT B	Stroop test IF	Verbal fluency words	Verbal fluency categories
Mean (SD) pre treatment	*88.7 (9.51)*	*28.6 (7.35)*	*74.5 (26.2)*	*2.16 (10.9)*	*42.4 (11.6)*	*38.9 (6.53)*
Mean (SD) post treatment	*89.8 (10.1)*	*25.3 (8.76)*	*60.2 (18.5)*	*6.30 (4.67)*	*44 (5.66)*	*41.8 (12.1)*
Pre/Post treatment comparison (n = 9, F=4, M=5 36 ± 12 years)	*W = 15,* *p = 0.363*	*W = 34,* *p = 0.096*	*W = 24,* *p = 0.230*	*W = 14,* *p = 0.180*	*W = 20.5,* *p = 0.617*	*W = 14.5,* *p = 0.500*

Nevertheless, the games are well accepted and understood by the patients. We present the virtual environment presence from participants (n = 7) who evaluated their presence using the SUS questionnaire (M = 3.5, SD = 1.5) with min. score 2.3 and max. 4.3. The presence score is affected by lower answers in some of the questions, however, the overall *sense of being in the virtual environment* (Q1) is evaluated higher (M = 4.5). The training creates minimal simulator sickness, measured with the SSQ average total raw score (M = 7.29, SD = 3.04, max = 11, min = 3). In a subjective anonymous written feedback, the participants report that raising of level difficulty is adequate (n=6), one reports the progress as too fast and one reports the progress as too slow. All of them enjoyed partaking in the training and the possibility to try out virtual reality. Six out of the nine participants subjectively perceive the training as beneficial, concrete examples of their reports are that they are better at working with

automatic negative thoughts or shifting between different needed behaviours.

4. DISCUSSION

The VRCT for training cognitive flexibility in patients with OCD might be a valuable addition to a classic CBT group therapy by enhancing cognitive flexibility in patients with OCD. The enhancement of CF can help the patients adapt to their environment less rigidly. The patients already involved in this study enjoyed the training, it is well tolerated and feasible, however, a bigger sample of participants is needed. A comparison to a control group will be done to evaluate its effectiveness on cognitive flexibility.

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Emotions

The session on Emotions explored the impact of VR on emotional experiences and brain function. Research presented included studies showing that biophilic, nature-inspired VR environments can positively influence mood and brain activity, particularly in university settings. Emotional memory was assessed using VR, demonstrating the potential for enhanced recall in immersive environments. Additionally, younger adults' emotional responses to various VR scenarios were analysed, providing insights into how different virtual experiences affect mood and emotional processing. Overall, the findings suggest that VR can be an effective tool for studying and influencing emotional well-being.

Beneficial effects on subjective mood and brain function of biophilic quality in university environments shown in virtual reality.

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ABSTRACT

Biophilic designs incorporate nature-based features into built environments. Raised theta activity is reported in biophilic environments. Virtual Reality allows greater control of experimental parameters than in-field studies. Participants provided subjective reports and underwent an electroencephalography assessment as they viewed interior spaces that varied (0 no features to 3 most features) in biophilic quality. Mood improved with biophilic quality. Theta power increased with biophilic quality for levels 1-3. Paradoxically, however, theta was also high in the condition devoid of biophilic features (Level 0). Findings suggest that the benefit of biophilic environments on mood is paralleled by alterations in theta.

1. INTRODUCTION

Urban living typically has an adverse impact on psychological wellbeing and health (Beyer et al., 2014; Engemann et al., 2019). The concept of biophilia (Fromm, 1964) proposes an innate need to engage with/exist alongside living-organisms and life-like processes that support wellbeing. Biophilic designs promote health by incorporating nature-based features into built environments (Gillis and Gatersleben 2015). The effect of biophilic built environments on brain function has been investigated using electroencephalography (EEG), which uses sensors placed on the scalp to measure postsynaptic changes in electrical potential produced during neuronal communication. Studies of biophilic building design show differences between urban and natural settings in theta activity (4-8Hz; Chen et al., 2020; Rounds et al., 2020; Jung et al., 2023). Chen et al. (2020), for example, show higher theta power recorded from participants seated in a garden than at traffic island. Change in theta was associated with increased vigour and reduced fatigue. Rounds et al. (2020) found theta increased during exposure to buildings/landmarks with biophilic features (ie., those that incorporated rotational twist designs and natural elements, such as trees and gardens). However, inconsistent findings exist (Grassini et al., 2019), and such in-field studies are difficult to experimentally control. Virtual Reality (VR) allows investigation of the effects of biophilic features during an immersive experience, whilst enabling control over other experimental parameters (Jung et al., 2023). The current study used VR to investigate self-reported mood and theta activity as a function of biophilic interior design features. Improvement in mood and increase in theta activity was expected as biophilic features increase.

2. METHODS

Participants (n=33; 18-90 years old) provided subjective reports and underwent EEG assessment (32 channels, Emotiv Flex, sampling rate = 2048 Hz internally downsampled to 128 Hz) as they viewed interior university spaces (classrooms, stairwells, corridors) that had either no biophilic qualities (level 0) or biophilic features (increasing intensity, levels 1 to 3; see Figure 1).

Stimuli were presented using an HTC Vive VR headset. At level one, the nature of the space was manipulated to allow refuge and prospect. Level two additionally included natural analogues. Level three added elements of nature in the space.

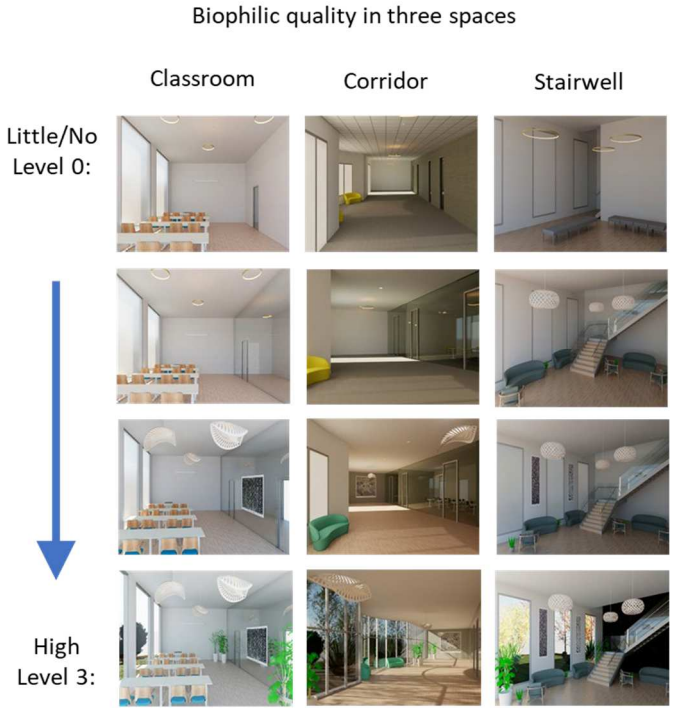

Figure 1. *Examples of stimuli. Level 0=no biophilic features; level 1= nature of the space altered; level 2= natural analogues added; level 3 = nature in the space added.*

Items from the Positive and Negative Affect Scale (PANAS; Watson and Clark, 1994) were used to measure subjective responses, based on four theories for biophilic benefit. Thus, these subjective responses included a positive- and a reversed-scored item to measure: i) Recovery from stress (*De-stress*; relaxed vs irritable); ii) *Restoration* of attentional resources (attentive vs fatigued); and iii) Provision of *Refuge* and prospect (self-assured vs frightened); and/or iv) fostering *Inspiration* and creativity (inspired vs downhearted). Signal processing was performed using EEGLAB (Delorme and Makeig, 2004). Data were re-referenced to the average and filtered using a 0.1Hz high-pass filter and a 60Hz low-pass filter. 30s epochs were created and independent components analysis was used to reduce ocular, cardiac and muscular artifacts. Epochs with residual artifacts were removed. Fast-Fourier transform was used to extract theta (4-8 Hz) power. Analysis of Variance was used to test for differences in PANAS scores and theta power as a function of biophilic *Level* (0, 1, 2, 3). Theta analysis was conducted at midline sites with an additional within groups variable, *Region* (frontal Fz, central Cz, parietal Pz); and at Lateral sites with *Region* (anterior frontal AF3/4, frontal F3/4, frontocentral FC3/4, central C3/4, centroparietal CP3/4, parietal P3/4) and *Hemisphere* (left, right) as additional within groups variables.

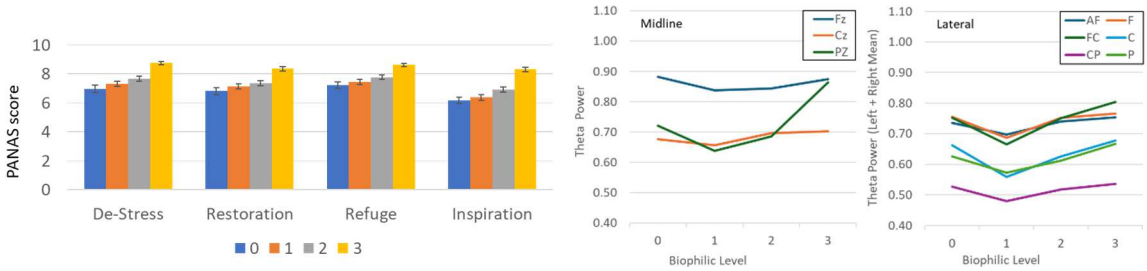

Figure 2. *Means for subjective response (left panel, error bars show standard error of means) and theta power (uV^2/Hz, right panels) as a function of 0-3 biophilic features. Lateral theta power was recorded over anterior frontal (AF), frontal (F), frontocentral (FC), central (C), centroparietal (CP) and parietal (P) regions.*

3. RESULTS

Figure 2 shows mean PANAS reports (left panel) and theta power (right panels) as a function of *Level*. For PANAS, there was a significant effect of *Level* (multivariate $F=8.41^{(12, 21)}$, $p<.001$, $p\eta^2=.83$, univariate $p<.001$ for each measurement). Effect sizes ranged from Restore ($p\eta^2=.46$) to Inspire ($p\eta^2=.60$). Theta at midline electrodes

(Fz, Cz, Pz) showed a significant effect of *Level* [$F=3.60^{(2.59,\ 83.00)}$, p=.022, $p\eta^2=.10$] and a significant *Level* x *Region* interaction [$F=2.99^{(2.58,\ 82.63),}$ p=.043, $p\eta^2=.09$], which was due to a significant effect of *Level* at Pz [$F=5.93^{(1.78,\ 57.00)}$, p=.006, $p\eta^2=.16$]. There was also a significant effect of *Level* at lateral sites [$F=5.47^{(2.44,\ 77.92)}$, p=.004, $p\eta^2=.15$]. No significant interactions were seen between *Level* and *age*, when included as a continuous covariate.

4. CONCLUSION

The current study used virtual reality to investigate the effect of biophilic features on mood and EEG theta power. Virtual reality provides advantages for a more robust experimental design, due to allowing deeper experiential immersion than images presented through 2D monitors and greater control over experimental parameters than real life. Self-report responses were based on four theories for biophilic benefit: Stress reduction, Attention Restoration, Refuge provision, and fostering Inspiration. In line with hypotheses, findings suggest an increase in biophilic features is associated with improvement in all subjective measures, with the greatest effect size for Inspiration. Moreover, the benefit of biophilic environments on mood is paralleled by alterations in brain function, independent of age. In line with previous work (Chen et al., 2020; Rounds et al., 2020; Jung et al., 2023), increasing biophilic features were associated with increases in posterior and lateral theta power. However, paradoxically spaces devoid of biophilic features showed higher theta than those with few biophilic features. This might reflect involvement of theta subtypes, that are differentially involved in positive and negative affect. Posterior midline theta has been associated with dopaminergic reward pathways and extraversion, whilst anterior theta has been associated with neuroticism (Chavanon et al., 2011). Theta subtypes may be related to specific elements in the biophilic designs. Future research on more design variations and incorporating other complementary psychophysiological measures (e.g., heart rate, skin conductance) would further support these ideas. Furthermore, confounding variables, not directly associated with biophilic features (e.g., stimulus complexity), might also have affected findings and should be investigated in future studies. Nevertheless, these novel findings contribute to an emerging body of evidence supporting the psychological benefit of biophilic built environments and underpinning brain mechanisms. Such evidence is important for policy decisions around the protection of green spaces, particularly in expanding urban areas, and for the design of built environments for work, education and healthcare facilities.

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Assessing emotional memory in VR

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ABSTRACT

In this study, we examined emotional memory encoding using virtual reality (VR). Our findings suggest that salient emotional stimuli affect memory encoding especially in high arousal situations. These results have important implications for understanding emotional memory processes and their use as diagnostic tools. It's important to address the study's limitations in its small sample size and homogenous population. Future research should include larger sample sizes and encompass more diverse populations for instance patients with anxiety disorders. This could further help understand emotional memory processes and aid in the development of effective diagnostic tools.

1. INTRODUCTION

To study human emotions and cognitive functions associated with them, affective states are often evoked in laboratory environment. In the research are mainly used non-immersive two-dimensional images or videos to elicit emotional states (for review see Skalníková et al. 2022). However, immersive virtual reality, which allows researchers to simulate environments in controlled laboratory conditions with high levels of sense of presence and interactivity, is becoming more popular in emotion research. The quality and variety of VR applications are rapidly increasing, providing a controllable approximation of the real world, crucial for studying emotional memory (Skalníková et al., 2022). There are robust trade-offs in memory when tested via recognition. That is, individuals do better at recognizing emotional elements within scenes than neutral elements, but they do worse at recognizing the contexts in which emotional versus neutral elements were presented (Kensinger & Corkin, 2003, Kensinger et al., 2007).

Imbriano et al. (2022) found that severity of PTSD symptoms, including depression, dysphoria, and panic attacks,was related to the tendency to remember studied negative material more accurately than studied neutral material. Importantly, negative memory biases can result not only from enhancements in memory for negative events but also from reductions in memory for positive events.

Our study therefore aimed to investigate how emotional stimuli are encoded in memory when presented using VR,and whether the valence and arousal of the presented scene affects the accuracy of memory for the contextual cuespresented.

2. METHODS

Twenty-three healthy participants took part in the experiment (11 men, 12 women, average age 22 18-35). All subjects were healthy, with normal or corrected to normal vision, and had no history or current symptoms of affective disorder.

Participants engaged seated in a VR scene that consisted of a set of 10 consecutively presented virtual rooms always equipped with the same basic furniture and varying in the four following parameters: (1) room wall color, (2) number visualised on the wall (3) dominant object present in the room (e.g. sofa, plant), and most importantly (4) animation of social interaction between two virtual avatars. Animations include various social interactions ranging from neutral (e.g., shaking hands) to emotionally loaded positively (e.g., hugging) or negatively (e.g., aggressive assault). One of the rooms was empty without the social cues (control room). Individual variants of these four parameters were randomly combined. The social interactions were selected to represent various emotional valence variants (positive, neutral, or negative), with three levels of arousal (low, medium, or high).

Participants were asked 30 minutes after the end of the VR scene to reproduce (recall) the presented combinations of the 4 above listed parameters shown in individual rooms using a set of paper cards. The 30-minute

window was chosen based on a pilot study using verbal emotional stimuli. To differentiate memory for emotional and contextual information we analysed two categories: "cue category" and "associated categories." Cue category referred to thefrequency of a parameter's recall used as the main association (e.g. how many times did the participants select a card with social situation). The associated categories comprised all categories stacked upon this cue category during the recall. To analyse the data, we employed the Friedman test. For pairwise comparisons we used the Dubin-Conover test. We normalized the counts of correctly and falsely associated categories by dividing them bythe number of associations used for each category.

3. RESULTS

Participants showed significant differences in the number of cue categories selected during recall ($\chi2(2) = 9.76$, $p = 0.02$, $df = 3$). Social interactions and objects were selected most often, with higher selection preference for social interaction compared to colors ($p = 0.03$) or numbers ($p = 0.003$) When normalized, significant differences were found in the counts of correct associations ($\chi2(2) = 13$, $p = 0.005$, $df = 3$) and counts of falsely associated categories ($\chi2(2) = 14.8$, $p = 0.002$, $df = 3$). When the social interaction was present in the stack participants made less correct associations compared to categories color ($p = 0.004$) and object ($p < 0.001$). In the case of counts of falsely associated categories when the social interaction was present in the stack participants made more mistakes compared to categories color ($p < 0.001$) and object ($p < 0.001$).

In means of social interactions selected during recall, the arousal levels differed significantly ($\chi2(2) = 6.3$, $p = 0.043$, $df = 2$), highest arousal cards were significantly more selected in comparison to the medium arousal ($p = 0.03$) and the lowest arousal ($p = 0.03$). Similarly associated categories varied for individual arousal levels ($\chi2(2) = 6.28$, $p = 0.043$, $df = 2$).

In means of valence of the social interactions selected during the recall, the sum of selected cards for each valencevariant did not differ significantly ($\chi2(2) = 2.59$, $p = 0.27$, $df = 2$) nor did the sum of associated categories ($\chi2(2) = 4$, $p = 0.16$, $df = 2$). However, when normalized, the correctly associated categories differed significantly between the valence variants ($\chi2(2) = 6.04$, $p = 0.049$, $df = 2$), participants made less correct associations when the negativevalence variant was present in the stack compared to the neutral one ($p = 0.02$).

4. DISCUSSION

This study aimed to investigate the encoding of emotional memory using VR and card recognition tasks. Findings of this study suggest that salient emotional cues attract attention of the participant and thus change encoding of othercontextual information present. This is prominent in the arousal level of the social cues where high arousal differedsignificantly from medium and low arousal. Understanding memory encoding could help design better diagnostictools to identify specific anxiety disorders. It's important to acknowledge the limitations of this study particularlyin its small sample size. Future research should address this limitation. Future studies should also include clinical population of patients with anxiety disorders to better understand the memory processes in emotionally loaded context.

In conclusion, this study highlights the significance of emotional cues in memory encoding processes and their possible usage as diagnostic markers in anxiety disorders. By addressing the limitations of this study, expanding the sample size, and targeting anxiety disorders, future research has the potential to develop new tools relevant to clinical research.

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Exploring Emotional Responses to Virtual Reality Environments in Younger Adults

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ABSTRACT

The study investigated the emotional responses of experienced and non-experienced virtual reality (VR) users to VR environments. While a discrete significant difference was found between the two groups, the findings suggest that positive affect may be associated with specific VR environments, as evidenced by a decline in Positive and Negative Affect Schedule (PANAS) scores for positive affect among experienced users. The observed pattern of increased excitement following exposure to the exciting VR condition and decreased excitement after a calm VR condition highlights the significant influence of VR experiences on emotional states. These findings underscore the potential of VR technology to modulate emotions and facilitate design of experiences for various applications, including entertainment, therapy, and education.

1. INTRODUCTION

Virtual reality (VR) environments create a sense of presence by immersing individuals in simulated realistic stimuli (Schöne, 2023). This sense of presence has the potential to generate a variety of emotional responses, including positive mood such as peace and excitement, as well as negative emotions such as anxiety and fear (Hariyady, 2021). As VR technologies become more widely used in health, technology, and education, it is increasingly important to understand their role in users' emotional states. Studying participants' emotional responses in virtual reality environments can provide valuable insights not only for engaging experiences (Mancuso et al., 2023), but also for designing virtual reality experiences that consider the emotional well-being of individuals.

Another important aspect to focus is on different user groups, especially if VR users are experienced or new to the technology. Therefore, understanding the responses of both experienced and non-experienced users to virtual reality (VR) is crucial for the effective application of VR technology in psychology. By examining how emotional reactions vary between these groups, psychologists can develop VR interventions to maximize therapeutic efficacy and user engagement (Baker, 2021; Freeman et al., 2017). Hence, the goal of this study is to investigate the emotional responses elicited by VR experiences among two distinct groups: experienced VR users and non-experienced in the psychology field.

2. METHODOLOGY

2.1. Methods

This is a cross-sectional study, where young adults were exposed to two VR environments, and emotionally assessed in terms of arousal, valence, and acceptance of virtual reality through two different self-report questionnaires: 1) Self-Assessment Manikin (SAM) questionnaire, which provides a pictorial scale for participants to express their emotions in three dimensions of emotion, namely pleasure (valence), arousal and dominance (Bradley, 1994); and 2) PANAS (Positive and Negative Affect Scale) questionnaire, which consists of 20 items measuring two basic dimensions of emotions (positive and negative). It asks participants to rate how often they experience certain emotions on a scale of 1 to 5 (Watson, 1988). Participants were divided into two different groups (experienced and non-experienced) according to their frequency of VR use. The inclusion criteria for this study were the absence of a diagnosis or psychiatric or neurological disorder; individuals with normal or corrected-to-normal vision; and young adults aged from 18 years old.

2.2. Procedure

We looked at how virtual reality (VR) environments make individuals respond emotionally to different simulated realistic visual environments. VR Quest 2 goggles were used, with which participants immersed for approximately 4-minutes, twice. One environment was a calm beach (calm condition), and the other, a parachute jump from a cliff (exciting condition). The procedures took about 30 minutes for each participant. Besides the demographic's questions, the two questionnaires (PANAS and SAM) were answered before (pre), after the first VR experience (mid), and after the second VR experience (post).

3. RESULTS

A total of 87 participants were included. Their mean age is 21.2 (SD = 1.83), and 21 participants are male. Regarding experience with VR, 80.5% are categorized as non-experienced, while 19.5% are experienced. After running a repeated measures ANOVA for both questionnaires: PANAS and SAM. Comparing the SAM results, we noticed that within-subjects effects indicate significant differences across both conditions and time points (pre, mid and post). Time point effects show some significance when interacting with conditions ($F(2, 166) = 4.75$, $p = 0.01$, $\eta^2p = 0.05$). However, interactions involving previous VR experience were not significant. Notably, the SAM factor's interaction with time points and conditions significantly impacted participants' responses ($F(4, 332) = 5.38$, $p < .001$, $\eta^2p = 0.06$), suggesting that emotional states vary across the three time points and conditions (calm and exciting). Furthermore, between-subjects effects did not indicate significant differences in SAM responses.

After a Post Hoc analysis on SAM x Time x Condition, it is possible to see that the happy mood slightly increased (scores are to 1=happier, and 5=unhappy) after both VR experiences, however more accentuated when the VR experience started with the exciting condition and ended with the calm one. Another important observation is that participants increased in excitement (scores are 1=excited, and 5=calm), as you can see in the Figure 1, when the first VR experience was exciting, and the opposite was observed when the first VR experience was calm.

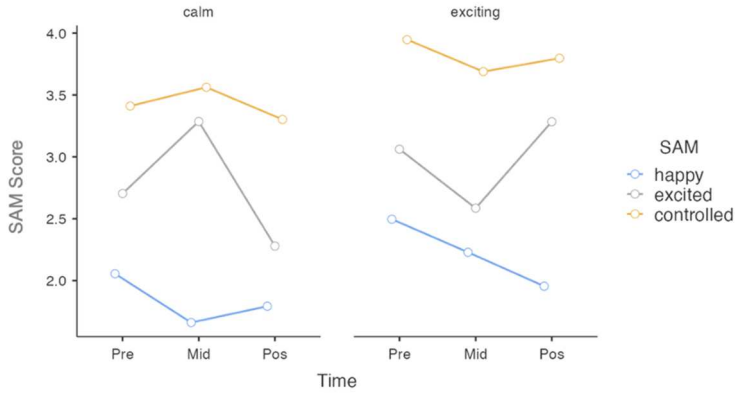

Figure 1 Self-Assessment Manikin (SAM) *scores. Time: pre = before VR experience; mid = after the first VR condition; Pos = after the last VR condition.*

Regarding PANAS, the within-subjects effects analysis reveals a significant interaction between PANAS, Time, condition and Experience ($F(2, 166) = 4.29$, $p = 0.01$, $\eta^2p = 0.04$). First it is possible to observe a difference between PANAS positive scores as illustrated in Figure 2, where Non-experienced VR users start with lower positive scores than experienced VR users when the first VR environment condition is exciting; however, this score decreases for experienced after the VR Calm condition. When the first condition is calm, experienced users increase in positive scores for PANAS, while non-experienced has a subtle decrease.

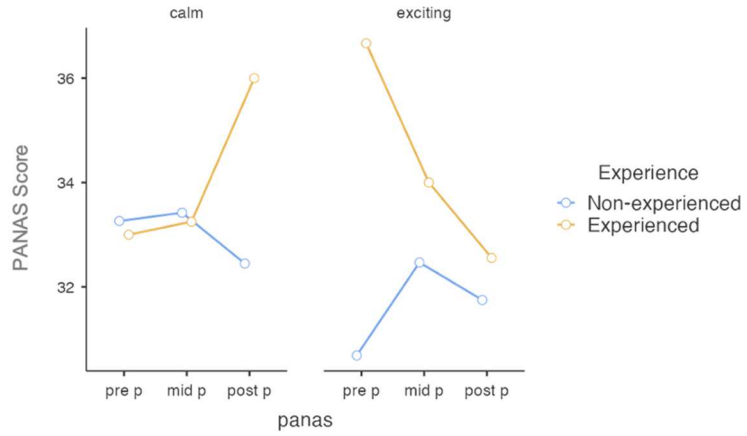

Figure 2 Positive and Negative Affect Schedule *PANAS scores for positive mood among experienced and non-experienced VR users. Calm = the first VR experience is calm. Exciting = the first VR is exciting.*

4. DISCUSSION

Our findings pointed out a discrete significant difference on experienced vs non-experienced VR users across exciting and calm environments. It allowed us to associate that positive mood can be associated with another type of environment, since this group had a decline into PANAS score for positive affect. As these users already have experience with VR, they might have certain expectations that do not comply with 4-minute pre-determined experiences, especially the calm condition. On the other hand, the non-experienced group increased the positive mood as they reported higher positive affect at the end of the whole experience. The novelty of the technology can play an important role into this finding as they highlight the influence of VR experience and environmental conditions on emotional states, providing valuable insights for understanding people's experiences in VR environments. Additionally, the observed pattern of increased excitement following exposure to the exciting VR condition and decreased excitement after a calm VR condition (figure 1) suggests a significant influence of VR experiences on emotional states. This finding underscores the potential of VR technology to elicit and modulate emotions in users, which has implications for various applications such as entertainment, therapy, and education. Understanding how VR environments affect emotional responses can inform the design of more immersive and engaging experiences tailored to specific user preferences and objectives.

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Education

The session on Education highlighted innovative uses of VR for enhancing learning and skill development. Presenters showcased VR's potential for immersive teaching, including using first-person VR simulations to teach psychopathology, offering a unique perspective on mental health conditions. Game-making tools were developed for socially marginalised groups to foster creativity and inclusion through co-designing activities. The use of VR for ethical decision-making training was discussed, with insights into its impact on learning outcomes. Memory techniques like the Method of Loci and PEG system were adapted into VR for ADHD patients, showing promise in improving learning efficiency. Additionally, realistic avatars were modelled for negotiation training games, enhancing user engagement and realistic scenario practise. Overall, the session demonstrated VR's versatility as a powerful tool for education and cognitive development.

Teaching Psychopathology from a First Person Perspective using VR simulation

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ABSTRACT

The proposed study applies an immersive VR simulation of selected psychiatric disorders from 1st person perspective aimed as a learning tool for medical education in psychiatry and clinical psychology. The game was tested and evaluated by a small number of experts in the field and a larger group of undergraduate medical students. The game was well received and rated as acceptable in means of system usability and cybersickness. While most of the features simulating psychiatric symptoms were well recognized, some specific features are in need for improvement in future game development. Future studies should evaluate the education potential of this experiential learning game in more detail, including the attitudes and emotional responses elicited by the simulation.

1. INTRODUCTION

Recently, virtual simulations are used to provide education tools for medical students and other mental health professions, as well-designed simulated scenarios could promote complex clinical skills and empathetic consideration of mental disorders (Piot et al, 2021). The most common approach utilizes virtual patients demonstrating symptoms typical for the simulated mental disorder (e.g., Kenny, Parsons, Gratch, Leuski, & Rizzo, 2007; Formosa, Morrison, Hill, & Stone, 2018). The proposed study applies a different approach demonstrating the symptoms from the 1st person perspective as a learning tool for psychiatry and clinical psychology students, providing first-hand experience, typical for destigmatisation studies. The proposed study aims to utilize simulation-based education approach to provide active engagement through experiential learning, by examining the preliminary feasibility of an immersive virtual reality (VR) education game that simulates the personal experience of the symptomology associated with manic and depressive phase of bipolar disorder (BD) and symptoms of psychotic disorder.

2. METHODS

2.1. Mental Health Disorders Simulation game

The simulation game was designed using Unity game engine. The psychiatric symptoms were simulated in a form allowing future extension to other diagnostic groups. The game also allows some scalability of individual symptoms (e.g. intensity of changes applied) to be potentially adjusted by the professional user (lector) as needed. Various visual and audio (verbal) effects were utilised to simulate selected psychiatric symptoms including positive and negative symptomatology (e.g. speed of movement, motion blur, bloom, vignette, chromatic aberrations, and sounds, voices simulating inner voice vs. hallucinations, reflecting the changing mood). These disorders were selected for several reasons: they are manifested by complex symptomatology, the symptoms can be to some extend simulated by visual and verbal cues, the changes presented in the behaviour, vision and verbal

commentaries can be easily recognised in contrast to simulation of a normal state. The repeated feedback provided by few experts at every stage of the development was essential in the game design.

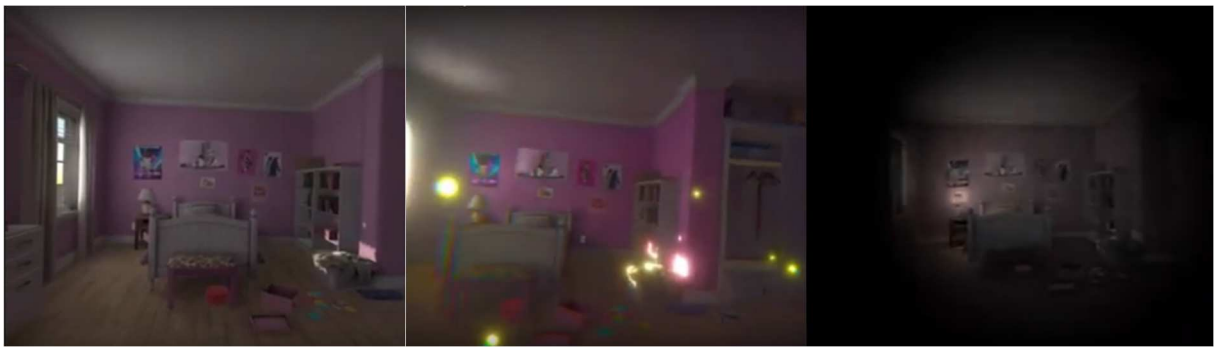

Figure 1 *Illustration of the visual effects used in the virtual environment to simulate symptomatology associated with bipolar disorder (remission, manic state, and depressive state).*

2.2. Study sample and procedure

The study sample comprises of 60 participants, including medical professionals (psychiatrists, psychologists, n=7, age 27-56, 4 females) and 53 undergraduate students (age 19-29, 34 females) recruited from the medical studies at 3rd Faculty of Medicine, Charles University and psychology students at the Faculty of Arts, Charles University.

Participants completed a VR game "Mental Health Simulation" presented via Meta Quest 2 VR headset. The game comprised of four short simulations presenting Normal behaviour (or remission), BD manic phase, BD depressive phase, and Psychotic disorder. All participants started the simulation with the normative behaviour and then were allowed to switch between individual states at any time point. During the simulation the participants could freely move around the house environment comprised of 2 floors and a basement. After the experience the participants filled in an online questionnaire including measures exploring user-experience System Usability Scale (SUS), cybersickness symptoms, recognition of specific symptoms in the app and some open-ended questions for suggestions to improve. In addition, the medical professionals also evaluated clarity and adequacy of the mechanics of simulated symptoms.

3. RESULTS

In means of system usability, the results obtained from both groups point in favour of the good usability of the application, as the game was rated mostly as acceptable (SUS score above 80), present cybersickness symptoms were mostly rated as none or weak. The scoring of individual symptom mechanics was also rated positively and majority of symptoms were recognised by the experts and students. However, the obtained results suggest some improvements are needed. For example, the ambient sounds used in the game were often not recognized, and the users had troubles to distinguish between simulations of inner speech and hallucinations, as the AI generated voice used was not gender specific and could be perceived as robotic. In addition, the simulation of more complex behavioural patterns (e.g. quality of sleep, social interactions or shopping behaviour) were mostly not recognised by the students, as they were represented only in a form of description or numerical data presented using the simulated smart device (associated with the game Menu). All the mentioned features thus need some improvements and increased control in the future experimental design. In addition, as the participants were allowed to freely move around the house, the simulated features might be perceived differently by individual participants, as some were more pronounced in different rooms (e.g. chromatic aberration was more visible in rooms with colourful items). This limitation could be in future addressed by constrained movement with specific tasks that have to be performed during the game.

4. DISCUSSION

The presented feasibility study provided important feedback about the good usability of the educational game and the potential of the utilized features to illustrate the simulated psychiatric symptoms. The feedback provided by the participants will be used for the future game development and experimental design. Future studies should

evaluate the education potential of the game in more detail and incorporate also measures addressing the attitudes and emotional responses provoked by the 1st person simulation.

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Enabling Creativity through Game Making for the Socially Marginalised: Co-Designing a Game Making Toolkit

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ABSTRACT

Digital games, and in particular, online games play an increasingly important role in facilitating and shaping social interactions amongst young people. In particular, those at risk of social exclusion often find an outlet and sense of belonging within games and gameplay. This passion for games can be leveraged to provide new pathways to education and learning and open means of engaging with creative output and wider education. Indeed, creativity in game design itself can lead to development of personal meaningfulness and have range of positive mental health outcomes. There is a need for inclusive game design practices and proposals for what these practices may look like as a tangible design tasks. Furthermore, work is needed that explores what impact these processes could have with a particular focus on those at risk of social exclusion as games offer an opportunity to engage such students with a creative process. Hence, this work sought to examine what role game making could play in enabling creativity. This included examining the use traditional paper prototyping and using emerging technology such as generative AI to reduce barriers to access. Through a co-design approach, a game making toolkit was collaboratively developed and tested with teachers and students. This paper report on the initial development and piloting phases.

1. INTRODUCTION

Videogames are increasingly becoming a primary source of entertainment among young people with the average time spend playing games (online and offline) standing at nearly 12 hours weekly in 2019 (Kienast, 2019). The impact of the popularity of videogames is well researched in academia with a particular focus on its relationship to mental health and identity development. Negative impacts include addiction (Kuss and Griffiths, 2012), exposure to toxic online communities (Kordyaka et al., 2020), and feelings of social exclusion and inequality (Birk et al., 2016). However, recent work has suggested that the research community often exhibits a concern-evidence mismatch and the focus on negative impacts often lacks theoretical consistency (Vuorre et al., 2022). Where videogame addiction is concerned, for example, prevalence rates for "excessive gaming" vary between 1% to 10% with most studies findings rates between 1% - 5% (Saunders et al., 2017), suggesting that a gaming and related culture is an issue for a relatively small minority of the gamers.

Indeed, taken in moderation games provide an important outlet for young people to socialise and exercise creativity. In particular, marginalised groups appear to find core meaning in engaging with games. Those with Autism Spectrum Condition (ASC) often will see being a "gamer" as a core part of their identity (Ringland, 2022). Indeed, such groups see higher rates of engagement with games that may be seen as addiction; however, for such groups this perhaps better fits the definition of a restricted interest, an intense interest in a specific topic or domain (Coutelle, et al., 2022) and is therefore of key importance in providing an outlet, sense of self and a platform for accessible socialisation. With the importance of game culture to this groups noted, there is opportunity to leverage this interest to create new learning pathways. For example, engaging with game the game making process can enable creativity and increase engagement with learning (Hughes-Roberts et al., 2022). However, this approach must be sustainable, low tech and cheap to implement to provide an actual reduced barrier to access. Hence, this paper explores the role "paper prototyping" can play in reducing barriers to access to the game making process and what impact this could have for students at risk of social exclusion. This work defines paper prototyping as the lo-fidelity practices of game development that do not require highly technical resources to engage with. For example, this could include, storyboarding, production of game art, use of modelling clay to visualise game assets or other tangible tools for aspects such as level design.

2. METHODS

This work took a co-design approach to developing a game making toolkit by bringing together key stakeholders included teachers, teacher assistants, artists, and students from differing backgrounds and levels of ability. Participants were recruited from two schools that specialise in students at risk of social exclusion. This included individuals with individual learning needs and students with significant behavioural issues that have led to placement in a Pupil Referral Unit (PRU) school; students from both cohorts represent those who have been deemed unable to engage with mainstream education. The project took a user-centred approach and carried out the following data collection sessions and co-design workshops:

1. Two focus groups with each participant school group to gauge their current engagement with games and game making.
2. A co-design session with academics, teachers and students to examine the range of lo-fidelity game making tasks that are defined in literature, evaluate their applicability and propose a cohesive game making toolkit for use by targeted stakeholder groups.
3. A piloting session to evaluate the game making toolkit and overall session protocol with target participants.
4. A final workshop session informed by the pilot to evaluate the final toolkit and overall session protocol.

Qualitative data was gathered through each of these workshops which were designed to capture the participant perceptions and allow them to feed into the final design of research outputs. In particular, the sessions sought to evaluate themes of creativity, collaboration and engagement as defined and noted in past work (Hughes-Roberts et al., 2023). Furthermore, the toolkit was evaluated for its ability to reduce barriers to access to game making and, by extension, feelings of creativity it elicits. Through these sessions and co-design workshops, the project explored their relationship with games and game culture, evaluating methods of paper prototyping to co-develop a game making toolkit and conducted some initial pilot tests of this toolkit.

3. RESULTS & DISCUSSION

Data collected in the initial workshops discussing relationships with games validated wider research which suggested games and game culture inform a significant part of the lives of young people represented by this studies' participants. Initial data also suggested that this relationship is more nuanced for different groups of young people who may be socially marginalised which warrants further exploration. The co-design session further explored these themes through the evaluation of potential game making tasks and included input from teachers and artists. This workshop developed the final bank of paper prototyping activities that made up the game making toolkit. This toolkit identified core game prototyping tasks and associated activities that could be used, such as:

- Core concept definition or "elevator pitch" – the use of concept maps, or text narratives.
- Game aesthetic – the use of mood boards which could be paper based or digital using tablet apps.
- Level design – the use of graphing paper, more tangible material, e.g., Lego or similar, or the use of Generative AI to produce art representing levels.
- Game narrative – the use of storyboards.
- Character Design – the use of tangible activities using modelling material, e.g., clay or similar. Again, the use of AI was proposed to generate characters in specific styles or levels of fidelity.
- Game mechanics and rules – a statement of what players can and cannot do. Participants suggested the use of tabletop games which organically generate rulesets through play. However, the sustainability of such an approach was questioned.

As noted, the framework proposed the potential use of generative AI to reduce barriers of access to the creative process, e.g., for learners who feel unable or lack confidence to express creative output due to skill etc. This raised a question for further research examining how generative AI could be used as an enabling technology for those at risk of educational exclusion.

Finally, the toolkit and associated tasks was trialled in two piloting session with the same groups of students who created their own game designs. The first was designed to gain initial feedback on the engagement the identified tasks offered but also sought to define a session protocol that could be used in wider trials. For example, it was determined that sessions can be no longer than two hours when working with the target participants in this

study; tasks centred around drawing were less favourable; sessions were more effective when formalised into group work to create a single game rather than one each; and the toolkit must be offered to groups through a "flexible" approach. This protocol was then evaluated in the second session in a final pilot where two groups of participants utilised the toolkit to create a full game paper prototype.

Initial results suggested that this low-tech means of accessing game making elicits feelings of creativity and pride. Within the final two-hour session, groups were able to create a fully-fledged game concept and design with examples of game assets and game rulesets. These were developed in full game prototypes by Higher Education students to demonstrate the "completeness" of the designs. Furthermore, group-based application of the toolkit enabled collaboration and the use of generative AI played a role in enabling students to express their ideas visually when unable to do so through explanation or artistic expression. Full paper will define the toolkit, explore findings in detail and detail a full trial of the game making toolkit in with 150 participating school children recruited from a local East Midlands inner city school.

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What happened after ethical decision-making training went virtual: some features about VREthics Application

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ABSTRACT

This pilot study assesses the experience of 113 internship psychologists while using a technological tool to train internship psychologists at the Portuguese Psychologists Association. The study found positive perceptions of the application, with participants noting its immersive learning experience. Correlational analysis revealed a link between flow states and positive VR experiences. While errors in decision-making were observed, participants expressed satisfaction with the training process, suggesting improvements in interface clarity and avatar realism. Overall, the findings highlight VR technology's potential to enhance psychologists' training, particularly in ethical decision-making, marking a significant advancement in leveraging technology for professional development.

1. INTRODUCTION

The use of technological tools, more specifically virtual reality (VR), presents itself as the next logical step in the development of psychological science. It allows psychologists to train skills essential to practice in a safe environment designed to meet needs, closing gaps between theory and practice (Oliveira et al., 2021). In response, in collaboration with HEI-Lab: Human-Environment Interaction (COFAC), the Portuguese Psychologists Association developed VREthics in 2020. This VR application targets ethical decision-making training for internship psychologists, focusing on theoretical concepts and principles outlined in the Code of Ethics and was integrated in the Junior Psychologist Initial Training course, in a 24h module that tackles ethics and professional deontology. VREthics immerses users in fictitious clinical cases, like one involving a client seeking help after being sexually molested by a family member, prompting trainees to navigate ethical dilemmas. Such training is expected to enhance flow states, a type of experience characterized by a complete concentration on the activity, a sense of control, loss of self-consciousness, and distortion of the perception of time (Csikszentmihalyi, 1990).

2. METHODOLOGY

2.1 Participants

A pilot study was carried out between November 2023 and March 2024, involving 113 internship psychologists, mostly female (84.1%), unmarried (88.5%), and with an average age of 27.49 years (*SD* = 6.29). 95.7% had Portuguese nationality, and the majority (61.1%) had completed a master's degree in Clinical and Health Psychology. 50.4 % of participants had never experienced virtual reality before.

2.2 Procedure and Measures

Participants enrolled in the Junior Psychologist Initial Training course in Lisbon and Porto since November 2023 were recruited for this pilot study. They provided informed consent, acknowledging the integration of virtual reality in the psychologist's ethics and professional deontology module. During a face-to-face session, trainees utilized this VR application to engage in ethical decision-making scenarios. Subsequently, participants completed a questionnaire covering: socio-demographic information, perceptions of innovation, sense of presence, learning

outcomes, satisfaction levels, cybersickness, and the Dispositional Flow scale - DFS-2 (Gouveia et al., 2012). Additionally, they responded to two open-ended questions regarding positive aspects and areas for improvement.

3. RESULTS

The **quantitative data** analysis was conducted using IBM SPSS Statistics version 28.Descriptive analyses of the different scales under study were performed. Among the 113 participants, the perception of innovation concerning VREthics (M = 4.68; SD = 0.69) was the response with the highest values, followed by the perception of satisfaction (M = 3.97; SD = 1.06); learning (M = 3.85; SD = 1.10), sense of presence (M = 3.74; SD = 1.24), and finally cybersickness (M = 2.05; SD = 1.01). Participants committed an average of 1.75 errors in choosing the most appropriate ethical decision (SD = 2.41), ranging from no errors to a maximum of ten errors. The patterns of associations between the variables was performed using a pearson correlation. Generally, the flow level seemed to be associated with more of a positive experience, showing positive and significant associations with the perception of innovation (r = .304, p < .001), sense of presence (r = .400, p < .001), learning (r = .423, p < .001), and satisfaction (r = .375, p < .001). Conversely, the number of errors in choosing the best decision is significantly but negatively associated with these dimensions: innovation (r = -.201, p = .033), sense of presence (r = -.249, p = .008), learning (r = -.226, p = .016), and satisfaction (r = -.276 p = .003).

The **qualitative data** analysis resulted from using content analysis using Nvivo 14 software. The responses revealed a highly positive reception of this application. They highlighted the realistic experience in contact with clinical cases and the feeling of being present. Additionally, they praised the innovative learning methodology, emphasizing its effectiveness in facilitating skill and knowledge development. However, they also identified areas for improvement, such as interface clarity and graphic quality, suggesting greater emphasis on therapist-client interaction and avatar realism. Furthermore, they expressed discomfort with equipment and external distractions, emphasizing the need to minimize environmental noise and allocate more time for application tasks.

4. CONCLUSIONS

This study underscores the transformative potential of VR technology in advancing the training of psychologists, particularly in ethical decision-making. By providing a simulated yet immersive environment, VR offers a unique opportunity for trainees to engage with complex ethical dilemmas in a controlled setting, thus bridging the gap between theoretical knowledge and real-world practice. The findings revealed positive perceptions regarding the innovation, learning experience, and overall satisfaction with the application. Participants reported a strong association between experiencing flow states and positive dimensions such as innovation, sense of presence, learning, and satisfaction, further underscoring the effectiveness of VR-based training. While participants identified areas for improvement, such as enhancing interface clarity and avatar realism, their feedback broadly supports the potential of VR technology to enhance ethical training and contribute to the continued professional development. This study signifies a relevant step forward in leveraging technology to empower psychologists with skills and competencies to effectively navigate ethical challenges in their practice.

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Method of Loci and PEG system in VR as learning method for patients with ADHD

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ABSTRACT

Patients with ADHD often face learning difficulties due to an inability to focus on a task, problems with organization and processing of information due to impairments in working memory. Various memory techniques such as Memory Palace or PEG system might help to overcome these difficulties, because they transform abstract disconnected information into interconnected visual memories. This study tests the possibility of practicing these memory techniques in the VR environment in order to make the memory techniques easy to use by individuals with ADHD.

1. INTRODUCTION

ADHD conditions often negatively influence ability to learn, leading to poor results in school and related issues (Visser et al., 2022). It is treated by medication, but also by various cognitive exercises and techniques. Memory techniques such as PEG system or Memory palace, also known as Method of Loci (MoL), might be beneficial for patients with ADHD and alleviate some of the learning related issues (Ruchkin et al., 2024).

These memory techniques leverage the brain's natural inclinations for visual processing, association, and storytelling. They transform abstract or disconnected pieces of information into concrete, visually stimulating, and interconnected memories which makes them efficient learning methods. Even though there are some drawbacks, such as high requirements on visuospatial imagination and need for intensive training, overall, they might be beneficial for people with ADHD, since they often find that their attention is more easily captured by engaging, dynamic, and interesting tasks. By creating vivid associations and structured paths for information retrieval, these techniques can help mitigate some of the working memory challenges associated with ADHD, making it easier to hold onto and manipulate information in the short term.

The feasibility study (Ruchkin et al., 2024), aimed to investigate potential of practicing the MoL by children and adolescents with ADHD. Results indicate improvements in memory test performance and with a decrease in both self- and parent-rated ADHD symptoms, suggesting the training's potential effectiveness. Most participants and their parents found the MoL training to be feasible and beneficial, though they suggested improvements since the method was found demanding and unmotivating.

1.1. Method of Loci and PEG system

Method of Loci is usually based on attaching new knowledge, usually an object serving as a mnemonic device, to existing knowledge of a well-known space such as one's home or an office. Previous research showed that even in novel space in VR people can quickly memorize the new environment, attach mnemonic devices and thus create memory traces in long term memory caused by episodic visuospatial experience (Novotník et al., 2023). We expected that it would be the same for people with ADHD. We combine this technique with mnemonic memory aid - the PEG system, which is usually a set of objects representing digits or letters in one-to-one manner. In our case the PEG system transforms abstract shapes of digits (0-9) to 3D objects, which have some similarity in shape or numerical connection with the digit, see Fig. 1. This combination of memory techniques is quite common and is intended for memorization of numerical sequences such as phone numbers, passwords, physical constants or dates.

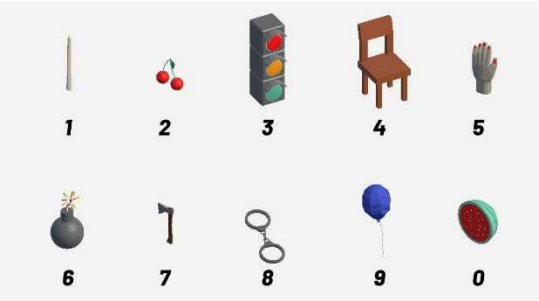

Figure 1 *The PEG system used for the VR application. It is a set of objects representing digits from 0 to 9. Objects have some similarity in shape or numerical connection with the digit.*

1.2. Memory techniques in VR

In our research, we integrate the MoL and PEG system within VR environments to overcome the extensive training required by traditional memory techniques. When practicing the memory techniques traditionally, users imagine the mnemonic spaces and objects in their head. By displaying them directly in VR, we enable immediate learning without prolonged training required by the memory techniques. This technology, proven to enhance engagement and reduce distractions (Huang et. al, 2021), might also particularly benefit ADHD users by limiting disturbing sensory input. Our combined use of MoL and the PEG system, allows the encoding of numerical information and memorization of sequences like phone numbers or historical dates. Evidence suggests that users can quickly form lasting memory in such VR environment, a benefit we aim to extend to those with ADHD.

2. METHODOLOGY

2.1. Virtual reality environment and UI

We tested three VR environments displaying three scenes with various spatial layouts. Users navigated themselves through teleportation and the system allows 6DoF. Objects were generated through a dial placed in the hand of the user, see Fig. 2. Generated objects were then frozen in space and could be freely manipulated by the controllers of the VR system. We tested a series of nine numbers in each scene, simulation of a scenario for memorizing a phone number.

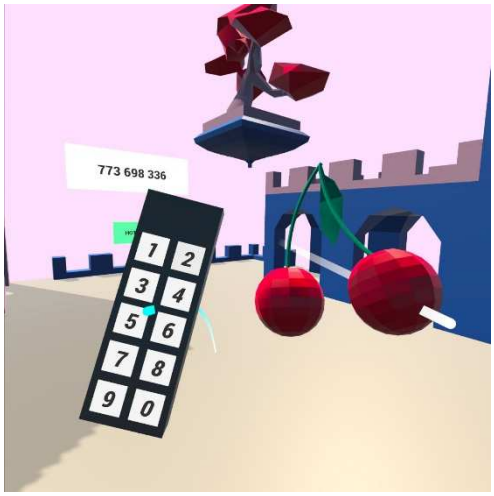

Figure 2 *A screenshot from the VR environment displays also UI with controllers.*

2.2. Setup of the experiment

Two days before the VR session, the subject received an image with a PEG system - a set of objects assigned to numbers with instructions to memorize it. Before the VR session we introduced the technique to the subject and explained how to navigate and control the VR environment. In the VR there are two testing scenes - one to train navigation in VR and second to train manipulation with the objects.

3. RESULTS

3.1. Pilot study

The pilot study was conducted with two males (40 and 27 YO) diagnosed with ADHD. The first subject had only limited previous experience with VR or memory techniques. After the first trial, the subject memorized a sequence of nine numbers without any problems, which normally posed quite a challenge to him. During recall he used episodic memory created in VR. The information remained in the memory even after one week from the VR session. Method was assessed as beneficial by the subject and the subject expressed interest in further participation in the research and potentially in practicing the method. One of the numbers sets we tested with this subject was a phone number of his relative, which he wanted to memorize but was not able to. This number remained in his long memory even one month after the pilot test and transferred from episodic to semantic memory. During recall he no longer used the visuospatial aid created in VR but recalled directly the number.

The second subject had no experience with VR which proved to be a challenge during the testing. During the first experimental VR scene the subject experienced strong feeling of awe caused by the novel experience of VR technology. Even though he managed to complete the task, he self-reported that he was not able to focus on the task because of the overwhelming experience and he did not remember the number. During second and third VR scene we observed slow reduction in this effect, which was seen also in the results as the third number the subject was already able to memorize and which remained also in long term memory. This was confirmed during the debriefing phase by the subject.

4. DISCUSSION

During our pilot testing we managed successfully to run a VR simulation of a memory palace with ADHD users. Results were rather promising when the learned information remained in long term memory of the users. The users self-assessed the method as beneficial and could imagine its further use especially for students. Of course, the result regarding memorization of number of a relative are biased because of the previous exposure of the subject the number sequence, however it shows potential for practical usage. What caught our attention in this case was the transfer from episodic to semantic memory. It seems crucial for subjects to have previous experience with VR or expand the initial testing scenes, since this heavily influenced the results. Our aim is to expand the testing on a larger group of ADHD patients and verify the initial findings.

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Modelling realistic avatars for the "P-game"

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ABSTRACT

It is challenging to convey to students how science and policy interact in environmental studies and social sciences. In this context, simulating environmental negotiations in serious games are effective experimental learning tools that can help. This paper presents the second version of the Negotiation Serious Game. How realistic avatars were developed for the game.

1. INTRODUCTION

Negotiation is a part of our daily lives. We all negotiate for several purposes to deal with. However, considerable research pointed that most people find it difficult when it comes to negotiate, for example, two studies conducted by Fisher et al. 1981; and Hindriks and Jonker 2008, have presented this scenario more considerably. Besides, there are a number of courses, such as live and virtual, that can help to improve the negotiation skills of participants. The goal of these negotiation training systems is either to offer people opportunities to practice or to impart knowledge (Ding et al. 2020). Concerning this issue, recently, researchers at the University of Continuing Education Krems (UWK) started developing a serious game dealing with sustainable Phosphorus (P) production and management that aims to improve the negotiation skills of people. The game was thus dubbed the Phosphorus Negotiation Game (P-Game). The P-Game was inspired by two environmental negotiation games previously developed at the Massachusetts Institute of Technology (MIT). Najam (2001) developed the Chlorine Game for his dissertation: "Getting beyond the lowest common denominator: developing countries in global environmental negotiations". Building on the good experience of the Chlorine Game at MIT, Stokes and Selin (2016) developed the Mercury Game at the same school that simulates the global mercury treaty negotiations at the United Nations (UN). Both a live and virtual version of the P-Game are being developed at UWK (live game) and the University of Pannonia (UP) (virtual game) at the moment. Although our virtual game was already completed and tested earlier Lovas et al. (2022). We wanted to include much more realistic avatars in the game compared to the prototype.

2. METHOD

The virtual P-game consists of a virtual environment and a smartphone application so that participants can easily and comfortably participate in the game with their own mobile phones (smartphones). Since the P-Game follows the rules of British Parliamentary Style debating and we want to compare the live simulation with the remote virtual simulation, we consider it important that students in the virtual P-Game have avatars for better immersion.

We also created animations for the avatars to make them more realistic. We created different movement animations for the 8 players in random order. For example: resting your head, yawning, nodding, looking at each other, drumming on the table, leaning back, looking to the side, sneezing, stroking your hair, scratching your head, whispering to a neighbour, responding to a speech by nodding your head, disapproving, etc. We alternate these movements. We use a total of 1440 frames in our one-minute movement plans. Our 1440-frame schedule produces eight different movements, i.e. a total of eight minutes of action.

The latest version of the game was made in Unity. The goal is to replace the old avatars with new ones more similar to real people. Another goal is to create a new game area and animate the avatars within. We used

MakeHuman and Blender programs for the creation of the new avatars. The creation of the clothes and the animations only needed Blender. The new room created in Blender represents a home environment. For some components of the room, we used the Blenderkit online Blender library. We replaced the sitting and standing versions of the old avatars with the new ones in the game's Unity library. We replaced the old office room with the new one, where the arguing part of the game is happening. The displaying part of the GameID and portioning of the animations between the avatars are coded in Unity. We used C# programming language for the coding, because this type is required by Unity.

After the development process the System Usability Scale (SUS) questionnaire was used for testing. In the composition of the questions, we tried to cover both the ease/difficult usability of the program and the goodness of the visual elements.

3. RESULTS AND TESTING

The new environment created is more modern than the previous version. The movement of the avatars is much more realistic:

- spontaneous movements, e.g. turning to the side, fidgeting in a chair, leaning back, elbowing, etc.
- direct movements, e.g. leaning over to the neighbour (whispering), taking notes, etc.

As an avatar is assigned to a student, a visual effect will occur on the respective avatar when a student starts to speak/use a recording. These recordings can easily be prepared with the smartphone application (similar to TikTok, Snapchat or Instagram Reels). Raising questions will be more difficult than it is in the live simulation, and we will look at different ways how interaction between the participants could be realized in the virtual realm.

The System Usability Scale (SUS) questionnaire was used for testing. In the composition of the questions, we tried to cover both the ease/difficult usability of the program and the goodness of the visual elements.

We tested the game with 10 people. The standard SUS questionnaire was used, but we modified the 5th,6th,7th, and 8th questions to focus on the new visual elements. (5. The animations helped the game experience and were not distracting. 6. I think the application's visual design was difficult to interpret. 7. The elements of the game (e.g. characters, playing area) were attractive to me. 8. The visual style of the game did not match the theme or purpose of the game.)

We would highlight a few statements where the opinions were the most divided/agreed.

- 3rd "I think this app is easy to use." For this particular statement, only three out of 10 respondents completely agreed with this, but there were also three who remained relatively neutral on the issue. The remaining four people almost agreed with the statement. So, it can be said that although the answers are varied, they consider it easy to use rather than difficult.

- 6th "I think the visual design of the application was difficult to interpret." For this statement, the majority (6 people) did not agree with this at all, but two answers were neutral, that is, they could not decide whether they agreed or not. This means that the visual appearance can still be improved.

- 8th "The visual style of the game did not match the theme or purpose of the game." For this, we highlight this statement because the answer of the respondents was so unanimous. 9 people voted that they did not agree with the statement at all, and there was only one who remained neutral. According to the tested statement, our conclusion is that, according to the majority, the visual style was absolutely compatible with the theme of the game.

Furthermore, using the System Usability Scale as an evaluation method, the result we obtained is 84.25 points, which means an excellent grade. It can therefore be said that the testers describe the game as easy to use.

4. CONCLUSION

This work provides a summary of the newest version of the virtual P-Game. The live P-Game was developed at the University of Continuing Education Krems. It can be used for other subjects too. We show this work at the conference addressing how the game is, how it will be played and how it will be assessed in detail.

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Rehabilitation

The session on Rehabilitation explored the use of VR to enhance therapeutic interventions, particularly for complex conditions. Discussions covered barriers faced by therapists in adopting VR for paediatric brain injury rehabilitation, highlighting issues such as technical challenges and limited training. Longitudinal research on VR bike-based rehabilitation examined therapists' acceptance of the technology, indicating gradual improvement as they became more familiar with its benefits. An immersive VR system was developed specifically for rehabilitation of Ataxia Telangiectasia (A-T) in children, aiming to improve patient engagement and treatment quality. Additionally, a virtual environment was utilised to study and induce freezing of gait in Parkinson's disease patients using a split-belt treadmill, providing insights into better management of this challenging symptom. The session underscored the potential of VR to innovate rehabilitation practices while acknowledging the need for better integration and therapist support.

What stops therapists from using virtual reality in paediatric acquired brain injury upper limb rehabilitation?

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ABSTRACT

Upper limb movement difficulties in children with acquired brain injury (ABI) result in longer recovery. Intensive neurorehabilitation promotes good long-term functional outcomes. Virtual reality (VR) and video game technology are invaluable adjuncts to traditional neurological rehabilitation but are not routinely used in the NHS; it requires embedding to benefit children and their families. This study examined the influencing factors to use VR for rehabilitation. Five closely related major themes and thirty associated subthemes were developed: training, knowledge, promotion, consideration of barriers, and family factors.

1. INTRODUCTION

Globally, acquired brain injury (ABI) is one of the most common reasons for children and young people (CYP) to become neuro-disabled (Dunford et al., 2020). Every year, 1800 children in the UK suffer from moderate to severe ABI (Rathinam et al., 2023). A subgroup of CYP with ABI has a stroke-like presentation, resulting in functional loss upper of limb movement and increased reliance on others for daily functioning (Abgottspon et al., 2022). After an injury, upper limb function takes longer to recover, with CYP requiring intense neurorehabilitation as early and as often as possible to maximise the opportunity for recovery. A high degree of intensity and regular practice spacing needs highly skilled, labour-intensive work, often impeded by large caseloads and resourcing issues (Rathinam, 2021). Children struggle with motivation with prescribed exercise, as do their parents (Rathinam et al., 2018). Yet children enjoy computer games, and Virtual Reality (VR) based gaming technology is a clear and valuable adjunct to traditional neurological rehabilitation (Farr and Green et al., 2020). It has been recently used to treat CYP with cerebral palsy (Choi et al., 2020) and ABI (Shen et al., 2020), but it is not routinely used in clinical practice due to a lack of resources and IT support (Farr and Green et al., 2020). Here, we report on the findings of the factors that determine the use of VR on clinical therapists who lead paediatric ABI care.

2. METHODS

2.1 Design

A qualitative approach explored clinician experience, focusing on views toward VR for upper limb rehabilitation. This study was registered with the Birmingham Women's and Children's Hospital Research & Development office and in accordance with the UK National Research Ethics Service guidance (REC: 16/BWC/LA/Rathinam).

2.2 Participants

Purposive sampling strategy was used by inviting physiotherapists (n=3) and occupational therapists (n=5) experienced in treating CYP with ABI at Birmingham Children's Hospital (BCH) and Oxford Children's Hospital, UK. Play workers (n=1) and BCH Young Persons' Advisory Group members (n=4) through their coordinator were also invited. All the participants consented. Participants met in person or through an online platform (Microsoft Teams).

2.3 Procedure

Four focus groups and four 1:1 semi-structured in-depth interviews were completed, lasting between 60 and 90 minutes. A semi-structured interview guide facilitated the discussion. Participants were asked about VR experience, barriers, adherence factors, and reflections, as these were considered in the prior research by this team as the contributing factors to the use of technology for rehabilitation. CR undertook all interviews, and the interviews were recorded with permission. Written notes were taken simultaneously.

2.4 Analysis

Interviews were transcribed in full. Thematic analysis was conducted following Braun and Clark's (2006) guidelines. These themes were categorised, and five major themes and associated sub-themes were developed (Figure 1). Trustworthiness was ensured by triangulating the data gathered with previous study data. Analytical rigour was maintained with an audit trail and aligning the coding between the authors.

3. RESULTS

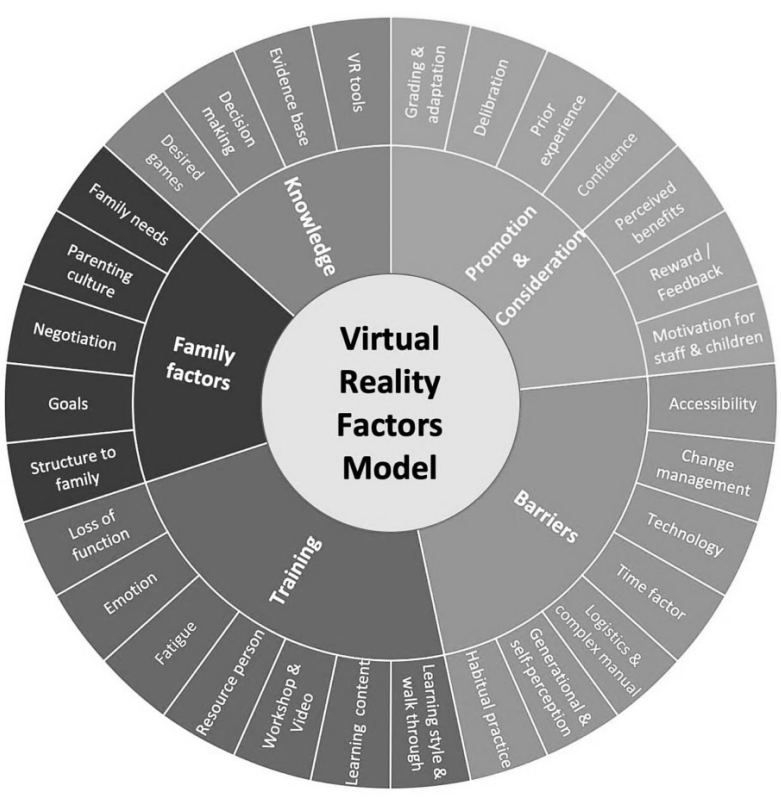

Figure 1 *Model for factors influencing virtual reality for upper limb rehabilitation for children with acquired brain injury*

4. CONCLUSION

To facilitate VR intervention for ABI rehabilitation, the NHS workforce requires extensive investment to improve awareness, knowledge, and a convincing evidence base for VR use. Basic infrastructure provision will eliminate many barriers, and positive behaviour changes among therapists will enable them to use VR for rehabilitation. Various factors related to affordability, digital poverty, and the family's readiness to try technology as a tool significantly limit the uptake of VR for rehabilitation.

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Exploring therapists' technology acceptance of virtual reality bike-based rehabilitation: A longitudinal study

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ABSTRACT

This study utilized the Unified Theory of Acceptance and Use of Technology (UTAUT) model to explore Danish municipal therapists' *user experience with*, *attitude towards*, and *acceptance of* a commercial virtual reality (VR) solution for rehabilitation purposes before deployment, and again a year later. The results indicate a positive shift in technology acceptance acquired from the actual use of the system, which also led to a more positive attitude towards the clinical use of VR in general.

1. INTRODUCTION

When implementing technologies that have been proven to work in controlled experiments into clinical settings, stakeholders often expect to see similar results as the ones demonstrated in the literature. In reality, the translation from original research to clinical practice is a tedious process which has been suggested to take an average of 17 years (Morris et al. 2011). Therefore, when studying technology implementation, it is crucial to analyse it continuously, taking into account the users' increasing experience with the particular system, rather than just capturing a single cross-sectional moment (Davis et al. 1989). To this end, this study explored the therapists' user experience with, attitude towards and acceptance of a commercial VR solution immediately before deployment in 2021 (baseline), and again the year after (follow-up).

2. METHODS

The study utilized the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al. 2003), with a Danish translated version of the questionnaire inspired by (Liu et al. 2015). The six UTAUT constructs that were used in the study was: *Performance Expectancy* (PE), which refers to the perception that using the system will result in improved job performance and achievement of goals, *Effort Expectancy* (EE) which refers to the perceived ease-of-use of using the system, *Social Influences* (SI), *Facilitating Conditions* (FC) refer to the individual perception of the existence of organisational and technical infrastructure that supports the use of the system, *Behavioral Intentions* (BI) is the self-predicted intention to use the system in the future, and *Use Behavior* (US). The questionnaire was circulated to all facility therapists in October, 2021 and November, 2022. To encourage participation, the respondents could participate in a lottery for a gift basket upon finishing the (anonymous) survey. For the statistical analysis, SPSS 28.0 was used, deploying a paired parametric test, since the data was found to be normally distributed using the Shapiro-Wilk test.

3. RESULTS

The questionnaire was distributed to all fifteen physio/occupational therapists in the unit, with twelve of them responding (80% response rate). Respondents had an average age of 33.2±7.3 years and 4.4±7.3 years of practice experience. The sample included seven physiotherapists and five occupational therapists. Seventy-five percent were full-time employees with bachelor's degrees. Initially, only half of the therapists had tried VR with patients, with only two (occupational) therapists still not having tried it in the follow-up. Interestingly, regarding the therapist's perception of patient adverse events (dizziness / cybersickness), at the baseline, 91.7% observed patient dizziness, which had dropped to to 41.7% in the follow-up. Therapists experiencing dizziness themselves dropped from 83% to 67% at follow-up.

A statistically significant difference was found between the baseline and follow-up measurements in three of the six constructs (FC, BI, and US). There was no significant difference between the baseline and follow-up for the constructs: PE, EE or SI (see Figure 1). The results indicate a positive shift in technology acceptance acquired from the actual use of the system, which has led to a more positive attitude towards the clinical use of VR.

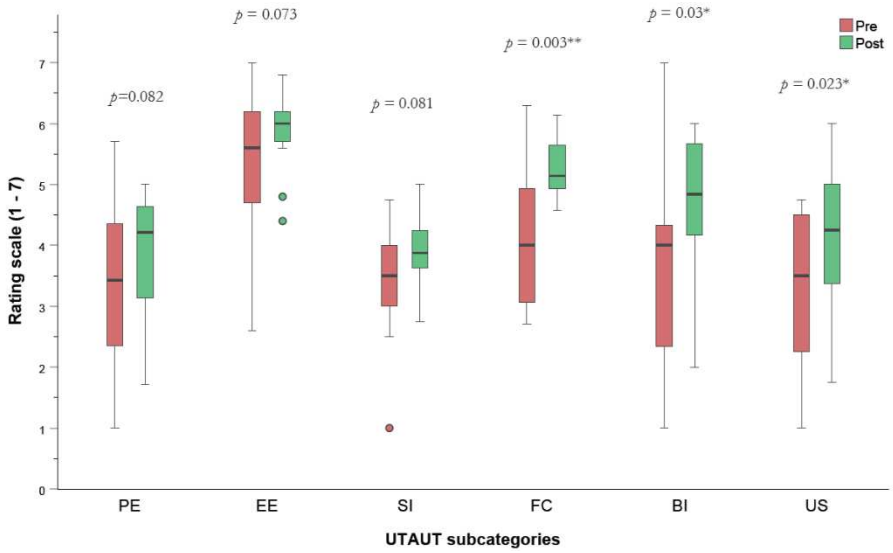

Figure 1: *The UTAUT questionnaire was measured at baseline and a year later (follow-up). Inference: * $p < 0.05$; ** $p < 0.01$*

4. DISCUSSION

The UTAUT model suggests that the *intention to use* technology is influenced by two factors: the perceived usefulness of the technology (PE), and the perceived ease of using the technology (EE), jointly referred to as the *attitude towards* technology. Surprisingly, The EE was generally highly rated at the baseline measure, indicating that the therapists found the system easy to use. This implied few practical barriers in setting the system up (using sensors, fitting the headset etc.). The perceived (acceptance) barriers were more related to the system's clinical usefulness (PE and US), but, the small sample size limits generalizability. At baseline, the therapists noted that they had experienced dizziness in patients many times *"Most patients become dizzy when using VR"* (P12), and that the clinical purpose was minuscule *"I cannot see the point of using VR with my patients. It is not rehabilitation but more of an activity"* (P3). In contrast, the number of negative sentiments in the follow-up had largely disappeared, thereby also supporting the significant increase in UTAUT scores overall.

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Development of an immersive Virtual Reality (VR) system to improve the quality of rehabilitation for paediatric Ataxia Telangiectasia (A-T) patients.

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ABSTRACT

Ataxia-Telangiectasia (A-T) is a rare and severe genetic disorder (approximately 1 in 300,000 live births (A-T Society, 2014)) that is paired with decelerated production of protein within the body. As a result, several bodily functions are damaged including but not limited to, a diminished immune system, poor upper and lower limb functionality, and heightened risk of malignancy of the blood. The research team have been investigating whether virtual reality (VR) equipment and its immersive environments can be used as a form of cognitive and physical therapy to reduce the rate of muscle degradation and improve mental wellbeing for paediatric A-T patients.

1. INTRODUCTION

In the UK there are currently only two centres that offer patient centred care for Ataxia-Telangiectasia (A-T). As a result, access to care can be complex and costly for most patients. Review of a patient condition will be hold on an annual/bi-annual basis. Consequently, there can be a time delay during which no support or treatment is offered to the patient. We therefore envision the use of Virtual Reality (VR) as an easily accessible solution to maintain patients engaged and entertained while at the same time slowing down the deterioration of physical functions via the gamification of rehabilitation. As such an investigation into whether systems based on an around Virtual Reality technologies could provide an engaging and safe environment for A-T patients whilst also improving their physical and mental wellbeing was proposed. Following interviews with parents of A-T patients, the project's consultant clinical geneticist and an analysis of published papers, it was noted that regular physiotherapy is recommended for all A-T patients to reduce the rate of muscle degradation (Unes et al. 2021). The integration of the VR system will provide a unique opportunity for A-T patients to conduct their physiotherapy through an immersive and interactive environment. Complete with mini-games and cooperative gameplay we intend to improve patient wellbeing and engagement with physiotherapy activities. To create this, a multi-disciplinary research team of academics, industry professionals and clinicians have collaborated to design and prototype a solution that is optimised for patient use.

2. METHODS

The research team is investigating the use of VR as a form of motor and cognitive therapy for 5–16-year-old Ataxia Telangiectasia patients, to improve to their therapy experience and quality of life. A patient, carer and public involvement and engagement (PCPIE) group was setup for regular meetings aimed to obtain feedback on a custom-made set of environments used in combination with hardware developed. Before patients use any VR equipment, a four-stage baseline test is used to assess their gait, grip and cognitive ability. Tests include the Box and Block test and Action Research Arm Test. Baseline testing will also be repeated at the end of the study to evaluate if any improvement has been made. Patients will then be gradually introduced to VR and a 360°

frictionless treadmill, combined with a rehabilitation frame (Figure 1) and supportive hoist via a four-phase induction process.

Figure 1 *Virtualizer Elite 2 - A 360* Frictionless Treadmill (Cyberith, n.d)*

Once fully inducted, patients will be required to complete a variety of tasks within the VR environment allowing the research team to gather quantitative data on their gait, motor, and cognitive skills. Using a mixed method approach through the NASA-TLX and PACES-S scales, the research team will be collecting engagement data before and after sessions are conducted to evaluate whether the use of the equipment has improved patient wellbeing. We believe this research could lead to a significant improvement in patient motivation and enjoyment whilst pro-actively decelerating muscle and cognitive degradation through an easy-to-use, accessible, and interactive experience.

3. RESULTS

The custom-built environment, modelled in Gravity Sketch, programmed in Unity and developed alongside clinical members of the research team contains seven bespoke mini games based on real life activities that participants wouldn't normally be able to do, each increase in difficulty and range of movements. For example, game one, a linear buzz wire, requires the player to move a tool from left to right without touching the wire. This game requires lateral hip and arm movement and some rotational wrist movement. Game 6, is a variant of game one, requiring 120° rotational hip and wrist movement, with vertical arm movement. Each game can be adjusted by the 'assessor' to motivate/challenge players, such as reducing the time limit per game or adding additional objectives. The environment, paired with the 360° VR treadmill intends to provide upright support, aiding the user to walk naturally and build lower body strength. The solution aims to improve physical and mental wellbeing and provide accessible care. A mock-up of the intended VR environment (Figure 2) and a recorded demonstration video (Breedon et al., 2023) were used to exhibit a proof of concept to parents and clinicians at the A-T society family weekend event and various PCPIE group meetings. During the event the research team was provided with the opportunity to demonstrate the environment to two adolescent A-T patients by putting them in a VR headset, set in the mock up environment. The team identified a selection of critical design needs for the VR headset and its associating equipment that it is not truly inclusive for a disabled user. For example, whilst at the event it was noticed that the weight of the headset influenced the user's ability to hold their head up and look around the environment. Additionally, observations of the user's ability to grip the controller, press buttons and complete specific movement action was conducted. Movements were often sporadic with limited control over movements in both arm/hand movement. Further exploration will be conducted into alternative, inclusive methods of game control, including but not limited to; utilising hand tracking technology, integrating custom-made 3D printed controller grips, full body tracking through infra-red sensors and integration of smart textiles (Lugoda et al., 2022).

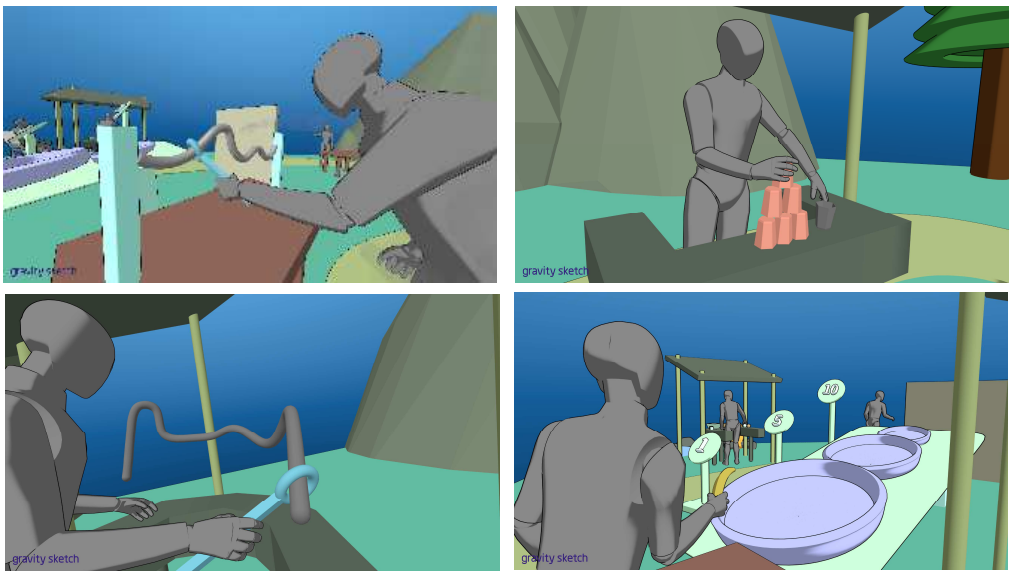

Figure 2 *Proof of concept examples developed during the pump priming phase (Breedon et al., 2023)*

4. DISCUSSION

Virtual Reality is becoming prominent within the UK medical sector, especially within rehabilitation (Mercer and Milliken, 2024; Morgan, 2024). However, cost and accessibility are some key limiting factors that could impact its true potential. Through our intended research study, we aim to establish a variety of adjustments to the VR equipment and software to make it more inclusive to further benefit A-T patients. For instance, we intend to improve social interaction between patients by adding multiplayer gameplay and in-game competitions but also add in-game tracking for clinicians to assess patient gameplay to provide live feedback from clinical locations.

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Conditions for inducing freezing of gait in Parkinson's disease freezers on a split-belt treadmill in a virtual environment

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ABSTRACT

Freezing of gait (FOG) is a common and complex symptom for many individuals with advanced Parkinson's disease (PD). There is currently no treatment available for FOG. An innovative first step to potentially develop FOG specific treatments is to create a protocol using the most common conditions for FOG, including speed changes, visual perturbations, and cognitive dual tasking on a split-belt treadmill (SBT) in virtual environment (VE). Evidence is presented of experimentally induced FOG in mainly more advanced PD freezers using a SBT in VE.

1. INTRODUCTION

Freezing of gait (FOG) is described as the feeling of the feet being 'glued' to the ground when walking forward (Nutt et al., 2011). It affects over half of advanced cases of Parkinson's disease (PD) (Giladi et al., 2001) and is a predictor of disease severity and significantly impacts quality of life (Candel-Parra et al., 2021). FOG is mostly resistant to the pharmacological approaches currently available and is not directly treatable (Lichter et al., 2021). Moreover, observing it in the clinic is also challenging (Snijders et al., 2008). Therefore, producing FOG episodes in a secure and reproducible manner is an important first step in readily observing and treating FOG. We studied clinical 'freezers', identified with the NFOG-Q, with conditions most known to cause freezing. These conditions include walking faster, split-belt treadmill (SBT) walking, cognitive dual tasking (e.g., Stroop test, arithmetic), and walking through narrow pathways (Conde et al., 2023). All conditions were presented in a protocol combining a virtual environment (VE) and SBT.

2. METHODOLOGY

2.1. PD Population

Ten individuals with PD were recruited with an average disease duration of 8.8±3.9 years. They all experienced FOG, as per the New Freezing of Gait Questionnaire (NFOG-Q). They were further stratified into high (HF, more severe) and low (LF, less severe) FOG groups based on a NFOG-Q threshold score of 20, $t(8)=-7.2$, $p < 0.01$.

Table 1: *Demographics for high freezer (HF, NFOG-Q ≥ 20) and low freezer (LF < 20) groups.*

Group	Sex (m/f)	Age (yr)	Disease Duration (yr)	NFOG-Q (/29)
LF	2/2	72.2 ± 6.9	10.5 ± 4.2	10.3 ± 4.6
HF	6/0	58.3 ± 8.8	14.9 ± 3.3	26.0 ± 2.4

2.2. Determining PD FOG and clinical scales

All participants completed a battery of five clinical scales. The New Freezing of gait questionnaire (NFOG-Q) was used to identify individuals with PD who experience FOG. Freezers who scored 20 or more points on the N-FOGQ were stratified into the high freezer group, while those who scored between 1-20 made up the low freezer group. The Montreal Cognitive Assessment (MoCA) assessed cognitive capacity, while the Activities-Specific Balance Confidence Scale (ABC) assessed balance confidence with everyday tasks. The MDS Unified Parkinson's disease Rating Scale Part III (MDS-UPDRS III) and Parkinson's disease Questionnaire-39 (PDQ-39) assessed motor function and quality of life, respectively, as they specifically pertain to PD.

2.3. Split-belt treadmill and virtual reality

Individuals wore a safety harness and walked in a FOG inducing protocol on a modular gait analysis system using a SBT (GRAIL with virtual reality D-Flow, by Motek, Netherlands) as seen in Fig.1A. The SBT allows for walking with left and right legs at equal or different paces. The immersive synchronized VE allows for sensorimotor integration with visual flow and spatial navigation.

2.4. Conditions for eliciting FOG

Four main variables were presented in the FOG inducing protocol. These included 1) visual loading with a series of narrow pathways projected in the virtual scene (see Fig 1A), 2) walking while dual tasking with either a modified Stroop test or arithmetic (Fig. 1A), 3) walking at normal and 125% increased speeds (Fig 1B), and 4) walking with a 50% speed reduction on the least affected side (Fig 1C). Each variable was presented individually or in combination, totalling 16 different conditions for the entire protocol. Each condition lasted for ~30 seconds of steady-state walking. Participants were tested in an 'Off' levodopa state.

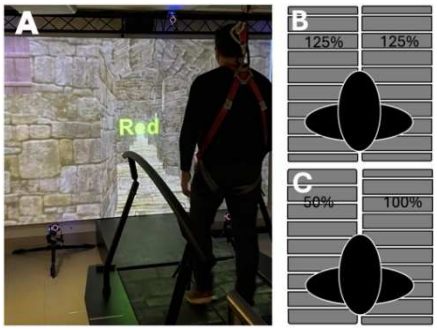

Figure 1 *Conditions on SBT and VR scene used for inducing FOG with A) visual loading (narrow pathway) and dual tasking (Stroop test/arithmetic), B) 125% speed increase, C) and walking with a 50% speed reduction on the least affected side.*

3. RESULTS

3.1. FOG frequency and duration in PD freezers

A descriptive analysis of heel position and ground reaction forces (GRF) in tandem with video review (see Fig. 2), revealed 5 of 6 HF individuals experienced FOG episodes on the SBT. Two HF participants accounted for 92 of all 113 FOG episodes. The types of FOG identified were mainly trembling in place (Fig. 2A) and akinetic (Fig. 2B) FOG. The condition yielding most freezing episodes (20) occurred in the faster paced split-belt and pathway condition, while longer episodes occurred with the dual-task during tied (6.6 s) and split-belt (14.5 s) conditions. Only 1 of 4 LF participants showed evidence of FOG episodes (Table 2).

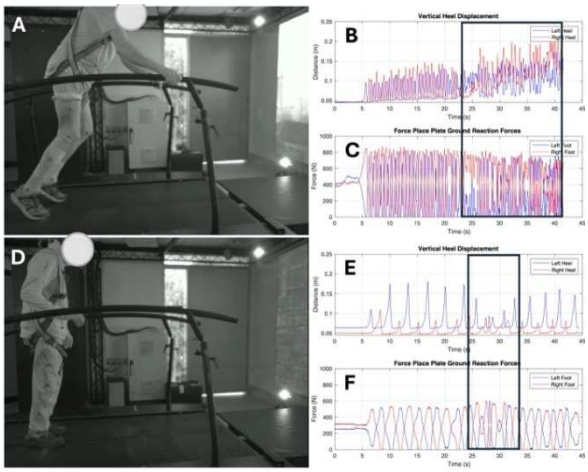

Figure 2 *A) A participant experiencing a sustained trembling-like FOG episode during the visual loading (i.e., pathway) and dual-tasking (i.e., Stroop) condition. B) Heel position is elevated at ~25s, and ground reaction forces (GRF) reflect both feet simultaneously weight-bearing. D) A participant in the same condition experiencing an akinetic FOG episode. Both feet are fixed to the ground, seen in heel displacement (E) and GRF (F) data.*

3.2. FOG frequency and duration in PD freezers

Independent t-tests revealed no significant differences in the clinical scales featured in Table 2, despite greater average MDS-UPDRS III and PDQ-39 scores in the HF group. For both groups, moderate negative Pearson correlations were seen between MoCA scores and FOG episodes r(8)=-.61, p=.06 and FOG duration r(8)=-.47, p=-.17.

Table 2: *Total FOG episodes and average FOG durations for HF and LF groups.*

Group (FOG/non-FOG)	FOG Total (#)	FOG duration (s)	Conditions with most FOG	MoCA (/30)	ABC (/100)	MDS-UPDRS III (/137)	PDQ-39 (/100)
LF (1/3)	2	2.4 ± 2.2	Split-belt	27.3 ± 0.5	61.7 ± 21.5	26.75 ± 14.2	42.3 ± 22.2
HF (5/1)	112	5.0 ± 6.8	Fast split-belt pathway	24.8 ± 3.1	63.1 ± 13.8	33.8 ± 11.1	57.7 ± 10.9

4. DISCUSSION

Evidence of trembling and akinetic FOG was seen in more severe FOG (HF) individuals. The HF group also showed many more instances of FOG compared to milder (LF) individuals. FOG episodes were more common in the HF group during conditions with multiple variables, such as the split-belt visual pathway condition. The duration of FOG, however, tended to increase during the dual-task condition. Future research could address several limitations to the study. For example, increasing the sample size and including a non-FOG group could further elucidate whether FOG symptoms are present on a continuum. Additional analysis may also discern which experimental conditions tend most to induce FOG and identify the FOG phenotypes associated with them.

5. CONCLUSIONS

It is possible to experimentally induce FOG episodes in a freezing PD population on a SBT in VE. The more severe FOG group experienced a greater number of FOG episodes and average FOG duration, compared to those with milder FOG. Further study is necessary to investigate which conditions best yield FOG episodes across FOG and non-FOG PD populations.

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Design Ideas

The session on Design Ideas explored innovative concepts for enhancing user experience and engagement through VR applications. Presentations included the design of virtual humans in mobile health (mHealth) apps, focusing on how realistic, interactive avatars can boost user adherence and engagement in health interventions. A study protocol was introduced for using an omnidirectional treadmill in VR to enhance exposure therapy for Obsessive-Compulsive Disorder (OCD), offering a new, immersive approach for treatment. Development of VR games tailored for bedridden patients was discussed, highlighting how interactive experiences can support mental well-being and provide entertainment. Additionally, research comparing 2D and 3D icons as menu interfaces in VR assessed usability and user satisfaction, providing valuable insights for designing more intuitive and engaging VR environments. Overall, the session showcased the creative potential of VR for improving user interaction and therapeutic outcomes.

Virtual Humans in Mobile Health (mHealth) Applications: Designing for increased user-engagement and adherence

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ABSTRACT

There are currently over 6 billion smartphone users and more than 350,000 mHealth applications available worldwide. Despite the promise of mHealth applications to increase access to healthcare and improve outcomes, maintaining user engagement and adherence over time is a main challenge to the efficacy of these apps: users may download an app enthusiastically but lose interest or motivation to continue using these apps regularly. The integration of Virtual Human (VH) agents into an mHealth application presents a promising opportunity to overcome the barriers associated with uptake and sustained engagement. The Battle Buddy (BB) project was conceived as a mobile wellness and suicide prevention mHealth application, empowering Veterans with an always-available resource concierged by an engaging and supportive VH agent. This paper presents our VH agent and human-centered design methodology that targets the negative effects of social isolation and loneliness, conditions that challenge Veteran healthcare and suicide prevention.

1. INTRODUCTION

Suicide is a preventable public health problem. Emerging mobile health (mHealth) technologies, specifically mHealth applications (apps) designed to support mental health, are considered promising tools for overcoming stigma and engaging individuals in their own care (Tam-Seto et al. 2018). This rapid rise in interest is in part due to the ability of these apps to transform mobile and wearable devices into monitoring and therapeutic platforms that can capture mental health symptoms in real time and deliver on-the-go mental health support (Torous & Roberts 2017). Mobile apps also offer a viable option to access care confidentially, anytime, anywhere – reducing stigma-related barriers to care, positioning these applications to be the future of mental health and suicide prevention in particular (Tam-Seto et al. 2018). Despite the promise of mHealth applications, actual use rapidly decreases after initial uptake. Face-to-face interaction, that incorporates dynamically assessing the other person's level of understanding and repeating or elaborating on information when necessary to elicit trust and communication with verbal and nonverbal behavior remains one of the best ways to communicate health information (Ter Stal et al. 2020). One path to replicating the benefits of face-to-face interaction, at-scale, is the use of virtual humans: digitally embodied characters designed to include the paralinguistic aspects of the voice (e.g., prosody or voice quality), as well as gesture and facial expressions (Hartholt et al. 2019, Gordon et al. 2019).

Battle Buddy (Fig. 1) is a specialized AI-driven mobile health (mHealth)application tailored exclusively for suicide prevention in Veterans developed at the University of Southern California's Institute for Creative Technologies sponsored by the US Army DEVCOM Soldier Center and the Department of Veterans Affairs (VA), in collaboration with SoldierStrong. The VH component of Battle Buddy is a computer-based dialogue system with virtual embodiment, utilizing various multi-modal language cues such as text, speech, animated facial expressions, and gestures to interact with users. Inspired by the US military practice of assigning fellow soldiers as partners to provide mutual assistance in both combat and non-combat situations, the name "Battle Buddy" symbolizes this app's mission.

2. METHODS

Battle Buddy's comprehensive approach aims to establish a suicide prevention ecosystem that can be customized to meet the unique needs of individual users. Battle Buddy not only provides valuable in-app health and wellness resources, it also acts as a springboard to real-world support networks, including friends, family, and various resources provided by the VA and the VCL (Veterans Crisis Line). In the event of a suicidal crisis, Battle Buddy's

primary focus shifts to guiding Veterans through their personalized safety plan, with the goal of creating time and space between suicidal thoughts and actions. By doing so, the app aims to play a crucial role in saving lives and providing the necessary support during critical Moments.

Our human-centered design model is unique as it incorporates a methodology borrowed from participatory action-research, Rapid Assessment Process (RAP), within the Information System Research (ISR) framework. The ISR framework has been independently applied in technology development, however, it has not been widely applied to the design of mHealth apps (Schnall et al. 2016). Our team previously defined a novel process for combining RAP with ISR for mHealth development, see (Mozgai et al. 2021).

The ISR Framework conceptualizes the design process as an embodiment of three closely related cycles of activities (Fig. 2). As applied to the ongoing design of Battle Buddy, the Relevance Cycle helps to bridge the contextual environment of the research project with the design science activities. The Rigor Cycle connects the design science activities with the knowledge base of scientific foundations, experience, and expertise. The central Design Cycle iterates between the core activities of building and evaluating the design artifacts and processes of the research (Hevner 2007).

3. DISCUSSION

When prototype development concludes we anticipate holding our first RAP session as part of the Design Cycle. The primary aim of this first session will be to determine alignment between our initial prototype and user-identified 1) mHealth needs, 2) mobile app design preferences (including VH elements), and 3) barriers to adoption and adherence. Successful RAP sessions depend on teamwork. Multidisciplinary research teams, comprised of both insiders and outsiders, have been shown to increase sensitivity to insider categories and definitions (Beebe 2001). Our multidisciplinary team will consist of both insiders (e.g., US military Veterans), and outsiders (e.g., Psychologists, Research Assistants, Software Developers, Content Creators, and Artists) who will contribute to study design, data collection, data analysis, and prototype refinement.

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Feasibility of using OCD exposure therapy application with VR omnidirectional treadmill: A study protocol

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ABSTRACT

Immersive virtual reality (VR) omnidirectional treadmills enable users to walk freely in objective reality while the movement is captured and transferred to VR. The use of such a device may potentially increase the immersiveness of the experience. However, there is also a number of potential disadvantages, such as cybersickness or overall discomfort in the VR treadmill harness. This paper describes a study protocol aimed at assessing the feasibility of using such a device with the application for obsessive-compulsive disorder (OCD) exposure therapy.

1. INTRODUCTION

With the virtual reality (VR) industry rapidly developing, there is an effort of human–computer interaction (HCI) devices manufacturers to provide users with natural means of interaction. The visual and auditory sensory modalities are commonly used in VR; however, haptic sensory modality (e.g., touch or walking) remains an area that is challenging to stimulate (Azofeifa et al., 2022). One of the aims of VR equipment manufacturers is to provide VR users with the ability to walk around and freely explore the virtual environment while having the haptic experience of human gait. However, the virtual environment can be vast or even infinite, which encounters the limitations of a physical area that a user sets in their premises. In order to provide a user with a 2-dimensional infinite ground, an omnidirectional VR treadmill can be utilized. It provides a physical platform for endless walking and is designed to be used in combination with a head-mounted display (HMD). A treadmill enables a user to make physical movements of walking or running in all directions in the 360-degree range while not changing their position in the objective reality (Hooks et al., 2020). Thanks to this, a user does not get into a collision with obstacles or walls. To ensure user safety and stability during operation, users are usually secured via a harness encircling the waist. The freedom of movement may increase the immersiveness, which may deepen the effect of applications for mental health care, such as exposure therapy for obsessive-compulsive disorder (OCD). Despite the assumption that the use of a VR treadmill could result in a decrease in perceived cybersickness, a study by Wehden et al. (2021) comparing the HMD with VR treadmill, the HMD without VR treadmill, and the traditional flat-screen gaming did not find the VR treadmill to achieve lower cybersickness than the other groups.

The major assumed advantage of using a VR treadmill is its capacity to let the VR user freely walk in the objective reality and transfer the captured gait into the virtual reality. However, potential disadvantages should also be considered – such as possible cybersickness, physical fatigue, or overall discomfort in the VR treadmill harness. Since omnidirectional treadmills for capturing user gait for virtual reality are not yet widely used, there is a lack of evidence about their usability for general and specific scenarios. The aim of this study is to assess the feasibility of using such a device with one of the applications developed at National Institute of Mental Health in the Czech Republic (NIMH CZ) for OCD exposure therapy.

2. METHODS

To assess the feasibility of using a VR omnidirectional treadmill with the application for OCD exposure therapy, this study will utilize the following materials and technology. As an HMD, an HTC Vive Pro full kit with 1440×1600 pixels per eye, a 90 Hz refresh rate, and a 110° field of view will be used. It will be complemented with a VIVE Wireless Adapter. An omnidirectional VR treadmill called “KAT Walk mini S” will be utilized for capturing user gait (see Figure 1). The virtual environment used in our study will be an OCD exposure therapy

application called “OCDhouse” (Fajnerová et al., 2023) (see Figure 2) developed at NIMH CZ. The application consists of a house with multiple rooms and a surrounding area (e.g., garden, garage). It offers a wide range of interactive objects for multiple types of interactions, addressing the heterogeneity of OCD symptoms (e.g., fear of contamination, checking tendencies, symmetry obsessions/compulsions).

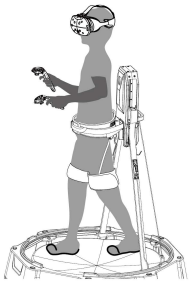

Figure 1 *Omnidirectional VR treadmill KAT Walk mini S (adapted from* KAT VR, n.d.*, p. 34).*

Figure 2 *OCDhouse developed at NIMH CZ (adapted from* Fajnerová et al., 2023*, p. 2694).*

To investigate the user interaction with our OCD exposure therapy application, we will employ a detailed qualitative methodology known as Interpretative Phenomenological Analysis (IPA) (Smith et al., 1999, 2009). This method explores an individual’s lived experiences and the meaning they attribute to these experiences while encountering a specific phenomenon, such as a brief event or an extended process. The objective is to construct an in-depth description of an individual’s lived experiences while engaging with a particular phenomenon. IPA is commonly utilized in exploring topics in areas that have not been extensively studied and offers adaptability in managing unforeseen data that may emerge during the investigation. Consequently, it serves as a suitable instrument for acquiring insights into the experiences of individuals using VR omnidirectional treadmills. The focus will be given to describing their lived experience from the various interactions with the virtual environment and OCD-related stimuli.

The research sample will consist of a small group of up to 10 participants. The inclusion criterion will consist of age between 18 and 55 years, and the exclusion criteria will be the presence or history of severe psychiatric or neurological disorders (including epilepsy).

The participants will undergo a research procedure consisting of, firstly, completion of a tutorial VR treadmill application – currently in development at NIMH CZ – and, secondly, experiencing the OCDhouse with the VR treadmill. They will be tasked with walking around the virtual environment and interacting with multiple objects, such as doors, furniture, and home appliances. Afterward, the data will be collected through semi-structured interviews incorporating questions from the area of hardware and software aimed at inquiring about the perceptions, sensations, thoughts, and emotions of the participants regarding their experience in VR.

The data analysis will be conducted in accordance with the IPA methodology, which offers several techniques for conducting analysis. In our study, we will employ idiographic case study analysis to examine multiple participants. The process involves a detailed examination of each case, followed by synthesizing insights across the entire participant group. The analytical procedure is cyclical and iterative, requiring repeated review and refinement of themes.

3. DISCUSSION

Among the potential limitations the proposed study can encounter is that the use of a VR omnidirectional treadmill may create possible discomfort during the research procedure since the participant will be wearing a VR headset and will be secured in the VR omnidirectional treadmill harness. Another potential problem is the risk of slipping on a VR omnidirectional treadmill. To mitigate these risks, the researcher will ensure that each research participant is not uncomfortable using the VR system and that they understand the instructions regarding the use of the VR system. If any participant in the research experiences cybersickness or experiences some degree of anxiety from fastening to the VR treadmill harness, the present researcher will offer assistance. The participant will be asked if they wish to continue with the research procedure and will be offered a few minutes break if needed.

Suppose the results of the proposed study will indicate that the technological system and the procedure are feasible, it may open a way to enhance the immersiveness of exposure therapy for individuals with OCD. The immersive nature of VR with an omnidirectional treadmill may potentially provide a controlled and customizable therapeutic environment, which may result in increasing patient engagement and adherence to treatment protocols. Future research should assess long-term outcomes to validate the approach's effectiveness and scalability on a larger sample from a diverse participant pool to ensure generalizability.

4. CONCLUSION

Omnidirectional VR treadmills offer freedom of movement in VR and safety harness that prevents users from collisions with physical objects. This paper briefly proposed a feasibility study of using the VR omnidirectional treadmill with the application for obsessive-compulsive disorder exposure therapy.

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Virtual Reality Games for Lying Patients

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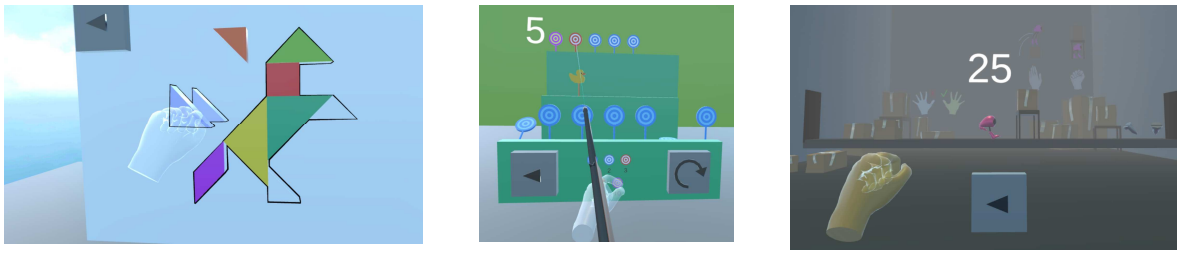
ABSTRACT

Lying patients who are either bedridden or on bed rest may suffer from muscle and joint weakness and low well-being. Virtual reality (VR) enables its players to gently exercise their arms and hands when controlling the VR applications, and video games are known to positively impact people's well-being. This paper describes a VR application containing three games suitable for lying patients, their mobilization, and entertainment.

1. INTRODUCTION

Despite the recent increase in the popularity of virtual reality, there are not many games people can play while lying down. It would be beneficial for bedridden patients to entertain themselves and incorporate non-vigorous arm and hand movement into their daily lives. Therefore an application is created that offers VR games for people of different genders, ages, and physical and mental capabilities, that can be played at any reclining angle between sitting upright and lying down completely with emphasis put on intuitive controls, motivating patients to mobilize their upper limbs and accommodating the limitations they might have.



(a) *Tangram puzzle* **(b)** *Shooting gallery* **(c)** *Endless runner*

Figure 1: *Screenshots of gameplay of the VR games the application offers*

2. METHODS

This application is designed for people of all genders aged 18–90, who spend prolonged periods in a supine position due to factors such as advanced age, spinal cord injury, or other physical ailments.

2.1. Hardware and software

The proposed solution is targeted at *Meta Quest 2 headsets*, as they are the most popular and most frequently owned by people or institutions. The VR controllers associated with the headset are not needed because the initial analysis of target users showed they may not be able to hold them or lift their hands while holding them due to a lack of grip or arm strength.

Preferably a *mobile device with Android 5.1 and above* should be used in addition to the headset with the application installed. It must be connected to the main (VR) application and for this connection to work, both devices need to be connected to the same network, so the last hardware component needed is a *WiFi router*.

The application is made in *Unity* game engine and uses *XR Interaction Toolkit* that provides a high-level interaction system for VR, and *Mirror networking*, which is a high-level networking library used for network connection of the mobile device application to the VR headset application.

2.2. Application features

Upright redirection: To ensure that patients lying at different angles of recline have the same experience, the application must recognize their current position in the real world and then rotate the virtual world so that they perceive it as if they are standing or sitting upright (as described by van Gemert et al. (2023)). Generally, the 0 and 90-degree angles of recline should be the most comfortable for the users (Luo et al. (2022)). All of the interactions with the application are independent of the user's position. The upright redirection can be performed whenever the users wish, in case they need to change their position in the middle of playing.

Hand gesture detection: Due to the physical limitations of lying patients, the application has to be controlled without VR controllers and thus features detection of certain hand gestures. The default gestures used in the application are the "rock" gesture (used mainly for grabbing objects and interacting with buttons from a distance) and the "paper" gesture (used mostly for performing upright redirection). All of the gestures in the application can be customized in case the patient is unable to move their fingers in a way that is needed to perform them.

Mobile device version of application: When the VR application is running, the second user (assistant) can connect to it from the mobile application. Then the assistant sees what the VR user sees and can help them control and navigate through the application by pressing respective buttons (for example "perform upright redirection", "back to main menu", "save new custom gesture" or "move the user forward in the scene").

Tangram puzzle game: Tangram, being a rearrangement puzzle and thus slow-paced and suitable even for elderly patients, focuses on the mental stimulation of the user's mind. The player grabs the puzzle pieces either by touching them or by casting a ray from a distance and then performing the rock gesture, then moves/rotates them by moving/rotating their hand and drops them by releasing the rock gesture. The rotations of the pieces snap to multiples of 45 degrees and the evaluation of the correct placement has a tolerance to avoid the frustration of the users and to help them reach the goal. There are currently three silhouettes to be assembled from the given pieces. See Figure **1a** to see a horse-shaped tangram puzzle almost completed.

Shooting gallery game: This game has two modes, the goal of the first one is to shoot N targets which makes it as fast-paced as the user wishes it to be, and the second gives the player T seconds to reach the highest score possible by shooting as many targets as possible (different targets reward them with different amount of score points). The second game mode may appeal more to younger patients. Both modes have two guns to choose from - rifle (both hands control its movement), and rifle on a stand (rifle with one control point fixed, thus one-handed). Figure **1b** shows rifle on stand aiming at one of the targets at the shooting gallery.

Endless runner game: The goal of this game is to reach the highest score possible by controlling an in-game character that runs and is faced with obstacles that need to be either jumped over or crawled under. The player has to perform the paper gesture so the character jumps and the rock gesture so the character crouches. See the player gesturing "rock" so the robot crouches under an obstacle in Figure **1c**. The obstacles come progressively faster and when the character hits an obstacle, the game is over. To motivate the users to perform even more gestures, screws were added that reward players with bonus points when collected. The environment in the game has a rest frame (Jerald (2015)) that should reduce the chances of the user getting motion sick.

2.3. Prototype study

The prototype of the application was tested twice at a home for the elderly, with participants aged 68–92. Some of the participants had physical limitations like a paralyzed arm or legs, limited shoulder or hand mobility, or blindness in one eye. In both testing sessions, the participants were first instructed on the controls and goals of the games. Then they were observed while playing the games and the mobile application was recorded, including audio, which enabled a thorough analysis of the gameplay after the testing. To support the notes gathered from the observation, the participants were interviewed using a set of questions afterward.

The first testing focused on the suitability of controls and upright redirection for the target user group and included 4 female participants. One of the participants was not able to control the application as she had limited finger mobility and could not perform the gestures (and they were not customizable). Some of the participants also found the rotation of the tangram pieces hard to perform at once because of limited wrist mobility.

There were 2 male and 3 female participants in the second study which was focused more on observing how the patients move when interacting with the application and finding out whether or not they enjoy using it. The second testing session showed interesting possibilities for adapting the games to the needs and wants of the users. In the endless runner game the participants struggled with timing the gestures and often lost the game immediately, but when they were instructed verbally by the researcher on when to perform which gesture, they started to improve and enjoy the game. One of the participants especially enjoyed collecting the screws in this game, but he often hit an obstacle because of that, causing him to lose the game quickly. Many of the participants had problems with distinguishing the puzzle pieces and the silhouette they were supposed to fill in.

In two cases, there were problems with the users not understanding the instructions that were given to them, which eventually caused either frustration or physical discomfort. A patient with dementia was unable to comprehend the goal of the tangram and eventually stayed in a position of holding a piece and not dropping it, so the testing was stopped. The second patient had a problem with the recalibration, where her head was at such an angle in comparison to her body that she could not reach the tangram pieces. After unsuccessful attempts to correct the position, she was given other games where she performed better. This shows the importance of the mobile application for the assistant who is experienced in helping the patients and thus can guide them as they can see the same things.

The observations in the second study show that participants found the tangram puzzle the easiest activity to control, but also the least fun. However, when asked about their preferred activity, every game was mentioned by one participant at least. Many participants were happy to continue playing the games repeatedly even though they were not particularly successful in them. The majority got better results after playing the games for around 5 minutes which showed that the games are easy to learn to control.

3. DISCUSSION

A summary of the VR application design was given in the previous section. The issues in the design or implementation gradually rise to prominence during the ongoing testing with users, which has already provided great feedback on what can be changed to improve the intuitiveness of the controls and the application overall.

The first testing showed problems caused by a lack of mobility. To stop them from occurring, a way of setting custom gestures was added and rotations of tangram pieces were multiplied to improve the range. In response to the problems in the second testing, a game mode for the endless runner was added which contains only screws, and the goal in it is to collect as many screws as possible in the given duration of the game. Audio instructions saying the name of the gesture before the player is supposed to perform it in the endless runner game were also added to help users focus more on performing the gestures rather than trying to perfect their timing. The tangram puzzle visualization was changed after the second testing – the silhouette is now removed and an outline marks the desired shape.

So far, the testing results show that the application motivates patients to move their upper limbs and provides entertainment in various forms from which the users can choose according to their preferences. The application thus seems to serve the intended purpose and will be the subject of more testing and modifications according to the results. In the future, the application will be able to record user behavior data such as movement of the hands and head, or events like target shooting or recalibration, which will be analyzed and used in the final study, which is planned to confirm the final application is well-suited for providing the target users with entertainment and gentle exercise. Eventually, the application may be provided to some institutions to be used with patients who might benefit from using it.

4. CONCLUSION

This paper describes an implemented VR application containing games suitable for lying patients as it can be used in any reclining position between upright and supine. It focuses on the application design that considers the target users' physical limitations, motivations, and frustrations, and which is gradually improved according to the results of the ongoing testing with users. The results already show the application is suitable for the given purpose as it entertains patients and motivates them to move their upper limbs. In the future, a case study will be presented utilizing the results of the final testing.

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Comparison Between 2D and 3D Icons as Menus in Virtual Reality Assessing the Usability of the Menus and User Satisfaction

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ABSTRACT

Over recent years, the popularity of virtual reality (VR) has surged, driven by advancements aimed at enhancing usability and optimizing human-computer interaction. This paper presents an experiment designed to assess the effectiveness and efficiency of 2D versus 3D icons as menus in VR environments. Usability was evaluated using the System Usability Scale (SUS), while user satisfaction was gauged through the After-Scenario Questionnaire (ASQ). Additionally, metrics such as task completion time (in seconds) and the frequency of unnecessary steps (errors) were recorded. 15 participants in this pilot study consistently rated the 3D menu higher in usability (M = 85 vs. M = 70 for 2D) and expressed greater satisfaction with task completion and overall system performance. Performance analysis revealed that the 3D menu facilitated faster task completion times, fewer non-required steps, and lower error rates compared to the 2D menu. These findings underscore the benefits of employing 3D menus to enhance both user experience and operational efficiency within VR applications.

1. INTRODUCTION

Human-computer interaction (HCI) is an area of study that focuses on the design of computer technology and more specifically, the interaction between humans (the users) and computers. Originally centered around computers, HCI has now expanded to cover nearly all forms of information technology design (IxDF, 2016). The user interface is a component of human-computer interaction and, usually, users deal with it using other tools to get information from the system such as the keyboard or mentors. The concept of a 3D user interface is defined in the book "3D User Interfaces: Theory and Practice" (Bowman et al., 2005) as a user interface that involves interaction in three dimensions. According to the book, 3D interaction refers to human-computer interaction where user tasks are directly performed within a spatial context defined in three dimensions (Bowman, 2014). The icon-based human-computer interaction (HCI) uses pictorial symbols to represent basic entities in a computer system. These entities can be processes or data, and their attributes, associations, or states can be indicated through a representation. Icons have a valuable ability to convey properties of system objects by sharing graphical elements. In certain situations, an icon interface can significantly reduce the need for other forms of media (such as commands) and provide more user-friendly interaction due to its ability to convey significantly more descriptive information while occupying the same or less physical display space (Gittins, 1986).

The 2D shapes and 3D shapes have both similarities and differences. Both types of shapes exist in our environment and are processed by the human visual system. However, there are distinct characteristics that separate them. 2D shapes are flat and have only two dimensions, such as length and width. They are typically represented on a plane, like a piece of paper. On the other hand, 3D shapes have three dimensions, including length, width, and depth. They are objects that occupy space and have volume. The perception of 3D shapes is influenced by factors such as lighting conditions and sample shape, whereas the perception of 2D shapes is less affected by these factors. Additionally, the visual effectiveness of presenting information in 3D images can be enhanced by considering the layout of items and the distribution of attention based on eye-tracking analysis (Raitanen et al., 2023; Krauze et al., 2023). Figure 1 shows some examples and differences between 2d and 3d objects.

Figure 1 *Example of 2D shapes and 3D shapes.*

2. METHODS

Various evaluation methods assess a system's usability and user satisfaction. One such method is the System Usability Scale (SUS), which aims to measure the usability of menus within a system. This is achieved through a questionnaire consisting of statements given to users after interacting with the system. The results were then converted into an SUS score on a scale of 0 to 100. Another method is the After-Scenario Questionnaire (ASQ), which measures users' satisfaction with the experiment. This is done using a questionnaire that likely includes questions related to user satisfaction with the system (Monteiro et al., 2019). Nine participants (5 male and 4 female) aged 20 to 30 years (median age 25.3) were recruited to participate in our pilot study. Each participant experienced 2D and 3D icon menus in a 3D environment in virtual reality. The experiment consists of two main tasks: navigating the menu to select certain icons and completing pre-defined actions. Each participant completed a training session to familiarise themselves with the two menu types. To evaluate the performance, we recorded objective measurements, including tasks completed, the number of steps not required to complete a scenario, and error rates. The SUS and the ASQ collect the subjective usability and satisfaction measures, which participants fill out immediately after each menu type. Fig. 2 shows the proposed 2D menu. the participants were asked to:

1- Choose a new game
2- Choose 2 characters for the game from the drop-down list.
3- Change the color for each one
4- Give them a name
5- Save the information for both

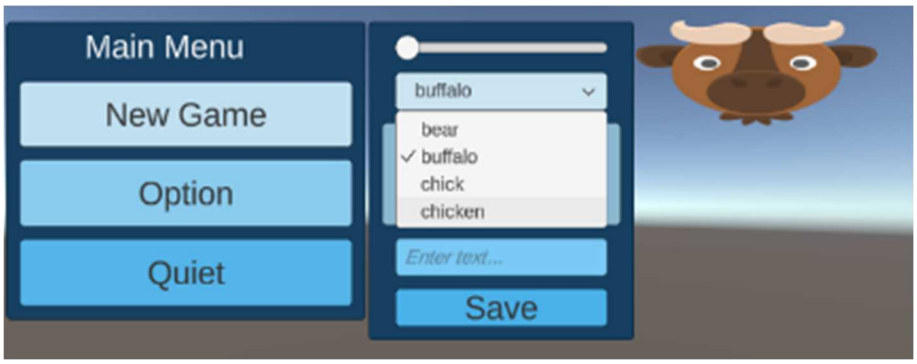

Figure 2 *Example of 2D menu scenario.*

3. RESULTS

The collected data indicate a clear preference for the 3D menu over the 2D menu among fifteen participants. The SUS scores for the 3D menu averaged 85 (SD = 5), which is higher than the 2D menu's average of 70 (SD = 8). This trend was consistent across the ASQ results. Participants rated the ease of task completion higher for the 3D menu (M = 6.6, SD = 0.4) compared to the 2D menu (M = 5.1, SD = 0.6). Similar results were observed for the time required to complete tasks, with the 3D menu receiving an average score of 6.4 (SD = 0.4) against the 2D menu's 5.3 (SD = 0.6). Overall satisfaction was also higher for the 3D menu, scoring an average of 6.5 (SD = 0.4) versus 5.2 (SD = 0.6) for the 2D menu. Performance measures showed that participants completed tasks more efficiently using the 3D menu, with a mean task completion time of 45 seconds (SD = 10 seconds) compared to a mean of 60 seconds (SD = 12 seconds) for the 2D menu. Additionally, the number of non-required steps was lower

for the 3D menu, averaging 2.1 steps (SD = 0.6) versus 4.0 steps (SD = 1.1) for the 2D menu. The error rate was also reduced with the 3D menu, averaging 1.2 errors per task (SD = 0.5) compared to 2.5 errors per task (SD = 0.8) for the 2D menu. Table 1 shows all SUS and ASQ results and a comparison between the 2D menu and 3D menu.

Table 1: *SUS and ASQ results and comparison between 2D menu and 3D menu.*

Measure	2D Menu	3D Menu
System Usability Scale (SUS) Score	M = 70, SD = 8	M = 85, SD = 5
ASQ - Ease of Task Completion	M = 5.1, SD = 0.6	M = 6.6, SD = 0.4
ASQ - Time Required to Complete Tasks	M = 5.3, SD = 0.6	M = 6.4, SD = 0.4
ASQ - Overall Satisfaction	M = 5.2, SD = 0.6	M = 6.5, SD = 0.4
Task Completion Time	M = 60s, SD = 12s	M = 45s, SD = 10s
Non-Required Steps	M = 4.0, SD = 1.1	M = 2.1, SD = 0.6
Error Rate	M = 2.5, SD = 0.8	M = 1.2, SD = 0.5

4. CONCLUSION

In this study, a comparison was conducted using statistical analysis of SUS scores, ASQ ratings, recorded task completion times, and unnecessary steps. The results from 15 participants consistently indicate that the 3D menu offers a more user-friendly, efficient, and satisfying experience compared to the traditional 2D menu in virtual reality environments. Participants rated the 3D menu higher in usability and reported greater satisfaction with task completion and overall system performance. Moreover, performance metrics revealed faster task completion times, fewer non-required steps, and lower error rates with the 3D menu. These findings underscore the advantages of adopting 3D menus to optimize user experience and operational efficiency in VR applications. For future work, we will assess a 3D menu over the 2D menu across three different VR environments: static, dynamic, and textured.

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Sexology

The session on Sexology focused on exploring the potential of VR in addressing sexual health and therapy. One presentation examined the use of VR in virtual sex therapy as a novel psychotherapeutic intervention for individuals experiencing sexual dysfunction. The approach aims to provide a safe, immersive environment for therapy, potentially increasing comfort and effectiveness in addressing sensitive issues. Another study analysed female sexual responses to different types of audiovisual stimuli presented in both 2D and 3D formats, as well as from first-person and third-person perspectives. The findings offer insights into how VR can be tailored to enhance engagement and response in sexual therapy contexts. The session highlighted VR's emerging role in sexology, offering new, non-invasive methods for therapy and research.

Virtual Sex Therapy: A virtual Psychotherapy Intervention to Help Individuals with Sexual Dysfunction Difficulties

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ABSTRACT

This paper presents a Virtual Reality (VR) based Psychotherapy intervention for sexual therapy for woman suffering from sexual dysfunctions. Our VR application is designed and developed in collaboration with a sex therapist and psychologist that aims to provide a confidential environment for psychosexual therapy, enhancing treatment efficacy and potentially creating a safe environment to receive therapy about a sensitive topic in a safe environment. The VR application as well as the planned evaluation of the intervention is described in this extended abstract.

1. INTRODUCTION

Sexual dysfunction is a highly prevalent disorder that describes a range of psychological distress that negatively affects sexual satisfaction (Fru¨hauf et al. (2013)). Psychotherapy, as a common intervention, is widely employed to help individuals suffering from sexual dysfunction. Review by Fru¨hauf et al. (2013) has demonstrated the effectiveness of psychotherapy for female sexual dysfunction, especially orgasmic disorders.

However, the finding in the review emphasizes the necessity and importance of conducting gender-inclusive research in this domain. Women's sexual health issues should receive broader attention and exploration to promote comprehensive and effective implementation of sexual dysfunction treatment. Virtual Reality (VR) has the potential as a tool for further exploration and promotion of sexual dysfunction solutions.

Several studies have shown the efficiency of VR as a tool for therapeutic interventions (Freeman et al. (2017), Fodor et al. (2018), Adjorlu (2020)). However, research on the application of VR in sexual therapy, particularly Psychotherapy for female sexual disorders, is notably limited.

Therefore, this project aims to explore the potential of VR technology in this underexplored domain, specifically focusing on female orgasmic disorders. One of the advantages of VR in a therapeutic sense is that it offers a safe environment for Psychotherapical interventions, especially on a sensitive topic such as sexual dysfunction. Additionally, the increased accessibility to affordable head-mounted displays makes VR-based Psychotherapical interventions available to a wider geographical population. Despite limited research on VR technology in psychotherapy of sexual dysfunction, the technology has shown great potential where Low et al. (2021) shows that VR-enhanced cognitive-behavioral therapy (CBT) is more effective than traditional CBT in reducing situation-induced body dissatisfaction and frequency of binges while Freeman et al. (2017), Fodor et al. (2018) validate effectiveness of VR exposure-based treatments in reducing anxiety disorders.

2. THE VR SEXUAL THERAPY INTERVENTION

The VR application is designed in collaboration with a sex therapist and developed using the Unity3D engine. The therapist's main requirement was the ability to enter the same virtual environment as their client and conduct a therapy session while talking to the client, as well as having access to 3D representation of female anatomy,

illustrations as well as a drawing board. A scene was created with two chairs, illustrations of female anatomy on the wall, and a whiteboard for drawing. Additionally, a 3D representation of female genital anatomy was placed in the scene (see Figure 1). The therapist and the client can grab the 3D item and have a conversation about female gender anatomy. The networking and voice communication mechanics are implemented using the Photon Pun plug-in for the Unity game engine. A natural 3D avatar represents the client in the virtual environment.

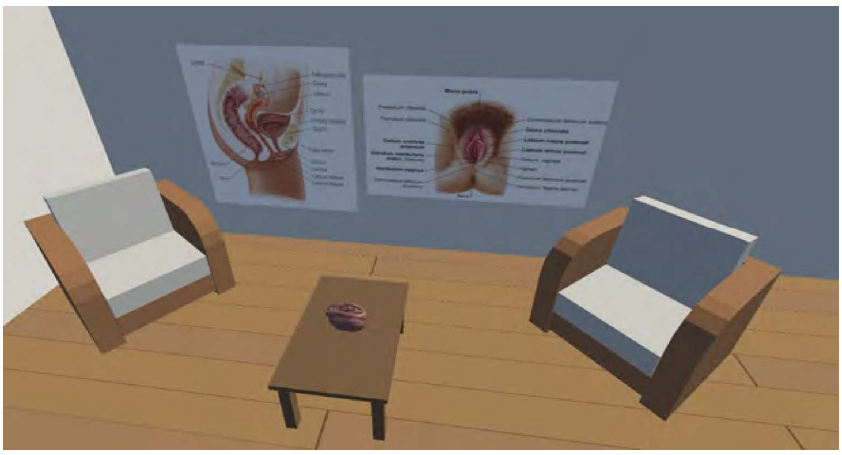

Figure 1: *The sexual therapy VR Environment*

3. CONCLUSION& DISCUSSION

In order to evaluate the VR sex therapy intervention, we are currently in the process of recruiting participants in close collaboration with a sex therapist and psychologist experienced in working with this topic. However, this evaluation poses the question: which methods should be applied to evaluate whether VR can be used as a tool to create a safe space to receive therapy for sexually related difficulties? Several scales can be used to evaluate the quality of therapy sessions, such as the Therapeutic Alliance Scales Gaston & Marmar (1994) or the Outcome Rating Scale Casey et al. (2020), which will be considered for the evaluation of the sex therapy VR intervention developed during this project.

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Female sexual response to audiovisual stimuli in 2D/3D modality and first/third person perspective

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ABSTRACT

This study investigates the effect of sexually explicit video stimuli displayed in a different modality (3D vs. 2D) and perspective (first vs. third person) on female sexual arousal, both subjective and genital, pleasantness ratings, and sexual and general presence. The results are surprising and contrary to our expectation with 2D modality being superior to 3D in most of the measured variables.

1. INTRODUCTION

Virtual reality (VR) technology is rapidly advancing and finding applications in diverse markets, the pornography industry included. The popularity of VR porn lies in its ability to capture real pornographic scenes with three-dimensional (3D) cameras with 180-degree views of the environment from the viewpoint of a person involved in sexual acts. The term "point of view" (POV) denotes this category and presumably provides a more realistic and immersive experience compared to the third-person perspective (3PP).

Two studies (Dekker et al., 2021; Simon & Greitemeyer, 2019) compared responses of male participants to POV stimuli differing in presentation modality: 2D (on a desktop monitor) vs. 3D (in a VR headset). Participants exhibited higher physiological response (measured via skin conductance) and reported increase in subjective sexual arousal, general and sexual presence to 3D compared to 2D modality (Simon & Greitemeyer, 2019). In 3D modality, participants felt higher subjective sexual arousal during exposure; desire for actresses, felt more desired, flirted with, looked into the eyes, and felt a greater urge to interact with the actresses compared to 2D modality (Dekker et al., 2021). Other studies tackled the perspective stance of a viewer (POV vs. 3PP). In line with studies mentioned above, men reported greater subjective sexual arousal and presence in 3D modality, and POV heightened those feelings (Elsey et al., 2019). Female participants also reported an increased presence (Elsey et al., 2019; Milani et al., 2022) and sexual presence (Brown et al., 2023; Milani et al., 2022) in 3D over 2D modality. Perspective stance (POV/3PP) did not influence ratings of presence (Elsey et al., 2019), but POV videos were rated higher on sexual presence compared to 3PP (Brown et al., 2023; Milani et al., 2022). The results, however, were ambiguous regarding subjective sexual arousal. Milani et al. (2022) reported an increase in subjective sexual arousal. Elsey et al. (2019) reported an increased subjective sexual arousal to POV stimuli compared to 3PP. Milani et al. (2022) did not find any difference in perspective stance. While 3D modality, and especially POV, seems to offer a more immersive sexual experience, the impact of 3D pornography on the female sexual experience is somewhat ambiguous. To unfold this puzzle, we compared presentation modality (3D vs. 2D) and perspective stance (POV vs. 3PP) on women's subjective sexual arousal, pleasantness ratings, feelings of general and sexual presence while watching sexual audiovisual stimuli. We expected (sexual) presence and subjective sexual arousal to be higher in 3D compared to 2D modality and in POV compared to 3PP. We also assessed genital arousal, which was has not been measured yet using VR. Although genital arousal can be elicited reliably in heterosexual women presented with sexual stimuli in laboratory settings, it is, to some degree, sensitive to the intensity of the sexual activity depicted in stimuli. But once the stimulus is of high intensity (i.e. explicit sexual intercourse), the genital response seems to be unaffected by a perspective stance (Bossio et al., 2014; Both et al., 2011). Therefore, we expect genital arousal to be unaffected by either condition, as all the stimuli are of high intensity across all conditions.

2. MATERIALS AND METHODS

2.1. Participants

We recruited 46 female participants (M_{age} = 28.96, SD_{age} = 6.84). To be eligible for the study, women had to be between 18-45 years old; fluent in the Czech language; sexually active; have experience with sexually explicit materials; predominantly heterosexual (1-2 on Kinsey scale).

2.2. Experimental stimuli

We purchased two 30 minutes long high-quality audiovisual stimuli for 3D modality (180-degree) from a production company that focuses on VR porn (VRporn.com). The first stimulus depicted a scene from the POV of a female actress, and the second from the 3PP. Stimuli depict the same heterosexual dyad in the same room engaging in similar consensual sexual activities. The final sequence (4 min) was the same for both modalities: kissing, touching, cunnilingus, and vaginal penetration. The 3D stimuli (both POV and 3PP) were converted into 2D modality and used the same videos in both modalities.

2.3. Genital arousal and subjective ratings

We measured genital arousal using a vaginal photoplethysmograph (VPG; BIOPAC Systems, Inc., Santa Barbara, CA) and the software AcqKnowledge version 4.4.0. Data were recorded continuously throughout each stimulus. We calculated the mean VPA (which reflects the cyclical changes in vaginal blood volume with each heartbeat) for the full length of each stimulus using peak-to-peak amplitude. After the presentation of each stimulus, women rated their subjective sexual arousal and pleasantness on a 7-point scale (1 - not at all sexually aroused/very unpleasant, 7 - very sexually aroused/very pleasant). Sexual presence was assessed using the questionnaire by Fontanesi & Renaud (2014). Presence was assessed using the Igroup presence questionnaire (IPQ, Schubert et al., 2001), but we only used the item general presence and subscale Involvement.

2.4. Experimental procedure

Participants first completed a short online sociodemographic questionnaire to screen for exclusion criteria, and then we invited them for testing to the Centre of Sexual Health and Intervention at the National Institute of Mental Health (NIMH) in Klecany, Czech Republic. Each trial consisted of the following: (1) audiovisual stimuli screened for 4 minutes with continuous measurement of genital arousal; (2) a time window in which the participant rated subjective scales on a tablet; (3) a cognitive distractor in the form of sudoku solving on a tablet for 3 minutes to decrease sexual arousal. Every participant completed four trials in total. The order of the stimuli was randomized using Latin square. The whole procedure took around 50 minutes and was approved by the Ethics Committee at the Faculty of Humanities, Charles University (no. 092022/Kli).

2.5. Statistical Analysis

ANOVA with repeated measures and two within-subject factors of modality (3D vs. 2D) and perspective (POV vs. 3PP) was calculated for all dependent variables. Statistical significance was set at $p < .05$. Effect sizes are provided as partial eta squared (η^2_p) for main effects and interactions and as Cohen's d for post hoc comparisons.

3. RESULTS

There was a main effect of modality on subjective sexual arousal, $F(1, 45) = 6.44$, $p = 0.02$, $\eta^2_p = 0.13$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli (M = 4.24) elicited more subjective sexual arousal than VR stimuli ($M = 3.70$; $d = 0.33$, $p = 0.02$). There was a main effect of perspective on pleasantness, $F(1, 45) = 6.89$, $p = 0.01$, $\eta^2_p = 0.13$. Post-hoc tests with Bonferroni correction revealed that POV videos ($M = 3.54$) were rated more pleasant than 3PP videos ($M = 3.11$; $d = 0.31$, $p = 0.01$). There was a main effect of modality on sexual presence, $F(1, 45) = 38.85$, $p < 0.001$, $\eta^2_p = 0.46$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 4.59$) elicited higher levels of sexual presence than 3D stimuli ($M = 3.60$; $d = 0.86$, $p < 0.001$). There was a main effect of perspective, $F(1, 45) = 21.24$, $p < 0.001$, $\eta^2_p = 0.32$. Post-hoc tests with Bonferroni correction revealed that 3PP stimuli ($M = 4.38$) elicited higher levels of sexual presence than POV stimuli ($M = 3.81$; $d = 0.50$, $p < 0.001$). There was a main effect of modality on general presence, $F(1, 45) = 45.62$, $p < 0.001$, $\eta^2_p = 0.50$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 5.43$) elicited higher levels of general presence than 3D stimuli ($M = 3.68$; $d = 1.09$, $p < 0.001$). There was a main effect of perspective, $F(1, 45) = 44.88$, $p < 0.001$, $\eta^2_p = 0.50$. Post-hoc tests with Bonferroni correction revealed that 3PP stimuli ($M = 5.16$) elicited higher levels of general presence than POV stimuli ($M = 3.95$; $d = 0.75$, $p < 0.001$). There was a main effect of modality

on subscale involvement, $F(1, 45) = 54.37$, $p < 0.001$, $\eta^2_p = 0.55$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 5.27$) elicited higher levels of general involvement than 3D stimuli ($M = 3.33$; $d = 1.30$, $p < 0.001$). There was a main effect of perspective, $F(1, 45) = 5.14$, $p = 0.03$, $\eta^2_p = 0.10$. Post-hoc tests with Bonferroni correction revealed that 3PP stimuli ($M = 4.48$) elicited higher levels of general involvement than POV stimuli ($M = 4.12$; $d = 0.24$, $p = 0.03$).

Regarding genital response, we did not find the effect of either modality or perspective.

4. DISCUSSION

The results of this study are surprising and contrary to our expectation with 2D modality being superior to 3D in most of the measured variables, namely subjective sexual arousal, sexual presence, item general presence (IPQ) and subscale involvement (IPQ). 3PP received higher ratings in sexual presence, item general presence (IPQ) and subscale involvement (IPQ) than POV. On the other hand, participants rated POV stimuli as more pleasant compared to 3PP. Although our results are mostly in discord with previous experimental studies, it only highlights the complexity of female sexual response. We can explain superiority of 2D over 3D modality by considering immersive level of the system used. Previous studies used VR headset for both modalities. While wearing VR headset, one expects 3D experience and when not faced it with, it might create confusion in perception of presented stimuli. Wearing VR headset, contrary to not wearing it, might also elicit some discomfort, be it a physical one, or psychical. Additionally, simple familiarity with 2D modality might be the cause of its preference. The use of latest technologies might not be essential, maybe even superfluous for measuring female sexual arousal, when less sophisticated technology can elicit similar responses.

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Relaxation & Nature

The session on Relaxation & Nature explored the therapeutic use of VR environments to promote relaxation and well-being. Presentations highlighted the calming effects of stylised digital forests, suggesting that visual realism is less crucial than the overall design and experience when creating soothing virtual spaces. Research also focused on creating nature-simulated VR applications for hospitalised seniors, aiming to enhance their mental well-being and provide a sense of tranquillity despite being in a clinical setting. Additionally, a VR game was introduced that teaches proper breathing techniques, featuring a dynamic environment that adjusts based on the user's breathing patterns. Overall, the session emphasised the potential of VR to offer immersive, nature-inspired experiences that support relaxation and stress reduction.

It's Not All About the Graphics: Finding Calm in Stylized Digital Forests

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ABSTRACT

Forest bathing has demonstrated positive effects on mental health. While digital alternatives lack the full sensory impact of real-world nature, they offer accessibility for those unable to engage in traditional forest bathing. This study investigated whether the level of graphical realism in virtual forest environments influences its psychological benefits. Participants engaged in forest bathing using either a photorealistic or stylized virtual forest using a VR headset. Both environments led to participants feeling restored, but we saw no reduction in felt anxiety. While the photorealistic environment felt more immersive, and we saw an overall positive effect of immersion on restoration, no significant differences were found between the two environments' restorative power. This suggests that simpler, stylized environments can be equally effective for delivering the mental health benefits of digital forest bathing, potentially making such experiences more widely accessible.

1. INTRODUCTION

A growing body of research indicates that time spent in a forest environment is beneficial for health and well-being. This practice has been called forest bathing (FB) or shinrin-yoku (森林浴) and is a common practice accompanying various therapeutic processes, especially in Asian countries. Many studies have explored the efficiency of forest bathing and reached similar conclusions. Staying in natural environments leads to improved mood, lessened feelings of anxiety, and general restoration (for a review, see Antonelli et al., 2022).

Several theories are linked to the efficacy of natural environment exposure and its effect on our mood. The first is the biophilia hypothesis (BH) (Kellert & Wilson, 1995; Wilson, 1984), proposing that forests satiate our inherent desire to connect with living organisms, and this connection with nature rejuvenates our mind and calms us. The Attention Restoration Theory (Kaplan & Kaplan, 1989) suggests that forests are ideal restorative spaces, eliciting soft fascination and a sense of being away, allowing the mind to wander from daily tasks and alleviate mental fatigue. Lastly, Stress Recovery Theory (SRT) by Roger Ulrich (Ulrich, 1983) suggests that as forests served humans throughout history as a source of food and shelter, they elicit positive feelings, resulting in a stress-reducing environment.

But there are groups that are prevented from benefiting from forest bathing practices, be it due to their physical limitations, or long-term separation from natural spaces. Photorealistic digital alternatives have found their way into this domain in the last few years, offering virtual nature visitations. Forest bathing has been implemented as 360 videos or virtual environments that can be explored on a PC or using virtual reality (VR) headsets (for a review, see Frost et al., 2022). While studies examining the effect of digital forest bathing on our psychological state are few, they generally agree that digital versions have similar positive effects, albeit smaller than real experiences (Frost et al., 2022).

However, many of these studies employ different methods of forest bathing and differ in how they implement the digital environments and the detail and relative “realness” in the visual and auditory domain. The question we set to answer was, to what extent should we strive for perfect photorealistic experiences and where simpler graphical visualizations might suffice? This is a practical question, as photorealistic graphics are very demanding, and the hardware capable of rendering such scenes for VR is expensive and not currently achievable with affordable hardware. If we could achieve similar effects using simpler graphics, we could deliver the experience to a much wider audience.

In this research, we aimed to compare forest bathing in stylized and photorealistic virtual environments and see its impact and potential differences in the benefits these two versions can have for our well-being.

2. METHODS

We have recreated a forest close to the Czech University of Life Sciences Prague in two distinct versions: a photorealistic and a stylized one. For illustration, see Figure 1. Both versions were built using positional LiDAR data from a real-world location (similar to our study published previously, Hejtmánek et al., 2022), but one was recreated using highly detailed and real-textured assets, while the other used simple, stylized, and colourful assets, leading to a more unnatural, game-like look.

Figure 1 *Visualization of the two environments. Stylized on the left, photorealistic on the right.*

Fifty-four participants attended the experiment (44 female, 10 male, mean age 23.074 (SD = 6.434)). The majority of participants were university students (4 students in a master's program, 34 students in a bachelor's program, 5 participants with university education but no longer students, 11 participants had secondary education and were not attending university). Participants were recruited using university social networks and bulletin boards. Students could be rewarded with course credit for participation.

Some participants experienced the photorealistic environment, and some the stylized one. Participants visited the environments using a VR headset, the HTC Vive Pro 2 and were free to walk around the chair in an area of approximately 3x3 meters. We collected participants' restorativeness using the Restoration Outcome Scale (ROS) (Korpela et al., 2008) and anxiety using the State-Trait Anxiety Inventory (STAI) (Marteau & Bekker, 1992) before and after the experience. We also collected participants' feelings of immersion using a modified Slater Usoh Steed immersion questionnaire (Slater et al., 1994).

3. RESULTS

We conducted a two-way ANOVA examining the effects of time of measurement (before vs after the experience) and type of environment visited (photorealistic vs stylized) on ROS scores. The results showed that the main effect of the environment is statistically not significant and very small ($F(1, 156) = 0.01$, $p = 0.921$; Eta^2 (partial) = 0.00006, 95% CI [0.00, 1.00]), main effect of time of measurement is significant and large ($F(2, 156) = 175.01$, $p < 0.001$; Eta^2 (partial) = 0.69, 95% CI [0.63, 1.00]), and the interaction between the variables is not significant ($F(2, 156) = 0.03$, $p = 0.968$; Eta^2 (partial) = 0.0004, 95% CI [0.00, 1.00]). Using the same procedure to examine the effects on STAI scores mirrored the results from ROS and revealed that the effect of environment is statistically not significant ($F(1, 208) = 1.11$, $p = 0.293$; Eta^2 (partial) = 0.005, 95% CI [0.00, 1.00]), the effect of time of measurement is statistically significant and large ($F(3, 208) = 1142.15$, $p < 0.001$; Eta^2 (partial) = 0.94, 95% CI [0.93, 1.00]), and the interaction between environment and time is not significant ($F(3, 208) = 0.36$, $p = 0.780$; Eta^2 (partial) = 0.005, 95% CI [0.00, 1.00]). Our results suggest no significant differences exist between stylized and photorealistic environments in their restorative power.

Exploring other variables, we compared how immersive the environments were, as measured using the SUS questionnaire. Interestingly, we found a difference in felt presence, with the group in the photorealistic environment reporting feeling more like in a forest, than the group in the stylized version (mean photorealistic = 24.11, mean stylized = 19.88, $t(45.38) = 2.42$, $p = 0.019$; Cohen's d = 0.66). We fitted a linear model predicting final ROS scores with the SUS score. We found the effect of the felt presence on felt restoration was statistically significant and positive (beta= 0.41, 95% CI [0.17, 0.65], $t(52) = 3.44$, $p = 0.001$; Std. beta = 0.43, 95% CI [0.18, 0.68]).

4. DISCUSSION

While previous research has already addressed a similar concern (Newman et al., 2022), we have followed up with our last protocols and recreated a real forest in its real-world structure. We included measures of both restorativeness and anxiety and asked participants about immersion. We replicated results from our previous research (Hejtmánek et al., 2022), where we observed positive benefits of the digital experience on restoration, but here we saw no effect on felt anxiety. This might be due to the relatively low stress levels before the experience and a potential floor effect.

Interestingly, contrary to the previous studies, we have not found any significant differences between the levels of graphical fidelity and their effects on restorative power. Participants were similarly restored in both environments. However overall, we have found a positive relationship between the restorative power of the experience and the level of felt immersion. The more immersive the environment felt to the participants, the more restorative it was. But despite participants reported that the photorealistic environments felt more immersive, this has not in our sample translated to them being more restorative.

Our results generally suggest that digital nature can be used to improve one's emotional state and that the level of graphical fidelity does not make a significant difference. This would be an interesting and exciting prospect, as visually simpler environments can be made more affordably and distributed even on lower-end hardware.

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Designing Nature Simulated VR Application for Hospitalized Seniors

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ABSTRACT

In this paper we present the design consideration of an altered version of an existing interactive VR application prototype, Zenctuary VR that we aim to further develop for senior generation treated in hospitals with multimorbidity. The outcomes of this are based on the initial design considerations of the Zenctuary VR as well as on background literature and workshop organized with healthcare professionals and psychologists working with senior population hospitalized.

1. INTRODUCTION

There are less VR application designed for elderly population. This is for several reasons such as cybersickness, lightweight of the headset could be an important problem, also the novelty of the technology for this generation can also cause further challenges (Youngjae Jeong et al., 2023). Several experiments that are conducted with them about their VR usage is rather about Designing interactive VR applications for senior populations needs special attention from the creator's perspective. There are a handful of studies only that scrutinize the guidelines to how to design such experiences and what are the possible effects that these VR experiences have. According to the review conducted by Thach and colleagues (Thach et al., 2020) VR can have often result in positive changes in emotion, but the question of accessibility is something that due to the headset designs are often neglected. Silva and colleagues also listed the needs of the senior population that has to be taken into consideration: aging related physical impairment and cognitive impairment, user experience (Santos Silva et al., 2019).

In 2023 the design researchers of Moholy-Nagy University of Art and Design together with software developer team from Code and Soda company developed an interactive nature simulating free-roaming PC VR application that followed the design guidelines of therapeutic gardens. The main design features are that a high-quality computer-generated graphics was used, as well we implemented many interactions that were rather urging the users to discover the environment and not to behave as in a VR game (Bakk et al., 2023). We also relied on the multimodal design possibilities that VR allows and beside visual and auditive elements, we also included the tactilo-kinesthetic feedback that the controllers allow. Together with researchers from ELTE University, Affective Psychology Department (led by Dr. Renáta Cserjési) the application was pilot tested with adults diagnosed with ADHD and also with neurotypical participants. The participants gave feedback in open-ended questions regarding the design: it was mentioned that the space should be bigger, but the graphics and the sound were rated positively such as the overall calming effect of the environment (Tölgyesi et al., 2023). The project was not yet piloted in hospitals treating older adults as patients.

The design and research team aims to further develop the application into a standalone version, in order to test its effectiveness with senior population who are long-termly treated in healthcare centers' in order to offer them experiences that are otherwise not available for this population due to their health condition and physical and cognitive impairment. Our thinking was driven as several design features of the VR app can actually enhance the wellbeing of this population for the following reasons: it represent a natural environment of Central and Eastern European fauna. According to Bruun-Pedersen outdoor virtual environments for elderly should include many life and diversity-related elements, such as "trees, wind, water, climate changes, animals, and events. These elements inspire exploration and help to avoid the feeling of static environment" (Bruun-Pedersen et al., 2014). Also the interactions are aiming to imitate real-life interactions as much as the VR technology as a medium allows it, because "the interface has to be easy to use exploiting interaction metaphors that require almost no learning curve"(Caggianese et al., 2014).

2. METHODOLOGY

In order to further understand the need of the elderly population treated long-term in health care centres, we initiated a workshop where we invited healthcare professionals (psychology researchers, psychology therapeutants), software developers and design strategists. Total amount of participants was 9, all Hungary-based professionals. The workshop followed the guidelines described by Holtzblatt and Beyer (1998) and the outcomes of the workshop will be discussed in the following – based on Santos Silva et al. (2019).

3. RESULTS

The outcomes of the workshop are grouped based on the needs of elderly population: aging related physical impairment and cognitive impairment, user experience (Santos Silva et al., 2019).

Physical impairment related suggestions: the designers should carefully aim to understand the visual and auditive capacities of the elderly generation who might use it. As they often have this impairment the applications should be able to offer them full experience. Also, the patients often have limited physical possibilities to move, therefore the interactions should be carefully designed (e.g. that they do not fell out from the wheelchair or from the bed). It is also important that the interactions do not cause them the sense of failure (e.g. they cannot reach out for an apple on a tree). On the other hand the application should also offer them VR productions that can be multifaceted and rich experiences, especially compared to 360 videos, which offer no new layers for meaning making during the VR experience. As older adults condition often cannot be rehabilitated, the aim of the planned VR experience is to offer them better life quality while hospitalized.

Cognitive impairment: it is suggested that less gamified interactions are included in the application, and the users can rather enjoy the interactions. This means that as little as possible gamification elements should be included and the application should focus on the exploration.

The education of healthcare professionals towards how to use it is also an important factor. It is important to note how conductive interventions with older adults can be challenging and the professionals should be trained specially to do it. When planning the intervention is important to have an interface for the researchers, so they cannot follow directly the interactions of the patients.

4. DISCUSSION

The challenge is to define the experiment participants because of comorbidity, medication possible health problems that might influence the results. The application should also contain such interactions that work similarly to experiential therapy: once the elderly population tries the application it can help them to remember how they used to garden.

Possible further application could be a sandbox VR experience in which the users can have a more tailor-made and long-term experiences. Another avenue for development also includes the multiplayer aspect of the application, this way the participants can socialize in VR and can be motivated more to follow a joint goal.

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Design virtual reality games that instruct proper breathing techniques with dynamically changing virtual environment

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ABSTRACT

This research aims to present the development of a "serious game" utilizing the Oculus Quest 2 VR device to enhance breathing techniques. Targeting individuals with breathing difficulties such as Chronic Obstructive Pulmonary Disease (COPD) and post-COVID symptoms, the games serve as rehabilitation tools and aids in anxiety management. Additionally, the project involves adapting the virtual environment based on biofeedback data. Three virtual reality games were developed, each showcasing different breathing techniques: Box Breathing, 4-7-8 Breathing, and Humming Breath. These techniques offer structured methods for relaxation and calming the nervous system, potentially benefiting individuals experiencing heightened stress or anxiety.

1. INTRODUCTION

The objective of my research is to develop a "serious game" utilizing the Oculus Quest 2 VR device, focused on enhancing breathing techniques. These innovative games aim to aid in the rehabilitation of individuals experiencing breathing difficulties such as Chronic Obstructive Pulmonary Disease and post-COVID symptoms, while also serving as a tool for managing anxiety. Additionally, the project entails adapting the virtual environment based on biofeedback data, considering the user's psychological state, age group, and individual preferences. (Ghorashi et al., 2022)

2. METHODS

We focus on creating VR-based serious applications for rehabilitation, primarily using the Oculus Quest 2 . This device, powered by Android 10, is complemented by Oculus Touch controllers equipped with various features like analogue joysticks and haptic motors for enhanced user interaction. For software development, we utilize the Unity game engine along with Blender, known for its versatility in generating virtual reality content. (Unity, 2024; Blender, 2024)

3. RESULTS

Throughout the game, the virtual reality environment dynamically adjusts based on the user's heart rate, monitored by the Polar 10 chest strap. As the heart rate increases, the environment becomes brighter and more cheerful, with added sunshine to alleviate stress. We've developed three virtual reality games featuring animated characters to demonstrate proper breathing techniques to users, allowing them to practice in an immersive and interactive environment.

3.1. “Box breathing” techniques

The first technique is the Box Breathing technique, also known as square breathing, is a structured method of breath control that can quickly induce a state of relaxation. This technique is particularly useful in moments of heightened stress or anxiety. Moreover, numerous articles discuss its various effects, including its potential efficacy in alleviating symptoms of COVID-19 and respiratory issues. The user is required to follow these steps: Inhale deeply through the nose for four counts, filling the lungs. Hold the breath for four counts. Exhale slowly

through the mouth for four counts. Pause for four counts after exhaling. (Ahmed et al., 2021) In the development process, we utilized the Blender Foundation's Ellie character. (Ellie, 2024)

Figure 1 *User with Oculust quest 2 device and Screenshot from the 3D VR serious game*

3.2. "4-7-8 Breathing" techniques

Developed by Dr. Andrew Weil, the 4-7-8 breathing technique is a simple but powerful method for calming the nervous system and promoting relaxation. In this task, the user begins by placing one hand on the belly and the other on the chest to focus on their breath. Inhale deeply and slowly through the nose, counting to four as fill the abdomen with air, allowing the belly to rise. After the lungs are full, hold the breath for a count of seven. Then, exhale slowly and completely through the mouth, counting to eight as empty the lungs, feeling the tension melt away with each exhalation. (Pandekar & Thangavelu, 2019)

3.3. "The Humming Breath" techniques

The humming breath, also known as bhramari pranayama. In this exercise, the user is required to adhere to the following steps: Inhale deeply through the nose, drawing the breath in slowly and steadily for a minimum of five seconds. Subsequently, close the mouth and softly hum, mimicking the sound "hmmm." While exhaling, allow the vibration to permeate throughout the body. Repeat this sequence five to seven times, concentrating on the calming sensation induced by the humming breath. Finally, take a moment to sit quietly and observe the sensations in the body and mind before resuming daily activities. (Sattar, 2022)

4. DISCUSSION

The research aims to develop a "serious game" using Oculus Quest 2 VR technology to improve breathing techniques, targeting rehabilitation for conditions like COPD and post-COVID symptoms, as well as anxiety management. The project includes adapting the virtual environment based on user data. Three VR games have been developed, each focusing on different breathing techniques: Box Breathing, 4-7-8 Breathing, and Humming Breath. These techniques offer structured methods for relaxation and calming the nervous system.

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Cyberspace, Behaviour and e-Therapy (CYBER)

The CYBER session showcased an array of projects leveraging digital innovations to address diverse aspects of human behaviour and therapy. The program highlighted interdisciplinary collaboration, pairing students from Human Behaviour Backgrounds (HBB) with those from Exact Sciences and Engineering Backgrounds (EEB) to work on projects involving VR, machine learning, and digital interventions.

Research topics included VR-based training for body image improvement, gamification for modifying attentional biases, and VR exposure therapy for selective mutism in children. Other studies focused on predicting educational dropout using machine learning, assessing oxygenation changes under stress, and exploring verbal patterns to evaluate mental health indicators like anxiety and attachment style. Additional projects involved developing an AI-enabled virtual therapist for cognitive rehabilitation and a VR cybersecurity training simulator for workplace employees.

Explorations into the psychological impacts of digital tools featured projects on enhancing engagement in long-distance relationships via VR, assessing the impact of virtual embodiment on attitudes towards gender-based harassment, and using AI to adapt cognitive tasks for individuals with schizophrenia. The session also included innovative approaches like employing multimodal chatbots for mental well-being, deep learning for personality assessment, and digital interventions for addressing psychological impacts of severe health conditions. Overall, the CYBER program demonstrated a strong commitment to merging technology and behavioural science for therapeutic and educational advancements. For more information, visit the CYBER project website:`https://www.cyber-t.eu/`.

VR-based training for improvement of positive body image: A Pilot Study

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ABSTRACT

This study aimed to evaluate the impact of ACT-based intervention on body image flexibility and body awareness of healthy participants. Using virtual reality as a main tool, the study implemented mixed-methods design, and the data from 14 people was collected. Findings revealed statistically significant improvement with a large effect size for body image flexibility. Future considerations include a larger and more diverse sample and a refinement of measurement tools.

1. INTRODUCTION

Traditionally has largely focused on the negative aspects of body image (BI) while ignoring its positive components (Guest et al., 2022). Positive body image is a multifaceted construct that encompasses several components. Individuals with positive BI tend to maintain self-care behaviours, adequate sleep, keep physical fitness without focusing on appearance, and are able to resist the negative effects of media exposure (Alleva & Tylka, 2021). Activities that accentuate the connection of body with mind such as yoga, meditations, etc. can be a supporting factor in positive body image maintenance (Piran, 2016; Cox et al., 2017).

One of the components of positive BI, body image flexibility, has recently gained attention in research. It is an ability to experience thoughts or feelings about the body without attempting to act on, avoid, or alter them. One way to address this component is throughout acceptance, a strategy that comes from Acceptance and Commitment Therapy (ACT) (Linardon et al., 2021).

One of the tools that has been widely used both in assessment and treatment of eating and weight-related disorders is virtual reality (VR) (de Carvalho et al., 2017; Serino et al., 2018). Despite the significant success in the use of VR to address BI concerns, most of the existing studies with VR target negative BI, while positive body image hasn't been explored in this context. The primary objective of our study was to develop and test the effectiveness of a VR training for improving positive body image components in healthy adults.

2. METHODOLOGY

2.1. Participants

Participants for this study were recruited through social media advertisements. Eligibility criteria included being between 18 and 45 years old, having no history of diagnosed eating disorders, and proficiency in English or Spanish. Participants were excluded if they did not complete the tasks in VR and/or did not fill out pre- and post- intervention measurements, resulting in a final sample of 14 individuals (4 males, 10 females; M_{age} = 29.14, SD = 5.246, range = 20-39).

2.2. Measurements

There were two points of measurement: before and after the intervention. Prior to the intervention we collected participants' demographic information including gender, age, race, height, and weight to calculate BMI. Also, the participants were asked to fill out Scale of Body Connection (SBC; Quezada-Berumen et al., 2014; Price & Thompson, 2007), 20-item questionnaire that measures body awareness and bodily dissociation and Body Image Acceptance and Action Questionnaire (BI-AAQ; Sandoz et al., 2013; Mónica Hernández-López et al., 2024), 12-item questionnaire that measures body image flexibility. The last section contained open-ended questions to help us identify how the participants viewed and acted towards their body. After the intervention, participants repeated the questionnaires.

2.3. Procedure

Prior to their lab visit, participants completed pre-intervention measurements and provided a detailed informed consent. They then completed the Body Image Acceptance and Action Questionnaire (BI-AAQ) and the Scale of Body Connection (SBC) and responded to open-ended questions.

At the lab, participants were briefed on the VR intervention and trained in using the equipment. They selected the language for the virtual environment and engaged in the intervention, which included a meditation and interactive virtual garden. They started with the guided body scanning meditation that lasted approximately 12 minutes. Participants were asked to be sitting for this part but could "leave" the virtual room and meditate outside of it. The voiceover was recorded via AI and the script asked the participants to focus on the sensations of the body, its functioning and appreciation. Following this, they participated in a 6-minute ACT-based narrative and interactive tasks in a virtual garden. Similar to the meditation, there was a narrator who guided participants through the tasks. Post-intervention, participants completed the same questionnaires to assess the immediate effect of the intervention. The whole procedure took around 35 minutes. Afterwards we asked about participants' overall experience and feedback.

3. RESULTS

3.1. Data analysis

Data from the questionnaires were analysed by using IBM SPSS Statistics Version 21 (IBM Corp. Released 2011). First, normality tests were run. Afterwards, we ran a paired sample t-test to compare pre- and post-intervention scores for each participant. Moreover, we calculated the effect size to see the magnitude of the intervention effect. Qualitative data was thematically analysed.

3.2. Results

First, Shapiro-Wilk test was conducted to check the scales' normality. Body image flexibility scale before the intervention was not normally distributed, thus it was decided to conduct non-parametric Wilcoxon Signed Ranks Test to compare scores on this scale. As for the SBC, normality tests revealed no deviation, so a paired sample t-test was conducted.

A Wilcoxon Signed Ranks Test revealed that there is a positive significant difference between the pre-treatment and post-treatment scores ($Z = -2.137$, $p = .033$). Additionally, the effect size was calculated manually by dividing the absolute statistic Z by the square root of the number of pairs. An effect size of 0.571 indicates a large effect.

The results of the paired samples t-test of SBC revealed that the mean difference between the pre- intervention and post- intervention scores was 0.025 (SD = 0.25476), that demonstrates a minor increase in the scores following the intervention. This difference was not statistically significant, $t(13)=0.367$, $p=0.719$.

Preliminary results of the thematic analysis demonstrated a complex understanding of body image among participants. The derived themes emphasize a balance between acceptance and having a potential to improve. The topics of health and functionality over aesthetic looks prevailed. Participants revealed a range of attitudes from critical and neglecting to positive and proactive.

4. DISCUSSION

In this study we aimed to cultivate positive body image in healthy adults by using VR as a main tool. Overall, participants indicated their satisfaction with the intervention highlighting the relaxation, full engagement in the VR, and the message behind the ACT metaphor.

Despite significant improvement of body image flexibility with a large effect, scores on body awareness remained practically the same. Moreover, before the treatment, most of the participants indicated that their tendency to maintain healthy lifestyle and appreciate functionality of their bodies over the aesthetic views and they commented that some of the questions were not clear or did not apply to them indicating that the inclusion criteria should be reviewed. The other limitations include absence of a control group and a small sample size. These limitations indicate the need for a more robust design in the future.

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An individual longitudinal follow-up exploratory study of neurophysiological reactions among adults during psychometric testing

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ABSTRACT

Our goal is to investigate the integration of self-report and neurophysiological data in a new measurement system. Multi-sensor and multimodal methods were used through individual longitudinal follow-ups at one-week intervals across three sessions. We tracked individuals' scores to analyze their evolution over time and establish meaningful correlations within each participant. Psychometric tests such as Hospital Anxiety and Depression Scale (HADS) and State-Trait Anxiety Inventory (STAI-S) were used to correlate self-report measures of anxiety and depression with neurophysiological measures. Control psychometric measures such as 10-Item Big Five Inventory (BFI-10), STAI-T, and Fear Questionnaire (FQ) were also included. We collected raw data from eye-tracking and heart rate variability (HRV) sensors from (n=10) participants resulting in a comprehensive dataset used for data analysis. The study found high interindividual variability and low intraindividual variability, indicating that while individual participants maintain consistent responses across sessions, there are significant differences between participants. This highlights the need for personalized approaches in psychological assessments.

Keywords: IoT, machine learning, multimodal, neurophysiological, multi-sensors, psychometrics

1. INTRODUCTION

Sensor technologies have vastly evolved in the past decade (Trigona et al., 2020) providing new tools to observe and measure human behavior (Ancis, 2020). Among these new technologies, are non-invasive sensors such as HRV that are commonly used in cyberpsychology research. With advancements in sensor technology and the emergence of cyberpsychology, we can now consider integrating sensors as a new tool for psychological assessment (Caponnetto & Milazzo 2019). Meta-analyses proved that HRV is a compelling biological marker sensitive to an individual's physiological and psychological states (Donnelly et al., 2023). However, in the literature, few studies in psychophysiology employ multimodal approaches (Baig & Kavakli, 2019; Patrick et al., 2019). On the other hand, in cyberpsychology, we argue that anxiety assessments are not yet objective considering an individual's physiological signals (Senaratne et al., 2021). Some researchers compared physiology with self-report measures but employed weak methodology. Few studies have used comprehensive sensors and analysis tools (Hickey et al., 2021) and results are criticized for not having a specialist in the research team (Alrefaei et. al., 2023). Few employed multimodal and multi-sensor metrics however the predictive features are said to be confounded (Pizzoli et al., 2021). Considering these limitations, we tried to determine whether our new multi-sensor and multimodal protocol can provide efficient assessments of anxiety and depression.

2. METHOD AND TOOLS

2.1. Population

Adults aged 18-30, fluent in French with basic English proficiency were recruited via poster ads and word of mouth. Basic English proficiency was required because the student researchers for this protocol were not French speakers. Strict exclusion criteria include physical, medical, psychiatric, or psychological disability and

psychotropic medication use, ensuring participant safety and data integrity. Ethically, all participants were provided with informed consent and fully briefed on the study's procedures, data usage, and their rights, including voluntary withdrawal in compliance with the General Data Protection Regulation (GDPR). Data privacy is ensured as personal information is pseudonymized and securely stored on the UFR Biomedical Information Technology Service's data servers, accessible only to authorized researchers and protected against unauthorized publication.

2.2. Data Collection

The data collection process was initiated with a brief semi-structured interview, where participants provided demographic details and signed informed consent forms. Subsequently, they are equipped with Pupil Labs Core to facilitate precise eye-tracking, along with Polar H10+ and Moofit HW401 sensors for monitoring HRV. The setup, configuration, and calibration of these devices are efficiently achieved within five minutes to ensure both comfort and accuracy. Participants then engaged in a baseline assessment by reading task, which preceded the psychometric evaluations conducted via HuMans software, originally developed by Thales. Thales engineers assisted us in configuring all the sensors in this new system, enhancing its accuracy and functionality for the purpose of our current research. These psychometric tests include the HADS, STAI, BFI-10, and FQ. The entire experiment procedure takes 30 minutes, concluding with participant feedback to discuss experiences and address any emotional distress with available mental health resources.

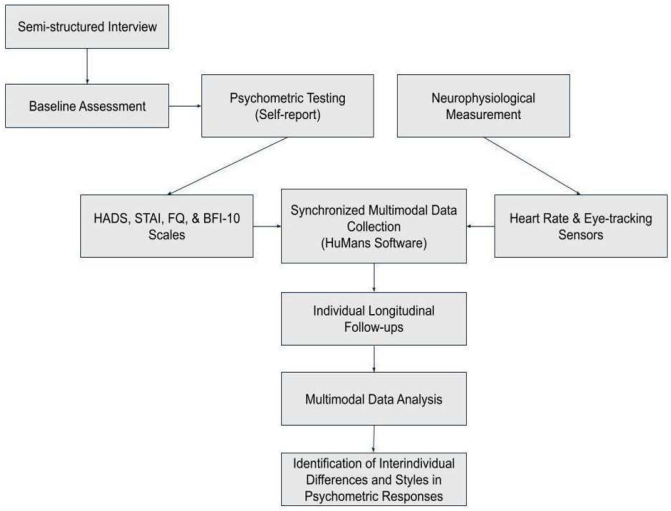

Figure 1 *Summary of the study's integrated psychometric and neurophysiological data collection methodology with longitudinal follow-ups.*

2.3 Data Analysis

Eye-tracking data from Pupil Labs Core underwent Time Series Analysis (TSA) to identify patterns in pupil dilation and blink rates, providing insights into participant behavior during psychometric testing. HRV was analyzed using Time Domain Analysis (TDA), focusing on Root mean square of successive RR interval differences (RMSSD) and Standard deviation of NN intervals (SDNN) metrics to assess the impact of anxiety on autonomic nervous system function. These analyses, complemented by HADS and STAI-S for measuring anxiety and depression (normal: 0-7, borderline: 8-10, abnormal: 11-21) and state anxiety (minimal to very high anxiety levels: 20-80), with BFI-10, FQ, and STAI-T as control measures, use multiple regression and ANOVA and longitudinal data across three sessions were used to detect and analyze individual anxiety patterns, supporting more informed decision-making.

3. RESULTS

In this study, we aimed to evaluate each of the 10 participants individually through a longitudinal follow-up. Two participants in the group exhibited the highest levels of anxiety and depression across all sessions, emphasizing moderate psychological distress. This trend was further reinforced as these two participants also scored the highest in anxiety (HADS-A), depression (HADS-D), introversion, conscientiousness (BFI-10), and phobia (FQ) revealing a persistent pattern of psychological distress across three sessions. All participants' response durations decreased over time, indicating a habituation effect as they became more familiarized with the testing process, reflecting increased efficiency and reduced cognitive and or emotional load with repeated exposure to the psychometric tests. Pupil dilation and heart rate variability (HRV) data emerged as crucial indicators of cognitive load and emotional response during psychometric testing. For instance, during the HADS test in session 1 for one

participant, the average pupil diameter increased by 25%, rising from 3.2 mm at baseline to 4.0 mm, alongside a decrease in HRV (RMSSD 22.71 ms, SDNN 17.77 ms), indicating elevated anxiety and cognitive load. Early in the study, heightened pupil dilation and increased heart rates were observed, indicating elevated cognitive load and anxiety as participants engaged with unfamiliar tasks. Moreover, neurophysiological markers began to stabilize when the participants became more familiar with the contents of the psychometric tests over time. HRV and pupil dilation data provide real-time physiological signals into the participants' levels of cognitive and or emotional loads that might not have been sensitively assessed through self-report measures alone.

4. DISCUSSION

Further work in this area should focus on optimizing the prototype hardware to increase data consistency and reliability, as well as integrating additional sensors such as skin conductance and facial movement. Expanding the sample size and including a more diverse participant pool would also strengthen the generalizability of the findings. Future studies could explore the long-term effectiveness of using multimodal sensor data in clinical settings, assessing how these technologies can be seamlessly integrated into routine psychological assessments. Lastly, developing more advanced machine learning algorithms to analyze comprehensive datasets could improve the predictive accuracy for anxiety and depression, leading to personalized approaches in mental health care.

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Multisensory Integration and Embodiment: A Virtual Reality-Based Study

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ABSTRACT

Multisensory Integration (MSI) is at the basis of our everyday experiences, including Bodily Self Consciousness (BSC). MSI refers to integrating information from different sensory modalities (e.g., visual and tactile) and spatial frames first (1PP) and third-person perspective (3PP). The link between MSI and BSC is well represented by Body Illusions, which use multisensory conflicts to make individuals perceive an artificial body as their own body. In this study, we investigated if and how MSI abilities influence embodiment strength with psychotic-like symptoms as a covariate. Participants were presented with an artificial body within an immersive virtual environment from both 1PP and 3PP while undergoing synchronous or asynchronous visuo-tactile stimulation.

1. INTRODUCTION

MSI involves the integration of sensory information from different modalities as well as the combination of information from different spatial frames - namely, 1PP (egocentric) and 3PP (allocentric) perspectives (Lenggenhager et al., 2007; Petkova & Ehrsson, 2008). Research on Body Illusions (BI) in Virtual Reality (VR; e.g., full body illusion; (Ehrsson, 2007) confirmed the key role of MSI in the formation and maintenance of Bodily Self-Consciousness (BSC), where BSC refers to body ownership, sense of agency, and self-location (Ehrsson, 2012). In particular, BI showed that congruent MSI was at the basis of embodiment, in which individuals incorporate artificial bodies into their self-representation. Accordingly, conditions characterized by MSI deficits – like schizophrenia (Michael, 2014) and eating disorders (Riva & Dakanalis, 2018; Riva & Gaudio, 2018) – usually present distorted body experiences (Brizzi et al, 2023). In this study, we specifically investigated how MSI abilities affect embodiment strength. This research sought to deepen our understanding of MSI's role in shaping human self-awareness and interaction with technologically mediated environments.

2. METHODOLOGY

2.1. Participants

20 healthy participants (15 female; age = 24.77, sd = 3.67) without a present or history of psychopathologies and/or neurological conditions participated in this study. All participants were volunteers and signed informed consent before the experiment. Table 1 shows participants' descriptive statistics.

2.2. Procedures

The experimental session started by asking participants to sign the consent form, provide sociodemographic information, complete the SIFI task to assess MSI abilities, and fill out the CAPE-P15 scale to assess the frequency of individuals experiencing psychotic-like symptoms. Then the VR full-body illusion was proposed for 90 seconds, followed by the embodiment questionnaire. The BI was presented four times, manipulating visual perspectives (1PP and 3PP) and stimulation congruency (synchronous and asynchronous; Figure 1).

Table 1: *Descriptive Statistics of Variables (Mean, SD) Between Groups (High Error Rate, Low Error Rate), N = 20.*

	Group:High (N=8)		Group:Low (N=12)		
	mean	**sd**	**mean**	**sd**	**p-value**
Cape_score	141.75	31.83	121.58	29.34	<0.01
Age	24.77	3.67	26.13	4.23	0.11
1PP Async Embodiment Score	3.06	1.04	1.86	1.11	**0.03**
1PP Sync Embodiment Score	3.46	0.88	2.18	1.16	**0.01**
3PP Async Embodiment Score	2.96	1.35	1.58	0.71	**0.03**
3PP Sync Embodiment Score	3.03	0.78	1.96	0.91	**0.01**

Note: T-test was used to evaluate sample characteristics, bolded p-values indicate statistically significant differences between groups. To determine whether there is a statistically significant difference, we used an independent sample t test to calculate the p value.

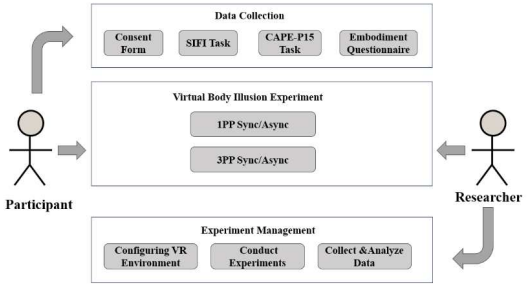

Figure 1 *User case diagram*

2.3. Sound-Induced Flash Illusion (SIFI) task

It is considered a reliable test for measuring MSI (Keil, 2020). Participants were asked to place their fingers on the numbers 1 & 2 to indicate their response in the trial. This task comprised two blocks, requiring respondents to report either how many beeps they heard or flashes they saw. There were 2 trials, initially, the individuals experienced a Fission Illusion in which they reported the flashes once they saw the flash on the screen and heard the beep simultaneously. Then Fusion Illusion started in which they reported the beeps once they heard them while seeing the flash on the screen simultaneously.

2.4. 15-item Community Assessment of Psychotic-like Experiences-Positive Scale (CAPE-P15)

CAPE-P15 scale assesses three dimensions from 15 items: Persecution Ideas (PI), Bizarre Experiences (BE), and Perceptual Abnormalities (PA) (Zhang et al., 2022).

2.5. VR Full Body Illusion

Before the VR experience, the position of the avatar was adjusted to conform to the participant's 1PP or 3PP. During the experiment, the Oculus Quest2 controller was used to synchronously or asynchronously manipulate the suspended ball in VR to stimulate the abdomen of its avatar, while the controller applied corresponding stimulation to the participant's real abdomen. The illusion was proposed four times by manipulating visual perspectives (1PP vs. 3PP) and stimulation congruency (synchronous vs. asynchronous visuo tactile stimulation). After each session, they were required to fill out an embodiment questionnaire to embodiment strength. The order of presentation was randomized (Figure 2).

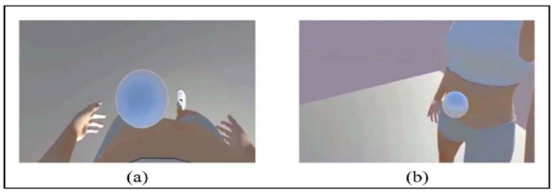

Figure 2 *The figure illustrates what users see in the (a) 1PP and (b)3PP.*

3. RESULTS

This study explored the relationship between MSI abilities and embodiment strength over a virtual body in VR. Participants were firstly grouped according to their accuracy level in the SIFI task based on sample mean score: we obtained a high group (N=8) and low group (N=12).

$$\text{SIFI Error Rate} = \frac{N_E}{T}$$

where N_E represents the number of incorrect SIFI task responses, and T denotes the total response.

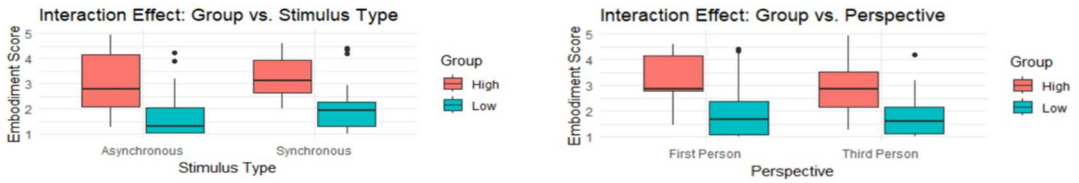

Figure 3 *Embodiment level between Groups (High vs. Low error rate) under Stimulus Type and Perspective*

Through mixed-effects ANOVA model and post-hoc analysis, we observed there is a significant relationship between group differences at the embodied level. The high error rate group had significantly higher levels of embodiment than the low error rate group in both the synchronous (t (76) = 3.666, p = 0.003, d = 4.021) and the asynchronous condition (t (76) = 4.022, p = < 0.001, d = 4.021). In addition, we analyzed the cases of first-person perspective (t (76) = 3.847, p = 0.001, d = 3.853) and third-person perspective (t (76) = 3.847, p = 0.002, d = 3.813) separately and reached the same conclusion. That is, participants with a higher tendency to integrate multisensory information showed a higher level of embodiment overall, irrespectively of the type of stimulation. No significant effects of the interaction of different factors on the level of embodiment were found. Additionally, using a mixed-effects ANOVA model followed by post-hoc analysis, we found that within the high-error group, participants with higher CAPE scores performed better than those with lower scores.

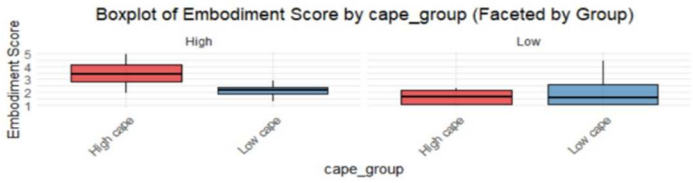

Figure 4 *Embodiment level between CAPE score groups under Groups (High vs. Low error rate)*

4. DISCUSSION & CONCLUSION

This pilot study substantiated the role of MSI on bodily experience, as suggested by previous research (Brizzi et al., 2023). Notably, conditions marked by distorted bodily experiences, such as eating disorders and schizophrenia (Michael, 2014), often show compromised MSI capacities, thus potentially leading to a disrupted body experiencesymptoms. In line with the predictive coding framework, which posits that the brain utilizes hyperpriors like spatiotemporal synchrony to integrate crossmodal information to shape perceptual experience, alterations in these hyperpriors may prompt individuals to integrate information unnecessarily, resulting in distorted bodily experience. Then, these findings offer insights into potential mechanisms involved in body disturbances. This aligns with the idea of embodied medicine (Brizzi et al., 2023), suggesting the use of multisensory technologies to alter disrupted body experience.

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Gamification of a VR Task to Modify Attentional Bias Towards Body Parts Related to Weight

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ABSTRACT

This investigation explored the impact of a gamified virtual reality (VR) task on attentional biases by leveraging "BodyGaze Game: The Bathing Ritual" to alter attentional biases towards body parts related to weight. We enlisted forty healthy adults and assessed their user experience via the GAMEX and SUS scales. A randomized controlled trial, aimed at contrasting gamified with non-gamified approaches, was developed for this purpose. No significant differences in usability were found between the groups (SUS, $p = 0.38$), but the gamified group showed high satisfaction (GAMEX mean = 76.45) with notable enjoyment (mean = 19) and absorption (mean = 22.75). These findings suggest that gamification enhances specific user experiences like enjoyment and immersion, though overall usability was similar across both groups.

1. INTRODUCTION

The incorporation of Virtual Reality (VR) into mental health treatments has significantly advanced, shifting from an innovative concept to a powerful therapeutic instrument for psychiatric disorders. VR's application in treating eating disorders exemplifies its evolution and therapeutic capacity, offering simulated environments that confront and alter maladaptive eating behaviors and body image issues (Maples-Keller et al., 2017). However, the broad clinical implementation of VR encounters challenges, prompting the investigation into gamification as a means to enhance engagement and motivation in therapy (Lindner et al., 2017). Gamification, the process of integrating gaming elements into non-game settings, has been proven to increase motivation and adherence in various sectors, including psychotherapy (McKeown, 2016; Sailer, 2013; Subagja, 2021). This project seeks to apply gamification to VR-based treatment for eating disorders attentional bias, as modifying such biases presents a promising therapeutic approach (Ascione et al., 2023; Renwick, 2013; Shafran, 2008). Evidence indicates that incorporating game features like animations and feedback significantly enhances user involvement (Zhang, 2018), suggesting that a customized gamification strategy could improve psychotherapeutic interventions. The central research question is: Does the inclusion of gamification elements in VR treatments for eating disorders, specifically for modifying attentional bias, increase user satisfaction compared to non-gamified interventions?

2. METHODOLOGY

2.1. Participants

Our study enlisted 40 healthy adults, 20 assigned to the experimental group and 20 assigned to the control group excluding those with self-reported psychotic or manic mental disorders, eating disorders (Anorexia nervosa, bulimia nervosa, binge eating disorder), pregnancy, epilepsy, or visual impairments affecting VR use or eye-tracking accuracy. The average age of participants was 24.85 years (SD= 6.85). Among the participants, 77,5% were female and 22,5% were male.

2.2. Measures and instruments

User experience in the study was assessed using the Gameful Experience Scale (GAMEX) and the System Usability Scale (SUS). The experimental intervention was delivered through a gamified VR tool for attentional bias modification, developed by our group, named "BodyGaze Game: The Bathing Ritual," featuring four levels. The control group underwent a non-gamified VR intervention aimed at modifying attentional bias (Ascione et al., 2023).

2.3. Procedure

The experiment, conducted in a single session, began with participants signing informed consent forms and completing a brief interview to confirm their eligibility. They were then randomly assigned to either the control or the experimental group. The control group engaged in a non-gamified VR experience designed to modify attentional bias, whereas the experimental group received a gamified intervention with the same goal. Before donning the VR headset, participants received instructions and underwent calibration of the eye-tracking sensors. Once immersed in the VR environment, they proceeded through the assigned experience. Following this experience, feedback was gathered, and participants filled out the System Usability Scale (SUS) and Gameful Experience Scale (GAMEX) questionnaires, The GAMEX scale was only completed by the group that underwent the gamified experience.

2.4. Data Analysis

We compared user experience scores between the experimental group, which underwent a gamified intervention, and the control group, which underwent a non-gamified intervention. Due to the comparative nature of the study, involving two distinct groups, an independent samples t-test was considered the most appropriate method for data analysis. The analysis examined the differences between the two groups in the SUS questionnaire. To analyze the data collected from the GAMEX scale we did a descriptive analysis with the total score and the punctuation in the different subscales, to make an easier report we converted the scores into percentages.

3. RESULTS

The results of the independent samples t-test comparing the groups' responses to the SUS yielded a p-value of 0.38. Therefore, no statistically significant differences were found between the control and experimental groups regarding their SUS scores. For the GAMEX, which was only completed by the gamified group, the total mean score was 76.45 which corresponds to 61.16% (SD=9,56). The subscale analysis revealed a mean score of 19 equivalent to 63.33% (SD=4,3) for enjoyment and a mean score of 22.75 equivalent to 75.83% for absorption (SD=4,53).

4. DISCUSSION

Despite the innovative approach of integrating gamification elements into VR treatments, our findings did not reveal statistically significant differences in user experience as measured by the System Usability Scale (SUS) between the gamified and non-gamified. This suggests that both interventions were similarly perceived in terms of overall usability. However, the Gameful Experience Scale (GAMEX) results showed high satisfaction in the gamified group, with notable enjoyment and absorption. These findings indicate that gamification enhances specific user experiences like enjoyment and immersion. The lack of SUS differences may suggest that usability is more influenced by VR technology and design quality than by gamification. Future studies with larger samples and qualitative methods are recommended to confirm these results and explore their implications.

In conclusion, while gamification did not significantly improve overall usability, it enhanced specific experiences, supporting its potential to boost engagement and motivation in VR-based therapies.

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Exposure therapy in Virtual Reality for children and adolescents with selective mutism: A usability pilot study

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ABSTRACT

In this study, exposure therapy in Virtual Reality (VR) intervention was first designed to improve the social skills of children and adolescents with Selective Mutism (SM). Afterwards, we tested the intervention's usability, asking patients to engage with the exposure therapy in the VR system to assess its functionality and provide a feedback program. Three patients participated and were assessed with different questionnaires on anxiety and usability. Preliminary results show high acceptance of the interaction with the program and variability in communication.

1. INTRODUCTION

Selective Mutism (SM) is an anxiety disorder characterized by a person's inability to speak in certain social situations despite being able to speak comfortably in others (APA, 2013), and affects 0.7% to 2% of individuals, often appearing in early childhood (Pereira et al., 2021). Traditional treatments, such as cognitive-behavioural therapy (CBT), have shown efficacy (Hipolito et al., 2023), but have limitations in uncontrolled environments. Exposure therapy in VR has become a relevant alternative indicating a positive impact on the treatment of anxiety disorders (Reeves et al., 2021). Nevertheless, its application in selective mutism remains unexplored (Tan et al., 2021). This pilot study represents the initial phase of an ongoing larger study dedicated to measuring the effectiveness of exposure therapy in the VR intervention to improve social skills in children and adolescents with SM. We follow the recommendations in the literature to conduct usability trials during the development or testing phase of exposure therapy in VR systems to evaluate the usability and user experience of the system. In addition, we analyse the impact of this intervention on clinical outcomes (e.g., verbalization in social situations, anxiety) and explore therapists' acceptance of exposure therapy in VR.

2. METHODOLOGY

2.1. Participants

This pilot study comprised three participants, aged between 12 and 15 years, living in Portugal, diagnosed with Selective Mutism as a primary disorder, and undergoing treatment for this disorder. Exclusion criteria included children and adolescents receiving treatment based on another primary diagnosis, those with neurological or intellectual impairments, severe psychomotor sensory impairments, or motion sickness that VR might exacerbate. The recruitment and administration of the VR program were done in a developmental clinical centre (Partners in Neuroscience)' with the assistance of their therapists.

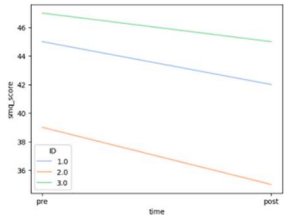
2.2. Measures

The psychological measures included the Goal questionnaire for individual and therapeutic goals, and the Subjective Units of Distress Scale (SUDS) (Tanner, 2011) to evaluate the distress intensity, also a systematic observation was conducted to document participant behaviour during the program interaction.

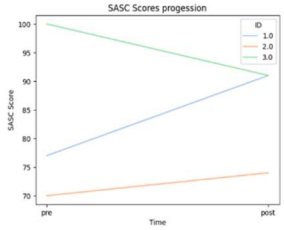
2.3. Procedure

This study consisted of four VR sessions designed to simulate real-life social situations in a virtual school. The experiment focused on developing social and verbal skills through six different activities divided into different sessions to increase the intervention level gradually. Before the first application, scales were administered, and participants had their initial encounter adapting to the technology and virtual environment. In the second session, the participant will perform the "finding Wally" activity. In the third session, participants will have to develop a task incorporating interaction with other classmates and the professor, answering questions regarding the previous activity. During the final session, the participant would be challenged to speak in front of the virtual classmates.

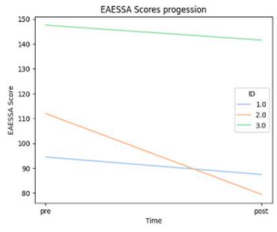
3. RESULTS



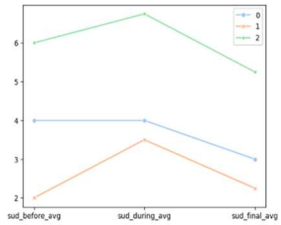
Graphic 1. SMQ descriptive scores pre- and post-exposure through VR.



Graphic 2. SASC-R descriptive scores pre- and post-exposure through VR.



Graphic 3. SAASA descriptive scores pre- and post-exposure through VR.



Graphic 4. SUDs descriptive scores exposure through VR.

Combining the SMQ and SASC scales, we found that the subjects' scale scores showed an overall downward trend, the experiment had a certain positive effect. The feedback shows that the VR program, maintains stability in goals-achieving, with a slight change in the index (Δ=1) in the same participant in different sessions, indicating a moderate benefit for the patient. Generally, the index of goals-achieving from the therapists (M=6.3/10) was higher than those from the participants (M=4.8/10) in each session, but the stability (Δ=2) was similar.

Despite being longer and more challenging than the first session, participants spent less time in the second session, suggesting the program's feasibility in maintaining interest and participation despite the increased difficulty. The participant's emotional performance was generally at the middle level (M=4.6/10), among which the average of session 1 (M=4.3/10) was lower than the average of session 2 (M=5/10).

4. DISCUSSION

This pilot study provides preliminary evidence that VR exposure therapy can increase interest and concentration among patients with selective mutism (SM). Despite the results, one participant's continuity had been impacted due to increased anxiety caused by the avatar design. In addition, some unexpected outputs showed, probably due to coexisting disorders such as autism, which also influenced their sense of presence in the virtual environment. Furthermore, this study is intended to be an iterative process, the software will be iteratively improved in terms of user interface, instruction, and experience optimization based on participant feedback.

For future studies, it is important to have a larger sample size and further evaluate the positive effects of this therapeutic approach. These efforts will help establish stronger evidence for the application of VR exposure therapy in treating SM.

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Predicting Dropout at an Innovative Tech-focused Vocational Education Program using Machine Learning

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ABSTRACT

This study presents a Machine Learning (ML) model to predict student dropout at a free after-school e-learning program. The best performing prediction model was found to be random forest, which achieved a prediction accuracy of 90.2%, precision of 90.3%, recall of 90.3% and F1-score of 90.2%. using predictors that fall under 3 categories: reported pathologies, sociodemographics, pedagogic engagement. The most significant factors used in predicting dropout at TUMO were found to be the pedagogic engagement factors, as the top ten predictors were all part of this category. To a lesser extent, sociodemographic factors influence dropout and reported pathologies were found to not be significant predictors of dropout by themselves but more so when a student is affected by more than one physical or mental health issue. The pathology category with the most significant effect on dropout behavior was learning disorders.

1. INTRODUCTION

Educational Technology (EdTech) merges digital tools with teaching principles to create effective e-learning environments. This study partners with TUMO Paris - Forum des Images, an innovative free after-school vocational e-learning program operating since 2018 for French students aged 11-18. Founded first in Yerevan, Armenia by American tech entrepreneur Sam Simonian and his wife Silva, TUMO offers training in eight tech-focused specialties. The program encourages self-learning, facilitated by peer coaches, and includes biweekly self-learning sessions, workshops and master labs with experts to enhance their skills.

1.1. Problem & Research Questions

A 2022-2023 study at TUMO Paris used interviews and questionnaires to assess student satisfaction and the program's impact. It found reasons for program enjoyment but not for dropouts. Despite over 4300 enrollments since 2018, only about 9% reached alumni status, indicating a need to be able to predict dropout and understand the factors that lead to this undesirable outcome.

Machine Learning (ML) models have emerged as useful tools in making predictions by generalizing rules or trends detected from past data examples. Algorithms such as Support Vector Machine (SVM) (Park & Yoo, 2021), Decision Trees (Park & Yoo, 2021; Tamada et al., 2022) and Random Forest (Andrade-Girón et al., 2023; Park & Yoo, 2021; Tamada et al., 2022) have demonstrated good predictive capabilities for dropout in various levels of education in the context of traditional education and e-learning.

Very few studies have examined dropout factors among adolescents in tech-focused education, specifically in French adolescent populations. Furthermore, no research has explored dropout trends in pedagogical models

like TUMO's, which combines peer coaching, self-learning, workshops, and masterlabs. Our research questions are:

- **RQ1** With the student data captured in the TUMO e-learning platform database, is it possible to predict a student's outcome (persist/dropout)?
- **RQ2** What are the key factors that can be used to predict a student's risk of dropping out of the TUMO program?

1.2. Hypotheses

- **H1G** The predictive model developed in this study can fairly accurately identify students at risk of dropping out.
- **H1O** The predictive model developed can fairly accurately identify students at risk of dropping out, taking into account the accuracy, precision, recall and F1-score prediction model metrics.
- **H2G** Reported pathologies significantly influence a student's likelihood of dropping out of TUMO.
- **H2O** In evaluating the fitted prediction model, factor(s) under the category of reported pathology will have high score and ranking, indicating that they significantly influence a student's likelihood of dropping out
- **H3G** Pedagogic engagement factors significantly influence students' likelihood of dropping out of TUMO.
- **H3O** In evaluating the fitted prediction model, factor(s) under the category of pedagogic engagement will have high score and ranking, indicating that they significantly influence a student's likelihood of dropping out
- **H4G** Sociodemographic factors significantly influence a student's likelihood of dropping out.
- **H4O** In evaluating the fitted prediction model, factor(s) under the category of sociodemographics will have high score and ranking, indicating that they significantly influence a student's likelihood of dropping out

2. METHODOLOGY

2.1. Population

The study used student sociodemographic, pedagogic engagement and reported pathology data exported from the e-learning platform database that contains student data and a longitudinal follow up of their progress in their course. The inclusion criteria was that records were to be complete with no missing values (N = 2151). To ensure the anonymity of each student record and comply with GDPR standards and ethical principles in research, the data records exported for the study were anonymized by not including the name and surname, physical address, or email address of any student record. Each record was only to be identified by a ten-digit number to facilitate the process of joining data exported from different sources into a comprehensive profile of each student. Once this was done, the identifier was discarded. The research protocol was submitted to the Data Protection Officer (DPO) of Université Paris Cité for approval.

2.2. Data Collection

Data used to predict dropout was categorized into reported pathologies, sociodemographic, or pedagogic engagement factors. Reported pathologies encompass physical disabilities, mental health diagnoses, and learning disorders reported to TUMO by students. In total, 144 students within the population sample reported some pathology while the rest of the population had no reported pathology. .Sociodemographic factors include age, gender, and income, while pedagogic engagement covers attendance, absences, and activity achievements.

2.3. Data Analysis & Model Evaluation

To evaluate the performance of the prediction models, accuracy, precision, recall, and F1-score were used. This combination of metrics accounts for class imbalances that may exist in the training data (the number of students who persist vs who dropout). The best performing model was then selected and fine tuned and the significant factors that the model uses for prediction were scored and ranked to interpret the factors that lead to increased dropout risk.

3. RESULTS & DISCUSSION

Preliminary results show promise, with the best performing prediction model of random forest having a prediction accuracy of 90.2%, precision of 90.3%, recall of 90.3% and F1-score of 90.2%. This indicates a good ability to predict the binary outcome variable (dropout yes/no). The most significant factors used in predicting dropout at TUMO were found to be the pedagogic engagement factors, as the top ten predictors were all part of this category. To a lesser extent, sociodemographic factors influence dropout and reported pathologies were found to not be significant predictors of dropout by themselves but more so when a student is affected by more than one physical or mental health issue. The pathology category with the more significant effect on dropout behavior was found to be learning disorders. Further analysis will be made to get a better idea of how the 3 categories of predictors influence student dropout.

4. CONCLUSIONS

In conclusion, this study aimed to create a predictive model for a tech-focused vocational program to identify key factors influencing student dropout or persistence. This model can help coaches and managers identify students needing more support through an Early Warning System (EWS), ensuring they complete their study track. Future research could include more variables like psychometric, personality, and behavioral measures to better predict dropout at TUMO.

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Exploring Verbal Speech Patterns to assess Attachment Style and tendencies towards Anxiety and Depression

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ABSTRACT

This study explores the potential of using a Large Language Model (LLM) to analyze verbal speech patterns to assess attachment styles and tendencies toward anxiety and depression. A diverse sample of 50 adults participated in the study. Participants were presented with images based on the Adult Attachment Projective Picture System (AAP) and asked to describe the scenes, with their responses transcribed and analyzed by the LLM. The LLM's identification of attachment styles showed a 58% true positive rate compared to the Relationship Questionnaire (RQ). The LLM overestimated anxiety and underestimated depression compared to the Hospital Anxiety and Depression Scale (HADS). These findings suggest that while LLMs show promise in attachment assessment, further refinement in context and prompt engineering is needed to improve accuracy, particularly concerning anxiety and depression evaluations. The study underscores the potential for automated tools in psychological assessment, paving the way for future research in this domain.

1. INTRODUCTION

As defined by Bowlby (1969), attachment is the emotional bond formed between an individual and their primary caregiver, which influences future social relationships. The original model views attachment as a stable trait and states that a person can have either secure attachment or one of three insecure attachments: anxious, avoidant, or disorganized.

Insecure attachment has been consistently linked to mental health issues, in a meta-analysis of 224 studies on the connections between attachment and mental health, Zhang et al. (2022) found that insecure attachment was significantly correlated with both depression and anxiety.

It has been shown that attachment patterns can be assessed with high validity and reliability by examining the semantic structure of verbal speech during psychotherapeutic sessions (Talia et al. 2015). One proven technique for provoking attachment-related verbal speech is The Adult Attachment Projective Picture System (AAP) (George & West, 2012). The AAP assesses adult attachment based on the analysis of narrative responses to a set of eight pictures. The pictures used in AAP are designed to evoke attachment-related responses and have been shown to be effective in stimulating the activity of the brain areas associated with emotional regulation (Buchheim et al. 2006).

The purpose of this study is to analyze the verbal speech of participants in response to attachment-related picture stimuli with the help of Large Language Model (LLM). The picture stimuli for the study were developed based on the original pictures from the AAP. By examining linguistic patterns with machine learning algorithms study investigates the association between participants' speech, their attachment styles and tendencies toward anxiety and depression.

2. METHODOLOGY

2.1. Participants

The study recruited a diverse sample of 50 adult individuals (M 22, F28), representing different age groups, ethnicities, and educational backgrounds.

Inclusion criteria required participants to be between the ages of 18 and 60 and native speakers of either English or Spanish. The sample included 12 Spanish speakers and 38 English speakers, as the analysis was conducted solely in these two languages. Conducting the study in participants' native language was essential for capturing the nuances of their verbal speech, ensuring more accurate interpretation and reliable linguistic analysis. Participants with diagnosed speech or language disorders, a history of psychiatric disorders, or recent use of psychoactive drugs within the two weeks prior to the study were excluded to maintain consistency and integrity in verbal speech analysis.

2.2. Procedure

Participants provided informed consent before participating in the study, which included consenting to the collection and storage of personal data, as well as audio recording. Initially, participants completed a demographic questionnaire to assess inclusion and exclusion criteria for the study. Following this, participants were screened with the Relationship Questionnaire (RQ) (Bartholomew et al. 1991) to assess their predominant attachment style and with the Hospital Anxiety and Depression Scale (HADS) (Zigmond et al. 1983) to evaluate their tendencies towards anxiety and depression.

Next, participants were presented with a series of pictures designed based on The Adult Attachment Projective Picture System (AAP) to elicit attachment-related thoughts and emotions. They were asked four questions about each picture, with each question allocated between 20 seconds to 1 minute for a response. The questions were: "What's happening in the picture?", "What led up to that scene?", "What are the characters thinking or feeling?", and "What might happen next?".

The verbal descriptions provided by participants for each picture were recorded and later transcribed into text. The transcribed speech samples were then analyzed with a pre-trained Large Language Model to determine each participant's attachment style and assess their level of anxiety and depression.

Subsequently, statistical analyses were conducted to examine the relationship between the linguistic patterns identified in participants' speech by the LLM, their attachment styles, and their levels of anxiety and depression. These analyses involved comparing the results obtained from the LLM with the baseline levels identified by the Relationship Questionnaire (RQ) for attachment styles and the Hospital Anxiety and Depression Scale (HADS) for anxiety and depression levels.

3. RESULTS

The Large Language Model demonstrated an overall true positive rate of 58% in identifying secure and insecure attachment styles compared to the Relationship Questionnaire (RQ). When analyzing responses by image and question, the LLM showed varying levels of accuracy. The best-performing image achieved 60% accuracy, while the least accurate images attained 50%. Among the questions, the highest accuracy (62%) was observed for responses about past events ("What led up to that scene?"), whereas the lowest accuracy (54%) was noted for responses to questions about future events ("What might happen next?").

In terms of depression and anxiety, the LLM overestimated anxiety level (M: 0.44, SD: 0.08) and underestimated depression level (M: 0.27, SD: 0.06) when compared with results from HADS (anxiety: M: 0.35, SD: 0.19; depression: M: 0.34, SD: 0.12). The results were not relevantly affected by gender.

4. DISCUSSION

The study's findings suggest that while LLMs hold promise in assessing attachment styles, anxiety and depression, further refinement is necessary to improve accuracy. The LLM's ability to identify attachment styles demonstrated a moderate true positive rate, indicating potential utility in psychological assessment. However, performance varied across different images and questions, highlighting the need for further adjustment in prompt engineering and context integration to enhance the model's accuracy.

The discrepancy in estimating anxiety and depression levels compared to the HADS raises questions about the LLM's sensitivity and specificity in detecting subtle emotional nuances. Future research should focus on

refining LLM algorithms to better capture nuanced emotional states and enhance their reliability and validity in psychological assessment contexts through additional training data and fine-tuning of model parameters. Additionally, exploring ways to integrate LLMs with traditional assessment measures could potentially improve the overall accuracy of mental health evaluations.

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Avatar-Enabled Virtual Therapist Application for Cognitive Rehabilitation Intervention in Traumatic Brain Injury and Post-Stroke Patients

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ABSTRACT

The quality of life of post-stroke and traumatic brain injury (TBI) patients usually drops after the end of rehabilitation due to their discharge from the hospital. This study explores the impact of adding the avatar of a "virtual therapist" to a 3D application used in hospitals for cognitive rehabilitation, allowing patients to continue using this application without the presence of a real therapist after rehabilitation discharge. A sample of 5 patients from Alcoitão Rehabilitation Medicine Centre were asked to continue their cognitive rehabilitation with the new avatar-enabled application for minimum 6 sessions. Comparing pre and post intervention, significant improvements in MoCA and WMS cognitive measurements were found suggesting effectiveness of using an avatar as the virtual therapist for cognitive rehabilitation in later stages of TBI and post stroke rehabilitation.

1. INTRODUCTION

Stroke and traumatic brain injury represent two major causes of death and disability, often leaving lasting cognitive deficits (Wafa et al., 2020). The survivors may experience a range of cognitive impairments. Dysfunction in memory, orientation, language, attention, and executive skills are the most frequently observed (Tatemichi et al., 1994). Patients with cognitive impairment often need to go through cognitive rehabilitation in a clinical facility, however, when they are sent home, the rehabilitation process abruptly stops. In addition, the improvements in executive functions require a more intense treatment approach (Oliveira et al., 2022). Longitudinal studies found that the quality-of-life scores reported upon rehabilitation discharge usually do not last (Schindel et al, 2021). The capacity to use Virtual Reality (VR) to carry out rehabilitation outside of the hospital environment and into patients' homes (Chen et al., 2019) creates opportunities for further assistance, removing constraints related to distance and encouraging long-term rehabilitation.

This study proposes an addition of a "virtual therapist" to an existing 3D serious game digital application named Systemic Lisbon Battery (SLB), to overcome this challenge. SLB is a validated application used for cognitive rehabilitation on several hospitals. Various studies have found evidence that SLB is a useful tool for improving cognitive functioning on different populations (Gamito et al., 2020; Oliveira et al., 2022). The added "virtual therapist" will help the patient perform simple daily routine tasks in VR. This way, the patients can continue their rehabilitation process for a longer time after being discharged from the hospital. The objective of this study is to find out if the use of this "virtual therapist" leads to cognitive improvements in post-stoke and traumatic brain injury patients.

2. METHOD

2.1. Participants

10 patients (5 post-stroke and 5 traumatic brain injury) including 8 males and 2 females, aged from 29 to 70, from Alcoitão Medicine and Rehabilitation Centre (Lisbon, Portugal), suffering from cognitive impairment. 5 patients were assigned to the control group and 5 to the experimental group.

2.2. Measures

Montreal Cognitive Assessment (MoCA); Frontal Assessment Battery (FAB); Wechsler Memory Scale (WMS); Motivation for Rehabilitation Scale (MORE); World Health Organization Quality of Life (WHOQOL-BREF). All the measures were validated for the Portuguese population. Each patient was evaluated in two different moments – before and after the intervention.

2.3. Procedure

Each participant had 6 to 10 training sessions over different periods ranging from 1 to 4 months. Patients were assigned to two groups: a control group, which used the SLB application with the assistance from a "real" therapist; and an experimental group, which used the avatar-enabled version of SLB as “virtual therapist” developed for this study (Figure 1). The sessions from both groups were conducted in the hospital setting and the therapist remained present during these sessions to ensure that everything went smoothly and only intervened if necessary. To get the patients more familiar with using the application, they had their first SLB session with the help of a real therapist before moving forward to the avatar version. The application included different levels of difficulty, and for analysis purposes, it actively collects data on the patient’s progress and offers various instructions and tasks to the participants. This feature facilitates monitoring the patients remotely by a real therapist for modifying and optimizing the process. MoCA, FAB, and WMS, were applied pre- and post-intervention on both groups. The other two scales of MORE and WHOQOL-BREF were only applied on experimental group. Repeated Measures ANOVAs was performed to measure the differences between two moments in time.

Figure 1 *Avatar-enabled SLB Application*

3. RESULTS

Regarding experimental group, statistically significant improvements were found in MoCA and WMS tests. MoCA showed an improvement ($F(1,4) = 22.86$; $p = 0.009$) in the mean results of the participants from the first assessment ($M = 22.8$; $SD = 2.68$) to the second assessment ($M = 26.8$; $SD = 1.30$). WMS also showed positive results ($F(1,4) = 19.66$; $p = 0.011$) on the memory quotient from the first assessment ($M = 86.4$; $SD = 9.74$) to the second assessment ($M = 106.2$; $SD = 5.97$). FAB showed a improvement on the mean scores from the first assessment ($M = 16.2$; $SD = 0.84$) to the second assessment ($M = 17.6$; $SD = 0.55$), although it was not statistically significant ($F(1,4) = 7.54$; $p = 0.052$). Neither the MORE (first assessment: M = 113.6; SD = 7.27; second assessment: M = 110.6; SD = 11.50) nor the WHOQOL-BREF (first assessment: M = 79.4; SD = 8.65; second assessment: M = 80.1; SD = 9.81) scales showed statistically significant changes between the assessments ($p > 0.05$). However, the mean scores of the participants were high on both scales compared to normative data. Regarding control group, although MoCA, FAB, and WMS did not show any statistically significant results ($p > 0.05$), the data showed slight positive trends across all scales.

4. CONCLUSIONS

There are recent studies showing the positive impact of an avatar in cognitive rehabilitation for older people (Lee et al., 2024), and in the improvement in Quality of Life of individuals with a diagnosis of schizophrenia (Şahinbaş, Tekin & Gökbay, 2024), However, there is a lack of information regarding acquired brain injuries (ABI) patients, which motivated this study. The improvement in MoCA scores from the baseline to the post intervention assessment is substantial and suggests that the avatar-enabled SLB intervention has a meaningful impact on cognitive function. Similarly, the WMS scores showed a notable increase between assessment points, indicating improved memory performance. Although the Frontal Assessment Battery (FAB) did not reach statistical significance, the trend toward improvement is noteworthy, suggesting that with a larger sample size, the intervention might demonstrate significant effects on frontal lobe functions. Although MORE and WHOQOL-BREF measurements did not show statistically significant changes, the high mean scores on both scales suggest

that participants were highly motivated and had a positive outlook both before and after the intervention. The sustained motivation and optimism are critical factors that can enhance the overall effectiveness of cognitive rehabilitation (Yoshida et al., 2022).

While the cognitive scores of the control group were not statistically significant, the slight positive trend across all scales anticipates a potential benefit of SLB sessions. These trends, observed in MoCA, FAB, and WMS scores, could be of practical significance and warrant further investigation with a larger sample size (Oliveira et al., 2022). Moreover, qualitative feedback from participants indicated perceived improvements in cognitive function, suggesting that the intervention may have subjective benefits not fully captured by the quantitative measures used.

The current study was limited by a small sample size and the preliminary nature of data collection for the control group since the gap between each session was longer than the experimental group, and the cognitive tests were not immediately applied after the last session due to logistics difficulties and availability of the patients. Future research with a larger cohort, longer follow-up period, and more frequent sessions and particularly with less gap time between the sessions is needed to determine the potential cognitive benefits of SLB sessions more conclusively. Overall, the results suggest that the "virtual therapist" and its associated avatar could potentially be at least as impactful as a real therapist, if not more, in the later stages of the rehabilitation process, providing a beneficial tool for continuing therapy after hospital discharge.

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Cybersecurity Assessment and Training Simulator In Virtual Reality for Workplace Employees

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ABSTRACT

In response to the escalating cybersecurity challenges worldwide, this study introduced a virtual reality simulator to assess and train individuals (N=18) in an organization's work setting for mitigating the risk of cyberattacks. This realistic simulator experience incorporates personalized feedback within real-world scenarios. Results show that the VR task increased online privacy awarness regarding information sharing. Further, performance in the VR task can predict the risk propensity of individuals. This work can be used to educate businesses and governments to follow more robust cybersecurity practices in organizations.

Keywords: Cybersecurity; Phishing; Vishing; Virtual Reality; Simulator Training; Simulator Assessment

1. INTRODUCTION

Human vulnerability presents a significant challenge in business communities when it comes to cyber-attacks, as insider risks can easily be exploited by hackers (Alsharif et al., 2021). Within organizational settings employees can commit unintentional mistakes which can serve as entry points for data breaches, which are then leveraged by attackers to compromise corporate data integrity (Tahmasebi, 2024). Preventative measures are the best cybersecurity defence. Therefore, training is vital in cybersecurity.

In the current study, we developed an assessment and training simulator in virtual reality to train technical and administrative workers in an organization for recognising phishing emails and vishing phone calls using feedback. Phishing is a form of social engineering cybercrime tactic which involves the use of deceptive websites, text messages, or emails to unlawfully obtain personal or corporate data (Jain & Gupta, 2018). Vishing involves fake phone numbers, SMS messaging, voice-altering software, and SE to deceive the user on the other end into giving critical information that can be utilized for identity theft, account takeover or financial gain. (Jones et al., 2021). Previous literature has established that simulator training is effective in increasing cybersecurity awareness (Scherb et al., 2023). Virtual reality simulation method offers a distinct advantage by closely mimicking real-life behaviors and scenarios (Xie et al., 2021).

2. METHODS

Ethical approval for the study was obtained from the Lusófona University, and the research was conducted at HEI-Lab, Lusófona University. Sampling occured between March 2024 and April 2024, with participants recruited from the same organization. Inclusion criteria included administrative workers of same organization. Exclusion criteria includes participants with any condition that makes it inadvisable to perform a task in VR. Data collection was conducted in two stages, with a 2-week interval between Wave 1 and Wave 2. During the first stage, participants provided informed consent and then completed a 15-minute assessment questionnaire on

Qualtrics. Measures included Impulsive Behavior Scale 8, General risk propensity scale, Cognitive Reflection Test (CRT-2), Trust in Cybersecurity and Technical Controls (TTC), Online privacy concerns scale (2018) and Digital Literacy Scale as well as sociodemographic information of the participants. Participants then engaged in a 10-minute VR training task using aVR Quest 2 headset, which simulated various workplace scenarios, such as, responding to emails, answering phone calls, and using a printer. Participants encountered simulated threats, including phishing emails and vishing phone calls, and received feedback on their actions. Feedback was provided on the number of incorrect responses (NIR) given by participants.

In the second stage two weeks later, participants completed a 10-minute follow-up questionnaire on Qualtrics which included GRP, OPC, DLS and ATC-IB (Attitudes Towards Cybersecurity and cybercrime In Business). Finally, they received a debriefing outlining the study's objectives.

3. RESULTS

Results revealed that the task increased online privacy awareness in participants regarding information sharing (Z= -2.04, p= 0-041, ((M= 6.50, S.D= 0.75 (Wave 1), M= 6.84, S.D= 0.45). Further, a linear regression was carried out which shows that the number of incorrect responses (NIR) in VR simulation task (ranging from 0 to 5) translated in risk propensity with NIR as potential predictor (B = -54, SE = 0.20, p = .02) and GRP as dependent variable (Adjusted R^2 = 0.21 F (1.1) = 4.89, p = 0.49), yielding significant results.

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Assessing Oxygenation Changes using fNIRS in a Time-Pressure Task

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ABSTRACT

This study investigates anxiety detection using HRV, EDA, and fNIRS biosignals in 30 participants at Lusofona University. Significant physiological changes were observed during tasks, especially in oxyhaemoglobin levels, measured by fNIRS, highlighting this sensor's potential in detecting anxiety-related cerebral blood flow changes.

1. INTRODUCTION

Biosignals analysis has become increasingly prevalent in anxiety research and recent studies highlight the precision of fNIRS (Functional Near-Infrared Spectroscopy) signals in identifying anxiety's physiological markers (Duan et al., 2020; Huang et al., 2022; Li et al., 2022). The current trend focuses on employing Machine Learning (ML) to enhance the prediction and monitoring of anxiety symptoms (Chun et al., 2022; Coutts et al., 2020), aiming to reduce the dependency on subjective self-assessments (Khatri et al., 2022).

For this research, it was analyzed HRV (Heart Rate Variability), EDA (Electrodermal Activity) and fNIRS biosignals, in order to improve anxiety detection, integrating data with the STAI -Y-1 and SAM self-report measures, tools extensively used in both research and clinical settings for anxiety assessment (Vaz et al., 2023; Aldayel & Al-Nafjan, 2024). This approach aligns with the broader goal of advancing anxiety research through more objective and reliable assessment methods, potentially leading to significant improvements in the treatment and understanding of anxiety (Tang et al., 2023).

2. METHODOLOGY

2.1. Participants

The present study collected data from 30 adult participants, including students, faculty, and non-faculty staff. The research was conducted at Lusofona University, Lisbon, Portugal. Participants undergoing psychiatric treatment were excluded. The proposed experimental procedure was approved by the ethics committee of the School of Psychology and Life Sciences at Lusofona University. Every individual taking part in the study received a written document containing detailed information about the research and was required to provide their consent prior to participation.

2.2. Procedures

After the participants read and sign the Informed Consent, one of the investigators placed ECG, EDA and fNIRS biosensors. For the first 3 minutes, the baseline of the biosignals were taken. After, the participants responded to a brief sociodemographic questionnaire and the self-assessment questionnaire STAI-Y-1. Then the participants started the biological activation for anxiety task, that consists in a 3 difficult levels matching game, to accomplish in a shorter amount of time than necessary to do, proposed by Gamito et al. (2023), with a duration of 5 minutes. During the task, it was also assessed two behavioral features: number of clicks and number of matches.

Opensignals software was used to record and process the biosensor data. After the experiment, the participants were asked to fill the SAM and STAI-Y-1 again (post). The scores of the experiment questionnaires, the physiological signals and behavioral data were used as a measure of anxiety induced by the matching game, which are then compared to the data model aimed to predict and classify the anxiety levels.

2.3. Measures

2.3.1. Physiological measures

Non-invasive PLUX biosensors were used to measure the physiological signals: fNIRS to assess brain activity, EDA for dermal activity and ECG for heart rate variability. The fNIRS was placed in the pre-frontal lobe area (center of the forehead), the EDA sensor (2 channels) was placed in the index finger and middle finger, and ECG sensor (3 channels) was placed in the lower part of the chest, on the left side.

2.3.2. Psychological measures

The instruments used to assess anxiety were: STAI-Y-1 (State-Trait Anxiety Inventory, form Y-1), validated to Portuguese population by Santos and Silva (1997). The STAI-Y is a shortened version of the questionnaire and form Y-1 specifically assesses state anxiety, which is a temporary and situational form of anxiety that people experience in response to specific situations, events, or stressors. The Self-Assessment Manikin (SAM) is a visual questionnaire created by Bradley and Lang (1994) to assess emotions, uses single-item scales for valence/pleasure (positive to negative), arousal (high to low), and dominance/control (low to high).

3. RESULTS

The analysis of oxyhaemoglobin (oxyHb) levels, measured using fNIRS, revealed significant differences between baseline and task periods ($p < 0.05$), indicating that fNIRS can effectively detect changes in cerebral blood flow associated with anxiety states.

Heart rate (HR) showed significant differences when comparing baseline levels to various stages of the task. Specifically, there was a notable increase in BPM during the first thirty seconds of the task compared to the baseline ($p < 0.05$). This elevation in heart rate persisted into the second thirty-second interval, indicating sustained physiological arousal early in the task ($p < 0.05$). Furthermore, significant differences in BPM were also observed between the baseline and the seventh and eighth thirty-second intervals of the task ($p < 0.05$), suggesting prolonged cardiovascular activation.

Electrodermal activity (EDA) demonstrated marked increase from baseline to the first thirty seconds of the task ($p < 0.05$). This indicates an immediate and robust autonomic response to the physiological activation stimuli. A significant positive correlation was found with SAM, between activation (arousal) and pleasure (valence) suggesting that higher levels of physiological activation were associated with higher reported levels of pleasure. This finding highlights the complex interplay between emotional and physiological responses during the task.

4. DISCUSSION

The oxyhaemoglobin (oxyHb) levels had significant changes during the task, indicating alterations in cerebral blood flow associated with anxiety states. This highlights the potential of fNIRS as a valuable tool for monitoring neural activity in real-time and detecting subtle changes in cognitive and emotional processing.

The increase in heart rate (HR) and electrodermal activity (EDA) in the initial stages of the task showing a rapid physiological arousal response, suggesting that the task stimuli triggered an immediate autonomic nervous system reaction, indicative of heightened alertness or stress.

For future studies it is recommended recruiting a larger and more diverse samples, and refining the task design, by increasing its difficulty. Also, longitudinal studies tracking individuals' responses over time could provide valuable insights into the temporal dynamics of these processes.

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Psychology of Frailty and Prediction of Fall among Elderly People Living in French Nursing Homes

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ABSTRACT

Psychological frailty is less researched and often operationalized to include the co-occurrence of physical frailty with low mood, apathy, depression, and cognitive deficits. In this study, we adopted a multicentric, longitudinal, and quantitative approach for participants living in emeis group's nursing homes. We have assessed anxiety, cognitive impairment, depression and their influence on falls, trained 5 machine learning classifiers that predict the risk of falls among participants in our small sample datasets and similar, larger group. The key strength of this study is that it uses state-of-the-art ensemble learners that have proven to be reliable in even more critical applications.

1. INTRODUCTION

Frailty is an age-related condition characterized by the presence of the following: unintentional weight loss, self-reported exhaustion, weakness, slow walking speed, and low physical activity (Fried et al., 2001). It is a prevalent geriatric syndrome that poses significant public health and social concerns, as it is associated with an increased risk of adverse outcomes, including falls (Tan et al., 2023). Falls are a major cause of concern, with the World Health Organization (WHO) reporting in 2021 an estimated annual occurrence of 684,000 fatalities resulting from fall-related accidents. However, It has been reported that older people experience the most risk of death or serious injury due to falls and this risk increases with age (WHO, 2021). The physiological state of the elderly known as physical frailty has been widely researched while little or less is known about the psychology behind frailty (Cohen et al., 2023).

First, we answered the questions as to what psychological pathologies, specifically: anxiety, cognitive impairment, and depression could influence the risk of falls among our participants. Additionally, we explored other complementary factors, such as age, gender, and the use of psychotropic medication, to see whether they can also contribute to the risk of falls. Therefore, the general hypothesis of our research is the assumption that depression, anxiety, and cognitive impairment can increase the risk of falls among elderly participants. At the operational level, a lower score on the Mini-Mental State Examination (MMSE), indicating cognitive impairment, is presumed to be associated with an increased risk of falls. Conversely, higher scores on the Neuropsychiatric Inventory (NPI) depression and anxiety subscales, indicating depression and anxiety, are also assumed to increase the risk of falls. Those fall-related psychopathologies were used in fall predictions to help prevent future falls.

2. METHODS

2.1. Population Sample and Criteria

Participants were required to be adults aged 65 and above, of either gender, living in emeis group nursing homes, and recipients of social security. Those who met the specific physical and cognitive criteria outlines for safe participation were included in the study. We adopted a multicentric study approach in the Île-de France region, spanning six months with monthly follow-ups to assess the participants' balance and physical strength. Ethical approval was obtained from the French Committee for the Protection of Persons (CPP Nord Quest-4) and the French Data Regulation Agency (CNIL). Additionally, the privacy and confidentiality policies governing the data collection, processing, and storage were strictly adhered to.

2.2. Study Protocols

In this study, French-validated MMSE was used to assess cognitive impairment, while the NPI-ES depression and anxiety subscale was employed to measure depression and anxiety respectively. Physical frailty was assessed using standardized performance-based measures of physical function; a maximal grip strength (kilograms) in the dominant hand, using a hand-held dynamometer. Moreover, a conventional Berg Balance Scale was utilized to measure the balance level of the participants.

2.3. Statistical Analysis

The mean and standard deviation (expressed as mean ± SD) were used to describe continuous variables that followed a normal distribution. Whereas, medians and quartiles were used to describe continuous variables. Frequencies and percentages were used to report categorical data. A simple t-test was used to compare continuous variables that followed a normal distribution. The association between fall-related variables was compared using correlation tests. Exploratory analysis, data pre-processing, feature selection, model training, and evaluation were conducted using R version 4.3.3 (2024-02-29 release). A p-value of less than 0.05 was regarded as statistically significant. We employed a classical train-test split approach and assessed the model's performance using Receiver Operating Characteristic (ROC) analysis. The dataset is randomly divided into a training set, comprising 70% of the data, and the remaining 30% were used in testing the models. Furthermore, we computed a partial correlation between the fall status of prospective fallers and non-fallers and investigated their influence on fall risk concerning age and gender. Adaptive boosting or AdaBoost (Mayr et al., 2014), Logistic Regression or LR (LaValley, 2008), Support Vector Machine or SVM (Mammone et al., 2009), Light Gradient Boosting Machine or LightGBM (Nayak et al., 2021), and Random Forest or RF (Biau & Scornet, 2016) were trained, tested, and analyzed for optimal model selection. Confusion Matrices were used to further evaluate and understand the performance of the classifiers, offering a comprehensive view that goes beyond simple accuracy and helps us fine-tune the models for better performance.

3. RESULTS

3.1. Participant Characteristics

Drawn from the clinical trial's internal database are 36 elderly participants (30 women, 83.33%, and 6 men, 16.67%) with a mean age of 91.5 years (SD = 8.55) and a median age of 90.5 years (IQR: 85.5-95.5). Cognition assessed by the MMSE has a median score of 24 (IQR: 20-27), implying a range for both mild cognitive to normal cognition. Depression and anxiety examined using the NPI subscales show (median: 2, IQR: 0-2.5) and (median: 2.5, IQR: 0-2.5) respectively. Records from the database show that in the twelve months before inclusion in the study, 61.11% (22 participants) had not experienced any falls, 19.44% (7 participants) had fallen twice or more, and another 19.44% (7 participants) had fallen only once. The Berg Balance Scale produced a median score of 39 (IQR: 35-39), indicating a moderate balance function. Moreover, handgrip strength was averaged at 11.4 kg (IQR: 8.7-13.1 kg). Proportionally, 61.11% (22 participants) were shown to have taken antipsychotic medications that are known to potentially impact fall risk due to their side effects on balance.

3.2. Results Interpretation

Cognitive function assessed by the MMSE showed a negative correlation ($r = -0.03,= 0.44$) with the number of falls, implying that the participants with higher cognitive scores are less prone to experience falls. Similarly, the Depression score measured by the NPI subscale has exhibited an overall negative relationship with ($r = -0.09,= 0.90$) loosely means that subjects who score higher on the Depression test could have less likelihood of falling. Furthermore, we observed a weak correlation positive coefficient ($r = 0.23,= 0.25$) between Anxiety and the number of falls, signifying increased chances of falls among participants with elevated anxiety levels. To further investigate the association between age and risk of falling; we have analyzed the partial correlation between fall status; prospective fallers, and non-fallers, resulting in ($r = 0.22$, $p = 0.04$) which signifies an increase in fall risk with advancing age among both male and female genders. As per the results in **Table 1**, Taking the four metrics into account, the AdaBoost has outperformed its counterpart considering its accuracy and sensitivity, and a balanced trade-off between AUC-ROC and specificity, making it the best and optimal model for the fall prediction. Although RF and SVM exhibit the highest accuracy (0.95), they fall short in specificity compared to the Adaboost. On the other hand, LR, and LightGBM possess reasonable accuracy and specificity, but their overall performance is not as impressive.

Table 1. *Performance of the 5 ML Models for Predicting Falls on the Test Set*

ML models	Threshold	AUC-ROC	Accuracy	Sensitivity	Specificity
LR	0.60	0.78	0.69	0.63	0.67
SVM	0.42	0.95	0.86	0.75	0.92
RF	0.75	0.95	0.83	0.75	0.86
LightGBM	0.42	0.92	0.77	0.69	0.79
AdaBoost	0.49	0.92	0.86	0.81	0.87

4. DISCUSSION

Despite the burden of age-related physical decline, we have observed that older adults with high cognitive scores and low anxiety tend to have a lower risk of falls. However, the correlation between cognition ($r = -0.03$, $p = 0.44$) and falls is not statistically significant, and the same thing goes with depression and anxiety having ($r = -0.09$, $p = 0.90$), and ($r = 0.23$, $p = 0.44$) respectively. Participants with high scores on depression are less prone to fall, and this could be due to a reduced quality of life, self-restricted activity levels, physical function, and social interactions (Sherrington et al., 2020). Additionally, ($r = 0.22$, $p = 0.04$) indicates that advancing age could lead to an increased risk of falls. Thus, there are insufficient evidence to back up our null hypothesis, some existing literature have supported our claims (Cohen et al., 2023; Tan et al., 2023). It is also very important to note that, the best-performing classifier; AdaBoost presented a higher proportion of False Positives (FP), meaning it incorrectly predicted instances as high risk (class '1') when they were ideally low risk. This occurs as a result of a higher priority given to generalization rather than balancing prediction accuracy during the tuning process. Therefore, future works should mainly address the issue of such false positive prediction by re-tuning the model parameters and exploring alternative means of leveling these limitations.

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Transforming perspectives: the impact of virtual embodiment on attitudes and responses to gender-based harassment in the metaverse

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ABSTRACT

In this study, we explore the impact of virtual reality (VR) on male participants' attitudes and helping behavior towards victims of gender-based harassment (GBH) in the metaverse. Sixty participants will be randomly assigned to either a harassment condition, where they embody a female avatar experiencing sexual harassment, or a control condition, with no harassment. Pre- and post-exposure measures will assess changes in attitudes, while a VR scene will evaluate the potential for encouraging bystander intervention. Results will contribute to understanding VR's effectiveness in preventing harassment in the metaverse by changing perspective through embodiment.

1. INTRODUCTION

In social extended reality spaces, referred to as the metaverse, users are represented by their 3D avatars, enabling the shift of activities like learning, work, and entertainment into virtual environments (Cheng, 2023). Simultaneously, a concerning social dynamic has emerged in these spaces, where female avatars experience increasing instances of gender-based harassment (GBH) by male avatars (Schulenberg et al., 2023). Unlike text-based harassment on social media, VR intensifies these experiences with real-time audio insults and physical interactions through avatar embodiment (the illusion of ownership and control over a virtual body), leading to breaches of personal space (Blackwell et al., 2019). This sensation is enhanced by the feeling of presence, the perception of truly "being there" that these environments enable (Slater et al., 2009).

At the same time, such embodiment illusions in VR can also influence social cognition by altering participants' implicit attitudes and responses when they virtually inhabit another body, allowing them to take the perspective of someone from a different race, age, or gender (Banakou et al., 2013; Maister et al., 2015; Slater & Banakou, 2021). VR has shown effectiveness in preventing and rehabilitating gender violence by enabling individuals to experience various situations from new perspectives in a safe and controlled environment (Bastardas-Albero et al., 2023).

In this sense, the primary aim of this study is to evaluate changes in attitudes towards sexual harassment against women through perspective-taking by comparing male participants embodying a woman experiencing GBH in the metaverse to a control group experiencing the same context without GBH. The secondary aim is to understand whether this approach can encourage helping behavior and mitigate sexual harassment in social VR. We hypothesize that those in the harassment condition will develop more positive attitudes towards women and be more likely to intervene as bystanders of GBH in the metaverse.

2. METHODS

2.1. Participants and Procedure

We expect a sample of sixty male participants recruited from the general population via email, social media, posters, and word of mouth. Exclusion criteria include individuals with epilepsy, history of violence, drug abuse, or current psychological treatment. Participants will be randomly assigned to one of two conditions: the harassment condition or the control condition. One week prior to the experiment, they will receive written informed consent via email and complete baseline measures of attitudes towards GBH. These measures include the Sexual Harassment Attitude Scale (Mazer & Percival, 1989), the Ambivalent Sexism Inventory (Expósito et al., 1998), a gender version of the Lexical Decision Task (LDT, Ducate, 2021), and the Social Desirability Scale (SDS, Ferrando & Chico, 2000). The experiment will take place one week later. After the experiment, they will repeat the baseline measurements (except for the SDS) and complete a questionnaire on body ownership and presence. Participants will then be exposed to another GBH scene in the metaverse as bystanders to evaluate helping behavior. Finally, a semi-structured interview will be conducted to gather their perceptions of the experience.

2.2. Metaverse Scenarios

There are two different metaverse scenarios: the Job Interview (experiment vs. control) and the Cafeteria, which will be used to evaluate helping behavior after the intervention. In the Job Interview scenario, all participants will start the experiment in VR by embodying a female avatar in a virtual room equipped with a mirror, where they will perform stretching exercises to get accustomed to their avatar's capabilities. They will then participate in a job interview in the metaverse for a Software Developer position. The interaction with the male interviewer begins with professional questions about experience, skills, and personal strengths. For the experimental group, the questions gradually shift to inappropriate personal inquiries (e.g., "Do you have a boyfriend?"). The interviewer then makes comments with inappropriate implications (e.g., "A smart woman like you, looking as good as you do, it must be easy to get ahead"), invades the participant's personal space, and makes physical contact by touching the avatar's hand. The control group will encounter the same scene, but it will only include professional questions.

To assess the previous VR intervention, all participants will experience another GBH context as bystanders in a virtual workplace cafeteria. They will embody a male avatar and perform the same embodiment exercises as before. In this scenario, participants will be seated in the cafeteria with two other men at a different table. The same woman from the first scene, who was hired after the job interview, arrives, and takes a seat for her coffee break. One of the men moves to sit with her without asking for permission and begins small talk that quickly becomes uncomfortable and inappropriate. The harasser makes comments about her work, invades her personal space by touching her shoulders despite her clear discomfort, then suggests they should meet up in a more private virtual space. This scene will be recorded, and participants' interventions will be coded and analyzed.

2.3. Materials

Participants will use a Head Mounted Display (HMD) headset for full auditory and visual immersion and hold controllers to simulate hand movements and interact with objects in the VR environment. The simulations will be developed using the Unity platform, with the QuickVR library (Oliva et al., 2022) to create interactive VR environments. Unity's built-in VR support, along with libraries such as the XR Interaction Toolkit and VRTK, will enhance interactivity. The Oculus XR Plugin will support Oculus Quest devices for head and hand tracking.

3. EXPECTED RESULTS

Based on previous research (Gonzalez-Liencres et al., 2020; Neyret et al., 2020), we expect that participants in the GBH condition will exhibit significantly stronger negative attitudes towards sexual harassment, reduced gender biases, and a higher likelihood of intervening in GBH situations compared to those in the control condition.

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The temporal neural dynamics of aesthetic appreciation for visual art

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ABSTRACT

Neuroaesthetics researches brain activity during aesthetic experiences, which are common when viewing visual art such as paintings. However, we know very little about how aesthetic experiences during art appreciation unfold across time in the human brain. This work aims to investigate the temporal neural correlates of aesthetic experiences with different types of artworks. Participants will view a wide range of visual artworks while we record EEG data. The resulting EEG response patterns will be analyzed in a multivariate representational similarity analysis (RSA) framework, which will allow us to link participants' explicit ratings of visual aesthetic appeal to their emerging temporal brain dynamics. Our study will clarify how rapidly the brain encodes the aesthetic appeal of visual art, and which features of the artworks enable the emergence of such beauty-related signals.

1. INTRODUCTION

Europe is home to thousands of museums that house various visual artworks. Many people visit these museums daily and find watching artworks a pleasant experience. However, why some artworks look more pleasing than others is a long-standing question in empirical aesthetics. How such differences are represented in the brain is the primary concern of the emerging field of neuroaesthetics.

Neuroaesthetics investigates neurobiological components of aesthetic experiences, such as emotions, valuation, actions, interpretation, and production related to artistic objects (Chatterjee & Vartanian, 2014). It has sparked relevant discussions about the correlation between brain structures/functions and art in different contexts, despite still facing challenges in quantifying data for experimental studies (Chatterjee, 2011). In addition, this discipline focuses on two scopes: comprehending the aesthetic pleasure elicited by art appreciation and the aesthetic experience of usual visual stimuli, like scenes or faces (Skov & Nadal, 2020).

The use of advanced methods, such as electroencephalograms (EEG), with computational modelling techniques has demonstrated how the brain processes aesthetic experiences related to real objects and a perceptual component in early cortical signals distinguishing levels of beauty (Kaiser & Nyga, 2020; Kaiser, 2022). However, the temporal dynamics of cortical processing underlying the appreciation of visual art still need to be clarified, although conceptual explanations and models have been proposed (Leder et al., 2004). Therefore, this study aims to test experimentally whether the brain dynamics encoding the beauty of everyday inputs are similar to those encoding the beauty of visual art.

2. METHODS

1.1. Data Collection

We aim to recruit 25 healthy participants between 18 and 40 years old with no neurological, or psychiatric disorders or visual impairment history and minimal to no formal knowledge about artworks. The experimental stimuli will be taken from the Vienna Art Picture System (VAPS; Fekete et al., 2023), a visual art dataset containing 999 art images of 13 historical periods and styles between the 15th and the 21st centuries. It includes five genre categories: landscapes, portraits, scenes, still lifes, and paintings featuring escalating degrees of abstraction.

We will record electroencephalography (EEG) activity while participants are presented with visual artworks. Participants will be exposed to all the images from the VAPS database. The visual artwork images will be presented for 150 ms in a rapid visual stimulus paradigm (RSVP) while participants will be engaged in a detection task (detecting the appearance of a particular target image). The brief presentation of the artworks allows us to measure the automatic encoding of visual beauty for visual art, without explicit deliberation and thought.

2.2. Data Analysis

Data will be analyzed using MATLAB and a set of toolboxes, such as CoSMoMVPA (Oosterhof et al., 2016), to conduct a representational similarity analysis (RSA) of the EEG data, following methods established in previous research (Kaiser, 2022; Popal, Wang & Olson, 2019). This approach will enable us to assess how similar pairs of images are in neural responses across time. This neural similarity will be correlated with the images' pairwise similarity in aesthetic appeal (obtained from the ratings in the VAPS database). We will also examine how rapidly cortical signals reflect the beauty of different artistic styles and content types in the database.

Additionally, we will conduct separate analyses for different image categories to explore the effectiveness of visual deep neural networks (DNNs) in predicting neural dynamics across these different styles and contents, providing insights into whether similar or different visual features predispose aesthetic perception for various visual artworks.

3. EXPECTED RESULTS

Considering that we are replicating methods utilized in Kaiser (2022) and in Kaiser & Nyga (2020), we expect to find similar results in how fast the brain encodes visual artworks' aesthetic experience and the early representation of cortical processing. Kaiser (2022) found that neural representations of scene attractiveness emerged within 200 milliseconds of stimulus onset in brain responses, independent of the task participants were performing. This study will clarify if the aesthetic experience of artworks is also automatically and rapidly encoded. Our rich image set will further allow us to clarify whether this automatic encoding is similar across a range of contents and artistic styles.

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Psychological Impact of Breast Cancer and Premature Menopause: Digital Intervention Approach

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ABSTRACT

This study explores the psychological effects of breast cancer and premature menopause on mental health, highlighting increased risks of depression and anxiety. A digital intervention using wearable devices aims to monitor patients' mental health and physical activity, providing timely psychological support. Over 6 months, 20 breast cancer patients experiencing premature menopause will participate, undergoing physical data collection and psychometric assessments. Statistical analysis will examine the links between physical activity and mood/anxiety symptoms to guide the development of effective interventions for these mental health challenges.

1. INTRODUCTION

A breast cancer diagnosis can significantly impact mental well-being (Fortin et al., 2021). Breast cancer patients face a higher risk of premature menopause, which can contribute to mental state disturbances, including depressive symptoms (Shea et al., 2020), anxiety symptoms (Bromberger et al., 2013), and sleep disturbances (Chung et al., 2018). These symptoms also have a bidirectional relationship with menopausal vasomotor symptoms (Bromberger et al., 2007). Furthermore, during the menopausal transition, these women encounter various stressors, role changes, losses, and aging-related psychological impacts (Bromberger et al., 2015). Thus, comprehensive treatments should include timely psychological and personalized care to mitigate the impact of breast cancer and premature menopause on mental health (Giese-Davis et al., 2011).

Digital interventions have already proven effective in preventing and reducing emotional distress and improving the quality of life for breast cancer patients (Medina et al., 2022). However, further research is necessary to provide timely psychological support for those facing breast cancer and premature menopause. The upcoming program, developed by the Catalan Institute of Oncology, aims to help specialists quickly respond to changes in the mental condition of breast cancer patients with premature menopause. It continuously and automatically collects users' physical activity data from digital sources, including wearables, and offers graphical reports to facilitate timely psychological interventions by providing detailed and reliable insights into patients' health, even outside the hospital. This approach can serve as an indicator of mental state and help alleviate the psychological burden of breast cancer and premature menopause on patients, given the correlations between step counts, heart rate variability, and mood state dynamics (Cho et al., 2019; Reinertsen & Clifford, 2018).

2. RESEARCH MATERIALS

Participants: 20 patients diagnosed with breast cancer and premature menopause within the past 1 year at the Catalan Institute of Oncology will be recruited. Inclusion criteria: women aged ≥40 years, with internet access and user-level skills, and fluency in Catalan or Spanish. Exclusion criteria: diagnosed major depressive disorder, psychosis, or substance abuse; autolytic ideation; impaired cognition. All participants will be informed of the study and must sign the informed consent. The observation period will span 6 months.

3. RESEARCH METHODS

3.1. Study Design

This study will follow a quasi-experimental single-group longitudinal design.

3.2. Data Collection

Essential participants' demographic information will be collected from their clinical records.

3.2.1. Physical Activity Data.

Wearable devices will be employed for the collection of the following data on physical activity: heart rate (every 10 minutes); peripheral blood oxygen saturation (every 10 minutes at night); body temperature (every 24 hours, collected actively by the patient); total daily steps (every 24 hours); sleeping hours (every 24 hours).

3.2.2. Psychometric Data.

The psychometric data will be collected through the Emotional Distress Thermometer (based on a Visual Analogue Scale (VAS) in the App ICOnnecta't (Medina et al., 2022)) - self-questionnaire utilized weekly as a screening method to measure emotional well-being. For patients with positive screening results (≥6 scores for two consecutive weeks): HADS (Hospital Anxiety and Depression Scale) (Costa Requena et al., 2009) is a self-questionnaire assessing the levels of anxiety and depression - scores >10 confirm clinical distress.

3.3. Data Analysis

Statistical analysis will be performed to distinguish the correlation between physical state and mental well-being of patients, using SPSS 27. Psychometric data will be analyzed using the program's central mobile application (App ICOnnecta't): patients can discuss their psychosocial state and cancer symptoms with healthcare providers; alerts can be scheduled for patients to complete questionnaires, aiding in monitoring medication adherence, emotional well-being, and other health indicators, including adverse events.

3.4. Data Screening and Reporting

Data Screening and Reporting are managed through the ICOnnecta't web application. The platform provides access to the following information: reports detailing the physical activity of patients; completed and pending questionnaires, along with reports summarizing questionnaire results; alert system indicating patients' current state.

4. EXPECTED RESULTS

After conducting psychometric and statistical analyses of data collected from wearables and the ICOnnecta't mobile application, correlational patterns between patients' physical activities and deviations in mental state related to breast cancer will be identified. A control group of 20 breast cancer patients without premature menopause is being considered for comprehensive comparison.

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Psychological Trait Assessment Prior to Therapeutic Sessions Using Open-Ended Questions

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ABSTRACT

Initial therapeutic interviews are crucial for establishing a positive therapeutic relationship, and a better understanding of the patient's psychological traits may help match patients with compatible therapists and prepare them for the initial conversation. This study aims to develop AI models for the psychological screening of patients prior to therapy, recognizing core psychological traits. Our methodology involves defining core psychological traits and developing text-based and speech-based deep learning models tailored to assess those individual psychological traits. This approach is expected to enable therapists to optimize therapy sessions based on pre-session insights and improve therapy outcomes.

1. INTRODUCTION

The effectiveness of psychotherapy is shaped by several factors, broadly divided into patient, therapist, and treatment factors (Constantino et al., 2021). Patient factors encompass the individual's motivation, readiness for change, and the complexity and severity of their symptoms. Treatment factors include the type, duration, and intensity of psychotherapy used. Therapist factors, such as the therapist's ability, experience, and skill in building a strong therapeutic alliance, are crucial. This alliance is particularly significant as it enhances patient engagement and openness, fostering a unique bond between therapist and patient (Stubbe, 2018).

Understanding patient's psychological characteristics beforehand could equip therapists better for the initial dialogue and subsequent sessions. With the advent of machine learning, collecting and analyzing such data swiftly and effectively is now possible, enabling therapists to adjust their approach and personalize treatment. This personalization is possible and can enhance therapy outcomes (Karyotaki et al., 2021). However, research on the impact of gathering patient factors before sessions to tailor and optimize initial engagements is still limited.

Therefore, our study aims to: (1) identify core psychological traits and factors that therapists should know before starting the psychotherapy process; (2) to create deep learning models tailored to assess those individual psychological traits. Data will be modelled using embedding representations via text-based and speech-based pre-trained deep learning models from both textual and voice responses.

2. METHODS

2.1. Participants

To ensure a targeted and effective engagement, our preliminary phase involves two critical steps: the definition of core psychological traits and the meticulous development of the interview process. Initially, we will utilize an online survey (n=30) and focus groups (n=10) practicing psychologists to define the most useful psychological traits for clinicians. Subsequently, we will undertake the task of identifying state-of-the-art questionnaires and developing tailored open-ended interviews.

Following this preparatory work, we will target the engagement of a diverse pool of 150 Spanish-speaking participants, adults aged 18 to 65. The selection process aims to encompass a broad spectrum of demographic variables, ensuring a representative sample reflective of varied psychological traits.

2.2. Data Collection and Pre-processing

An app is developed to facilitate remote interviews, utilizing 2D avatars for questions and cloud storage for voice-recorded responses These avatars, employing synthesized voices, will pose a series of open-ended questions designed to elicit rich, nuanced responses that reflect the participants' psychological traits and target variables chosen through the survey and focus groups.

2.3. Data Analysis

The goal is to create deep learning models tailored to assess target individual psychological traits. This implies a specialized approach where different models or model configurations are designed to interpret responses related to specific traits, employing two strategies for response embeddings. Using cutting-edge AI models: text-based via LLMs (e.g., GPT, Llama 2) and speech-based using pre-trained architectures (e.g., Hubert, Unispeech).

The first strategy involves using LLMs to convert textual responses into embeddings. By using models like GPT, the project aims to capture the nuanced linguistic features of participants' responses, translating them into a form that can be analyzed to predict psychological traits. In the second one, pre-trained architectures like Hubert and Unispeech, which are designed to process and understand speech, will be used to create embeddings from voice recordings. This approach acknowledges that how something is said (tone, pace, inflection) can be as informative as what is said, providing a richer dataset for analysis.

3. EXPECTED RESULTS

The main expected results of this study will be, first, the identification of core psychological traits, crucial for first appointment preparation. Patient's motivations and expectations, their objectives, and severity and type of symptoms are expected to be shown as important (Constantino et al., 2021; DeFife & Hilsenroth, 2011)

And second, confirm our hypothesis that advancements in Large Language Models and pre-trained speech models can enhance the accuracy of recognizing psychological traits, facilitating scalable models for personalized therapeutic approaches (Amin et al., 2023). Such models are expected to have broad applicability across diverse clinical settings, allowing the therapist to increase therapy effectiveness and patient satisfaction.

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Can an LLM-equipped Multimodal Chatbot adapted to psychological techniques improve Mental Wellbeing? A preliminary study description

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ABSTRACT

The use of agents such as chatbots in mental health care approaches, have shown promising results. Advances through the integration of Language Large Models (LLM) and other modalities of information (different from textual) could provide agents with a more dynamic and contextual engagement, although limitations still hinder effective interactions. With this in mind, we aim to develop and evaluate an LLM-equipped multimodal chatbot adapted to evidence-based techniques from positive psychology and effective planning to improve mental wellbeing. Remote/virtual users will participate, and self-report questionnaires will be administered for pre-post testing, which will be analyzed alongside the multimodal data.

1. INTRODUCTION

Conversational agents such as chatbots are an important tool for the development of evidence-based approaches to mental health promotion given their ease of application and expansion to diverse settings at low cost (Bendig et al., 2022; Boucher et al., 2021). In this sense, techniques from positive psychology and effective planning such as Best Possible Self Intervention (BPS), where a reflective question facilitates the exploration of a better possible self in the future, increasing optimism, self-esteem and subjective wellbeing (Carrillo et al., 2019; King, 2001), or Goal Setting, where defining a series of objectives in the personal context gives to the person a sense of progress and the projection of a desirable future (Klug and Maier, 2015; Sirgi, 2021), can be very useful.

Both approaches have been found effective in multiple studies from traditional or digitally supported forms (Carrillo et al., 2019; Klug and Maier, 2015; Sirgi, 2021). However, studies such as those by Greer et al., 2019,and Liu et al., 2024, have also referenced this type of exercises from conversational agents showing great potential, especially considering the advances from artificial intelligence and Language Large Models (LLM), which enable a more dynamic engagement through increasingly genuine conversations, allowing real-time and adapted feedback, fundamental for an adequate mental health care (Li et al., 2023; Liu et al., 2024).

These resources can be further enhanced by incorporating other modalities (different from textual) providing additional contextual information for accurate responses (Devi et al., 2024; Estecha-Garitagoitia et al., 2023). Some studies (e.g. Guerdan et al., 2021; Liu et al., 2023) have introduced advances in emotional recognition as well as interpretation of physiological signals from camera-based records, offering greater capacities to computational systems in the contextual interpretation of information for human-agent interactions. However, both in this field and in the interactions via chatbots, numerous challenges remain unsolved in terms of privacy, inaccuracy of responses, information management, biases in machine learning mechanisms and others that may limit their effectiveness (Coghlan et al., 2023; Gunes and Churamani, 2023), which is further highlighted in the context of positive psychology interventions and the adaptation of these exercises in chatbot contexts where evidence is still limited (Liu et al., 2024). Bearing in mind this information, this study seeks to develop and evaluate a multimodal (text, emotions and heart rate estimated from visual input) LLM-based chatbot adapted to Best Possible Self Intervention and Goal Setting to improve individual's mental wellbeing.

2. METHODOLOGY

1.1. Sample

Data will be collected from a minimum of 60 adults, whose involvement will be requested through a dissemination strategy in social/college networks. Participation will be virtual, allowing access to the dedicated link through e-mail or other means, where they will be asked to give their informed consent and to complete basic demographic data. Exclusion criteria will be: a) to be unable to complete the data collection procedure due to individual's limitations; b) to be in a psychotherapeutic process or undergoing other form of therapeutic support.

1.2. Technological development

The components of LLM-based multimodal chatbot will be developed independently of each other and then assembled. The first part would be to develop the LLM powered chatbot, which can be outsourced, either by using an existing platform API or by using LLM weights, which are available open-source. Separate pipelines would be developed to process the user video in two different directions, one to extract the emotions and another to extract the heart rate variability (HRV). Tools such as OpenFace (Zadeh et al., 2018), used to extract action units from video input, and FaceChannel (Barros et al., 2020), used to map the emotion portrayed by facial expressions onto the two-dimensional plane of valence and arousal, are antecedents in the first pipeline. Related to the HRV line, models such as PhysNet (Yu et al., 2019) and DeepPhys (Chen and McDuff, 2018), containing algorithms for remote physiological measurement signals by facial video-based records, will be trained using datasets for remote photoplethysmography. The outputs from these two pipelines will inform the dynamic adaptation of the chatbot's behaviour according to the techniques proposed.

1.3. Procedure and measures

Participants will interact with the multimodal chatbot which support the users through an exercise of an optimal vision of the future (BPS) and/or setting concrete goals and actions for the future where they can be seen in a specific time frame (Goal setting). Within the framework of these interactions, and as will be contemplated in the informed consent, access to their cameras will be requested to record the established signals. Self-reporting questionnaires will be used for pre-post testing (before and after the complete period of interaction). The following are planned to be used: Positive and Negative Affect (Watson et al., 1988), Satisfaction with Life (Diener et al., 1985), Rosenberg Self-Esteem (Rosenberg, 1979), and Life Orientation Test-Revised (Scheier et al., 1994).

1.4. Ethical considerations

The Helsinski Declaration and European Commission standards will be followed. Informed consent will be considered, informing about the policy of the company responsible for the system behind the agent.

3. EXPECTED RESULTS

An improvement in both individual's mental wellbeing and human-agent interaction is expected through much more meaningful and contextualized results, enabling analysis and development of recommendations and improvements regarding LLM-equipped multimodal chatbots in mental health settings.

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Enhancing Personality Assessment: From Self-Reported Questionnaires to Deep Learning Predictions

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ABSTRACT

This study explores new methodologies for personality assessment using deep learning models and audiovisual cues, building on the traditional Big Five Factor Model. The UDIVA v0.5 dataset, featuring multimodal, multiview videos of dyadic interactions, serves as the primary data source. Participants completed self-reported personality questionnaires. The study aims to enhance personality predictability by analyzing behavioral cues like gaze, gestures, and vocal characteristics. Features extracted from the dataset will be used in a transformer-based, context-aware model to regress personality traits. This research seeks to identify behavioral cues that correlate with personality traits and improve prediction accuracy.

1. INTRODUCTION

There are diverse ways of how individuals can present themselves and react to others, showing patterns of behaviour modulated by the context and the environment surrounding them. These patterns of thinking, feeling and behaving are understood as a person's personality (Soto & John, 2017). Personality has been traditionally assessed through self-reported questionnaires, measuring the personality perceived by the participant himself. The most used model to achieve that goal has been the Big Five Factor Model, formed by five main personality traits: extraversion ("E"), neuroticism or emotional stability ("N"), openness to experience ("O"), agreeableness ("A") and conscientiousness ("C") (Goldberg, 1993). With the rise of new technologies, novel approaches and possible assessments come up, bringing us to our hypotheses/empirical questions.

The emergence of new technologies brought the opportunity to assess personality in innovative ways, adapting multiple theoretical aspects to recent methodologies. For this, novel studies have been using the Big Five Model, the most well-known questionnaire, to teach a deep learning model to predict personality (Ortet et al., 2022). In order to achieve this goal, it needs to be proved if personality can be assessed, for example, through audiovisual

overt cues. If so, what would those behavioral cues be? For example, other studies have found that gaze can act as a good predictor of Extraversion (Lepri et al., 2012). To answer these questions, state-of-the-art studies about personality assessment used dyad samples applied in deep learning models (Palmero et al., 2021). The same will be done in this study. The most used sample is the UDIVA dataset, acquired from Palmero et al. (2020) which is a multimodal, multiview dataset of zero-acquaintance and previous-acquaintance, face-to-face dyadic interactions, composed of 188 interaction sessions, with 147 participants mostly originally from Spain. The sample selected correlates with the WEIRD countries (western, educated, industrialized, rich, and democratic), since the Big Five Model has been mostly validated for those countries (Minkov et al., 2022). The dataset contains audiovisual and physiological data. Dood et al. (2023) worked on the same database, finding that by using an attention-based fusion method, the predictability power was estimated at 46% of efficacy. This study will use the same dataset, proposing to enhance this model, through non-verbal and verbal cues.

2. METHODOLOGY

2.1. UDIVA dataset

In this study, the UDIVA v0.5 dataset will be used, which is a subset of UDIVA, acquired from Palmero et al., 2021. This is a meticulously crafted collection of time-synchronised multimodal, multiview videos. These videos capture non-scripted face-to-face dyadic interactions observed from synchronized camera views, during free and structured tasks performed in a lab setup. The dataset encompasses 90.5 hours of recordings capturing dyadic interactions involving 147 voluntary participants, 55.1% of whom are male, with an age range from 4 to 84 years (mean=31.29, sd=12.57). The participants represent 22 countries, with 68% hailing from Spain. Notably, the majority of participants (38.8%) are students, and 84.4% self-identify as white. The interactions are distributed across 188 dyadic sessions, with an average participation rate of 2.5 sessions per participant and a maximum of five sessions.

2.2. Psychometric Tools

Several psychometric tools will be used to complement the personality assessment. Concretely, participants answered a self-reported sociodemographics questionnaire; the Spanish adaptation of the Big Five Inventory Personality questionnaire (Gallardo-Pujol et al., 2022), assessing their recognized personality; and internal states questionnaires, before and after each interaction session, assessing participants' mood and fatigue.

2.3. Technical feasibility

Features will be extracted from the UDIVA v0.5. For the Video Modality, the possible features observed are gaze, action units, gestures, head pose and even body pose. Examples of potential chosen features regarding the audio are pitch, timbre, loudness, and vocal tone. With the help of transcripts provided in the UDIVA v0.5 dataset various NLP techniques will be used to extract relevant features. Furthermore, an important input is the Metadata of the Participants(ID, gender, age, z-score OCEAN personality values,total number of sessions done, session IDs), Session (session ID, participant IDs corresponding to each of the camera views, date and time of the recording, self-reported relationship among interaction partners) and Other(start-end times of segments). These extracted features will be fed into a transformer-based, context-aware (in the form of another interlocutor), and attention-based model, which will regress self-reported personality traits based on chosen psychometric tools of the target individual. The framework of the model used will be like the one presented in previous literature (Dodd et al., 2023). The main focus of this study is to see which features can help predict personality traits and how to represent them in the model used.

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Enhancing Emotional Connection and Engagement in Long-Distance Relationships: A Comparative Study of Virtual Reality and Video Calls

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ABSTRACT

This study investigates the effectiveness of virtual reality (VR) versus video calls in enhancing emotional connection and engagement during daily catch-up calls among geographically separated family members or friends. The study will be conducted using VR United, a virtual reality application that enables multiple users to interact together in virtual reality within the same environment, each one with an avatar that looks like themselves. We will compare three experimental conditions: Video call, Virtual Reality call, and Passthrough Virtual Reality call. Utilizing a mixed-methods approach, we assess the sense of co-presence, emotional closeness, and engagement of the conversations through self-report questionnaires, interviews, and behavioral observations in these 3 experimental conditions. We will analyze the qualitative findings using sentiment analysis. Findings will provide insights into how Virtual Reality might support long-distance familial or friendship relationships.

1. INTRODUCTION

Emotional closeness and engagement are critical components of healthy family relationships or those between close friends. While video calls are an effective communication medium, they lack the immersive quality necessary to foster a deep sense of co-presence and connection due to their two-dimensional nature. For example, there is no sense of space, no proxemics between people, and no interaction through body gestures or direct gaze. In contrast, Virtual Reality (VR) can bridge this gap by incorporating non-verbal communication through full-body avatars that represent the people involved, and which look like themselves. Despite its potential, VR's effectiveness in enhancing communication in a daily setting remains under-explored. This study aims to fill this knowledge gap by examining the impact of VR on emotional closeness and engagement among family members and friends who live far apart or are otherwise unable to meet.

2. RESEARCH OBJECTIVES:

2.1.Primary Research Questions

The primary research question guiding this study is: "Is virtual reality (VR) a more effective medium than video calls for enhancing emotional connection and engagement in daily catch-up calls among family members and friends who are unable to physically meet?".

To address this question, the study will have three key aims. First, it will compare emotional connection and engagement levels in VR, Passthrough VR mode, and video call interactions, providing a quantitative analysis of

how each medium impacts relational dynamics. Second, the study will assess the sense of co-presence experienced by participants in all mediums, exploring how the immersive nature and the Passthrough mode of VR might contribute to a greater feeling of closeness and involvement. Lastly, qualitative feedback will be analyzed to understand user preferences and experiences, offering deeper insights into the subjective aspects of communication satisfaction and perceived effectiveness in the video call, VR call, and Passthrough VR mode.

3. METHODS

3.1.Participants

A diverse sample of family members or friends living apart, including grandparents, parents, and young couples in long-distance relationships, will be recruited.

3.2.Experimental Conditions

Participants will be randomly assigned into three groups:

The first group is the Video Call Group: Participants will use Zoom/Facetime/WhatsApp video for their catch-up calls, whichever one they are most familiar with.

The second group is the VR Call Group: Participants will use the VR United platform for their calls(Oliva et al., 2023). They will be in a virtual environment for their calls and with avatars that resemble them.

The third group is the PassThrough VR Group: Participants will use the VR United platform for their calls. In both VR conditions participants will each have an avatar that resembles them. In the passthrough mode, their counterpart's avatar will be seen to be present in their physical room environment when they have conversations.

3.3.Procedures

Before the experiment begins, all participants will complete the Inclusion of Other in the Self (IOS) Scale (Aron et al., 1992). Additionally, a semi-structured interview will be conducted to understand their current emotional connection and closeness with family members or friends. During the experiment, participants will engage in daily catch-up calls for at least 20 minutes, three times a week, using their assigned communication medium over one month. After the month, participants in the VR group will return the VR headsets, with a one-week period allowed for continued voluntary usage to assess if participants choose to maintain communication using VR. Post-experiment, participants will again complete the IOS Scale along with the Networked Minds Social Presence Inventory (Biocca et al., 2001). A final semi-structured interview will be conducted to understand their experiences with the technology and their emotional closeness and connection with the family members after the study.

3.4 Measurements and Analysis

This study employs a multi-method approach. We will utilize self-report questionnaires, specifically the Inclusion of Other in the Self (IOS) Scale and the Networked Minds Social Presence Inventory to measure the sense of co-presences in all conditions. Semi-structured interviews will be conducted pre- and post-study to assess changes in emotional closeness between the two participants and to gather data on their overall experiences with video calls and virtual reality. Additionally, behavioral observations include the duration of calls, the content of conversations, and the frequency of continued VR usage for communication during an additional week following the experiment. This comprehensive methodology aims to provide insights into the effectiveness of VR as a medium for enhancing interpersonal relationships at a distance.

We will use ANOVA to compare emotional closeness, engagement, and co-presence among the 3 groups. Sentiment analysis (Naldi, 2019) of interview transcripts to identify common themes and insights into the overall experiences.

4. EXPECTED OUTCOME

It is hypothesized that VR will lead to higher levels of emotional connection, engagement, and presence compared to video calls. The findings will offer valuable implications for people seeking to maintain close relationships despite physical distance, as well as for developers of communication technologies aiming to enhance user experience.

Acknowledgment: this work is funded by the European Union Erasmus Mundus Joint Master Grant nº: 101048710. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

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Using artificial intelligence to model cognitive load and adapt challenging tasks during immersions in virtual reality: Phase 1 – a literature review and study protocol for people diagnosed with schizophrenia

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ABSTRACT

Artificial intelligence techniques offer the potential of improving the effectiveness of cognitive remediation tools by adapting their difficulty in real time based on the cognitive load of users immersed in virtual reality (VR). The presentation aims to (a) report on a scoping literature review documenting the literature on cognitive load, VR, and schizophrenia and (b) describe the study protocol of an upcoming experiment on the usability of adaptive VR environments designed for cognitive remediation in people diagnosed with schizophrenia. The themes emerging from the scoping review guided the selection of extraneous cognitive loads that will be tested in 12 VR scenarios.

1. INTRODUCTION

1.1. Scoping review

Immersions in virtual reality (VR) can be used for several applications, including training cognitive skills in people with mental disorders such as schizophrenia. Artificial Intelligence (AI) uses several techniques to uncover patterns in data, which can include biosignals (e.g., heart rate, skin conductance, pupil dilation, facial muscles). Such patterns can then be used to infer the cognitive load of users immersed in VR and adjust the VR stimuli in real time to optimize cognitive remediation scenarios in people diagnosed with schizophrenia. Before introducing AI into VR-based cognitive training, it is important to use an evidence-based approach informed by current VR and cognitive training research. This review should identify strategies for creating VR environments that adjust cognitive loads dynamically, offering an optimal remediation training for individuals diagnosed with schizophrenia.

The scoping review examined peer-reviewed publications in the SCOPUS citation and abstracts database from 1995 to March 2024. The keywords "virtual reality" and "cognitive load" were used for a search within the fields "Article title, Abstract and Keywords", which yielded 737 publications. The search was refined to look for any publication containing the word "schizophrenia". This search revealed 18 documents and one of these articles was rejected as a duplicated publication. All 17 publications were systematically reviewed and independently rated by co-authors (EB, AK, and SB) to document information about schizophrenia and emerging topics in the published literature. Among the articles, a few (n=8) studies were conducted on clinical samples [Parkinson's disease (n=3), ADHD (n=2), autism spectrum disorder (n=1), learning disabilities (n=1) and sleepwalking (n=1)]. No study has been conducted on people diagnosed with schizophrenia. Schizophrenia was mentioned in the articles to document the relevance of VR (n=5), the relevance of cognitive processes (n=5) or for other reasons (n=6) irrelevant to our research topic (such as author's affiliation or to reference a methodological procedure). Most studies (n=11) focused on the consequences of cognitive load on users' performance while immersed in VR, and all confirmed its impact on users. Only a few of the identified publications (n=3) focused on adaptive VR systems targeting cognitive load, and they were all recent studies. A few studies (n=3) mentioned practical information that can impact the development of our VR system, such conceptual clarifications (e.g., intrinsic cognitive load referring

to load arising from the nature of the task itself, vs extraneous cognitive loads referring to additional unnecessary load caused by contextual events) or specific examples.

In sum, the scoping review confirms the lack of published work on using adaptive VR tools based on cognitive load and dedicated to the cognitive training of people diagnosed with schizophrenia. Designing adaptive VR based on cognitive load seems to be gaining popularity, and the empirical study we propose is innovative. A few studies provided helpful, practical suggestions for developing the VR training environment.

1.2. Study protocol

As illustrated in Figure 1 below, three VR environments have been developed to implement cognitive remediation in people diagnosed with schizophrenia: (a) a restaurant where the user is a server taking dinner orders from customers, (b) a city where the user must take different bus routes and commute to exit at a variety of destinations, and (c) an apartment where tasks and social interactions require increasingly complex skills. Each VR environment has four levels of tasks that increase cognitive difficulties due to intrinsic cognitive load, for a total of 12 scenarios.

Figure 1. *Screenshots of three VR environments designed for cognitive remediation training: a restaurant (left), a city (centre), and an apartment (right).*

Our proposed research project will use four biosignals (i.e., heart rate, skin conductance, pupil dilation, facial expressions) recorded in real-time during immersions with an HTC VIVE Pro to adapt the stimuli and the environment to create extraneous cognitive loads as a function of the user's intrinsic cognitive load. For example, increasing ambient noise when performance on a memory task becomes sufficiently good. Algorithms are currently being implemented with biomarkers, and various extraneous cognitive loading factors are being designed to vary within all 12 levels of intrinsic cognitive challenges. Their usability and efficiency as modulators of cognitive load will be assessed according to the protocol summarized below, to be tested in the coming year.

The objective is to document the usability of an adaptive VR system using cognitive load to adjust cognitive remediation training challenges designed for people diagnosed with schizophrenia. A sample of 15 adults will complete all VR environments and their levels of difficulty (intrinsic cognitive load), with extraneous cognitive load varying in real time based on their biomarkers. All four levels of the VR environments will be completed in the intended increased order of difficulty, but participants will be immersed in each of the three VR environments in a randomized order. The following measures will be administered after each of the three immersions: (a) the System Usability Scale (Brook, 2013), which measures the efficacy of the adaptive VR environment, its efficiency and users' satisfaction; (b) the Simulator Sickness Questionnaire (Kennedy et al., 1993); (c) the ITC-Sense or Presence Inventory (Lessiter et al., 2001); and (d) the State-Trait Anxiety Inventory (Spielberger, 1983).

The poster presentation will illustrate the scoping review results and detail the study protocol to register it before beginning data collection.

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Awards

Best Paper award

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William Farr

External Fine Motor Markers of Neurodivergence: Pilot Results of the TangiBall

Nominee

Kathryn Devlin

Virtual Reality Driving Simulation May Enhance the Prediction of Real-World Unsafe Driving

Nominee

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Nominee

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Best Poster

Esra Bayısın & Asmar Khalilli

Using artificial intelligence to model cognitive load and adapt challenging tasks during immersions in virtual reality: Phase 1 – a literature review and study protocol for people diagnosed with schizophrenia

Industry Panel and Demos

Industry Panel on Virtual Reality in Mental Health and Rehabilitation: Trends, Challenges, and Preventing Entropy!

Moderator: Skip Rizzo, Ph.D., University of Southern California

Panelists:
Amir Bozorgzadeh, Virtuleap
Giorgio Koppehele, Magic Horizons
Stephane Bouchard , President and CEO, In Virtuo
Jan Hrdlička, Co-Founder and CEO, ComGuide
Gareth Walcom, CEO, withVR

Join us for an illuminating panel discussion featuring leading experts from the Virtual Reality (VR) industry, who are at the forefront of innovation in mental health and rehabilitation. This distinguished panel will delve into the latest trends and challenges shaping the landscape of VR applications in therapeutic settings. As VR technology continues to evolve, its transformative potential in mental health care and rehabilitation has become increasingly evident. Our panellists will explore cutting-edge advancements, coming up with a successful business model, share insights on integrating VR into clinical practice, and address the obstacles faced in expanding access to these groundbreaking interventions. This session promises to offer valuable perspectives for clinicians, researchers, and technology developers dedicated to enhancing mental health and rehabilitation through virtual reality.

Virtuleap

Virtuleap combines neuroscience and virtual reality to help increase attention levels, and address cognitive illnesses, disorders, and learning challenges. Their flagship product, Enhance VR, is a library of VR exercises designed by neuroscientists in order to test and train a range of cognitive abilities and make that data accessible through an enterprise platform. Amir Bozorgzadeh is co-founder and CEO at Virtuleap, a VR startup that unlocks neuroscience with virtual reality to help increase attention levels, and address cognitive illnesses, disorders, and learning challenges. Previous to Virtuleap, Amir founded Gameguise, a mobile games studio based in Dubai, and Time Dirham the first social impact startup to introduce time banking to the Middle East. He is an alumni of York University and THNK School of Creative Leadership. Amir has been a contributing writer to tech blogs like VentureBeat and Tech Crunch on the topics of emerging tech, spatial computing, and startup ecosystems. Magic Horizons Magic Horizons has developed a unique holistic platform of Mental Health Virtual Reality (VR) applications (360 videos and interactive games) for mental relaxation, calming, distraction, training and strengthening mental resilience. All is based on scientific research and a study by Humboldt-University, Berlin, Germany for Magic Horizons. Magic Horizons also cooperates with other international universities like Kings' College, London and the NHS Cambridgeshire. The Magic Horizons VR software is a CE certified medical product class 1.

Our main verticals are:

- Elderly Care: virtual trips and employee wellbeing for the staff
- Hospitals: calming and distracting patients while unpleasant treatments and employee wellbeing for the staff.
- Employee Wellbeing: for social facilities and large corporates

Homepage: `https://virtuleap.com`

Magic Horizons

VR applications and the VR platform have a holistic approach: 85 VR applications ranging from real nature to beautiful CGI worlds up to interactive brain trainings - Real nature experiences in 360 degrees and 3D: beautiful beaches, green forests and jungles, swimming with dolphins and many more - Binaural beats for deep relaxation: from delta waves for better sleep to gamma waves for new mental energy - Guided meditations, breathing exercises, help falling asleep, body relaxation and many more - Interactive relaxation exercises, resilience training and hand/eye coordination, kinesiology exercises - Fantasy journeys, visiting the Moon or Mars, gaining new mental energy, relaxing dream worlds, fairy tales and many more - 6K content for outstanding picture quality - 10 hours+ preset playlists and individual user playlists that you can create yourself ranging from deep relaxation up to gaining new mental energy - 150 training units for employees with integrated training plan - 1 year pre-programmed in the VR glasses with 3 x weekly use of the training plan.

Homepage: `https://magic-horizons.com/en/`

IN VIRTUO

IN VIRTUO was born in 2008 as a spin-off company from the work done by VR pioneer Stéphane Bouchard and his team at the Cyberpsychology Lab of UQO and the Universite du Quebec en Outaouais (UQO). Virtual environments developed for clinical and research purposes are made accessible via IN VIRTUO, allowing the team to offer high-quality virtual reality software (3D and interactive) to health professionals to assist them and their patients during exposure and other emotion-related exercises used in cognitive-behavior therapy. The software is compatible with all immersive devices running on the OpenXR standards (e.g., Meta/Oculus, HTC Vive, Pico, HP, etc.). We are also providing consultant and training services. IN VIRTUO's products represent evidence-based VR developed by and for clinicians and backed-up by science thanks to research done by our team since 1999.

Homepage: `http://invirtuo.com/en/`

ComGuide

ComGuide was created as an extension of the original company 3dsense located in the Czech Republic. The company is dedicated to the development of virtual applications where healthcare professionals can practise difficult communication. Our VR-based training places a strong emphasis on emotional engagement and provides a structured set of key learning points to empower healthcare professionals in their daily practice. It adapts to individuals' schedules, ensuring convenience and accessibility. It offers a distinctive opportunity to repeatedly practise challenging scenarios without any harm to real patients, fostering skill development and confidence. The team includes VR developers and clinicians and works closely with scientists and clinicians from several clinical facilities and medical faculties.

Homepage: `https://comguide.cz`

withVR

We provide customisable virtual reality speaking situations to support speech therapists and researchers in empowering individuals to use their beautiful voices. We work with Google Orange and other leading companies to bring our award-winning VR tools to stuttering, aphasia, autism, dysarthria and more. Come and try our software at our booth! We'd LOVE to chat and see how you can gain value from our software tool.

Homepage: `https://withvr.app`

Company Demos

Technomex

X Visio PRO (medical device) is a tool utilising immersive virtual reality technology to support professionals such as physiotherapists; occupational therapists; psychologists and psychotherapists (clinical psychology cardiology neurology psychiatric rehabilitation orthopedics); and neuropsychologists. It aids in the therapy of among others: seniors adults with neurological conditions (strokes and brain injuries, Parkinson's Disease, Multiple Sclerosis), adults with orthopedic conditions, adults and children (over 13 years old) with emotional-motivational disorders and children over 13 years old with orthopedic and neurodevelopmental conditions such as Cerebral Palsy.

Presenter: Bogusława Łysakowska-Będek
Homepage: `https://technomex.eu`

VR LIFE s.r.o.

VR LIFE is producer of VR Vitalis ® Pro application. The application is intended for physiotherapists and doctors as a supplement for various types of rehabilitation. VR Vitalis ® Pro is a certified medical device. The innovative application is specifically designed with the needs of professional rehabilitation departments in mind. It combines traditional rehabilitation techniques with the unique capabilities of virtual reality. VR Vitalis ® Pro increases the quality of care provided while reducing the operating costs of the healthcare facility.

Presenter: Marie Němcová
Homepage: `https://vrvitalis.cz/en/`

ComGuide

Virtual Reality for Practicing Difficult Conversations in Healthcare: Comguide is a startup that develops avatars for training and practising difficult communication in healthcare settings. Our target populations are healthcare professionals and students.

Presenter: Jan Hrdlička & Jiří Wild
Homepage: `https://www.comguide.cz`

VRspace

VR burns: The main aim of the intended project is to reduce feelings of procedural pain (when changing bandages) in burn patients through a developed and pilot-verified application for VR. For more information visit: `https://vrburns.eu/`

Presenter: Martin Zielina & Zbyněk Pohořelský
Homepage: `https://vrspace.cz`

Magic Horizons

Magic Horizons - a unique One Stop solution for Mental Health in Virtual Reality (see also Panel discussion)

Presenter: Giorgio Koppehele & Suna Koppehele
Homepage: `https://magic-horizons.com`

withVR

Therapy and Research withVR: We provide customisable virtual reality speaking situations to support speech therapists and researchers in empowering individuals to use their beautiful voices.

Presenter: Gareth Walkom
Homepage: `https://hello.withvr.app`

Somnium Space

VR1 PCVR headset Social VR Platform: Somnium Space is a pioneering company that develops an immersive Social VR world while also advancing VR hardware with our innovative VR1 headset, providing users with a seamless and fully integrated virtual reality experience.

Presenter: Artur Sychov
Homepage: `https://somniumspace.com`

Risk Environment Simulator (RES©)

Risk Environment Simulator (RES©) - a virtual reality serious game on the principle of cue-exposure therapy (CET) for the treatment of alcohol use disorders (AUD): Cue-exposure therapy (CET) in the treatment of dependence is a behavioral procedure consisting of repeated exposure to triggers related to the use of addictive substances without inducing the experience of reward. The goal is the gradual extinction of conditioned reactions to the relevant stimulus. Risk Environment Simulator (RES©) is a serious game from a first-person perspective to imitate an ordinary Czech pub with different types of real-world inspired cues. The idea behind RES development was to mediate a potentially risky experience based on cue exposure to persons, who are treated in a safe environment of hospitalisation. According to our previous experience, there is a tendency to overestimate individual resilience to different "risky" cues during hospitalisation in the population of AUD patients. RES could be a tool bringing a serious game with different types of "unsafe" cues to the "safe" environment of hospitalisation. The scenario of this game is based on a meeting with a friend in a pub. The person who enters the virtual world has no choice, the meeting must take place in a pub, which in principle represents a risky environment for people with a diagnosis of AUD. There are different types of cues in RES, such as proximal cues (grasping a glass of drink, simulation of drinking an alcoholic drink), contextual cues (pub equipment, pub noise, people consuming alcohol) and social cues (meeting with a persuasive, rationalising or manipulative avatar).

Presenters: Petr Hořejší
Matěj Dvořák
Jiří Podlipný
Homepage: `https://www.fst.zcu.cz`
`https://lfp.cuni.cz/en/`

CIIRC CTU - Natural Human-Robot Interaction

Human communication consists of many multimodal signals, such as speech, gestures, and gaze direction. We therefore designed an experiment focused on these three modalities within virtual reality, which serves as an effective replica of the complex real world. The design of the experiment was set in the iGibson simulation environment, where participants were tasked with teaching the robot to recognise concepts, colors, and more using pointing gestures and speech, ultimately enabling it to prepare a salad. The experiment was recorded in VR. Our goal was to determine the relationship between gestures and speech, the time interval between them, and then create a multimodal fusion scheme that would allow us to integrate these insights into a real robot.

Presenter: Karina Zamrazilova, Michal Vavrecka
Homepage: `https://www.ciirc.cvut.cz`

Center for Virtual Reality Research in Mental Health and Neuroscience - National Institute of Mental Health

Virtual Reality for psychotherapy in anxiety disorders and OCD: Virtual Reality for psychotherapy in anxiety disorders and OCD. Our projects aim at utilisation of VR in the context of mental health care, with an emphasis on exposure and relaxation techniques that have their place in cognitive behavioural therapy (CBT) for anxiety disorders. Several therapeutic tools using immersive VR technology will be introduced. 1) VRETcity created in collaboration with CIIRC CTU for exposure therapy of specific phobias, social phobias and agoraphobia, 2) MRI simulation, 3) OCD house applied to obsessive-compulsive disorder in the form of exposure with response prevention, and 4) relaxation method BreezeTerraVR applying mindfullness and deep rhythmic breathing techniques.

Presenter: Iveta Fajnerová, Karolína Zuzánková, Markéta Jablonská
Homepage: `https://brainvr.cz/en/`
`https://www.nudz.cz/en/`

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