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Clinical Education Innovation Enabled by XR Space Medicine Technology

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Illness perception focuses on how an individual mentally frames and experiences living with a disease (Weinman & Petrie, 1997). These patient perceptions have been shown to be immensely important and have been shown to be associated with functional recovery, treatment adherence and even hospital re-admission rates (Petrie et al., 2007; Sawyer et al., 2019). While patient perceptions are clearly important, most physicians rarely ask patients about the patient's perception or their ideas about of their condition (Waisberg et al., 2023a). We propose a novel method using extended reality for clinicians to gain an understanding of medical conditions from the patient's perspective with the goal of fostering an increase in clinician empathy.

Clinician empathy is a key aspect of professionalism in medicine and is a symbol of patient care at its best. Empathy in the context of healthcare, can be defined as a predominantly cognitive attribute that requires an understanding of the perspective of a patient and their concerns and experiences, while conveying this understanding to the patient with an intention to ameliorate the problem. The benefits of increased clinician empathy are manifold, from protecting against professional burnout and stress, to improving patient compliance, clinical outcomes and reducing complications (Hojat et al., 2017).

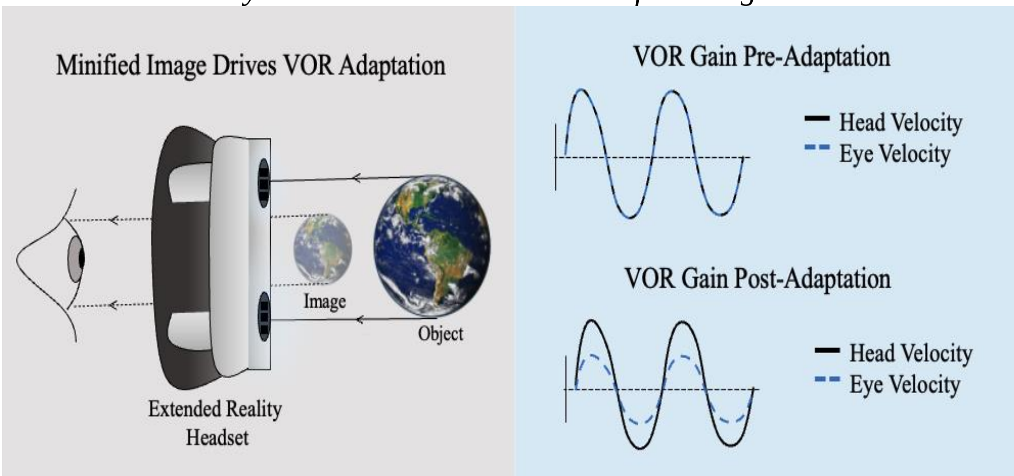
Previous research to improve clinician understanding of patient perceptions was conducted with the help of "healthcare simulation-based enactement." This simulation process in the involvement of educators, clinicians and patients together, with the goal of reinforcing the personal experience of each patient at every clinical encounter (Kneebone et al., 2016). Clinicians that attended these simulation-based enactements reported that they gained new insights on patient concerns as a result of this process.

Head-mounted extended reality (XR) has recently emerged as a powerful tool in medical education for simulation of clinical and surgical situations (Masalkhi et al., 2023; Waisberg, 2023b). Another potentially powerful clinical tool of XR may be to help clinicians further understand disease from the patient's perception. At the moment, there is very little literature on this utilization of XR for this type of education in the clinical space. These tools can be built upon simulating physiology to help develop a stronger sense of empathy and deepen clinician-patient rapport.

In our work to develop a training tool for astronauts undergoing interplanetary gravitational transitions, we identified a unique opportunity to also develop this emerging tool for clinicians specializing in vestibulo-ocular disease (Waisberg et al., 2022b) This XR program allows clinicians to experience a visual simulation of vestibulo-ocular impairment by utilizing a minifying lens effect (Figure 1).

Figure 1

The Extended Reality Headset can Produce a Minified Image in Real-Time



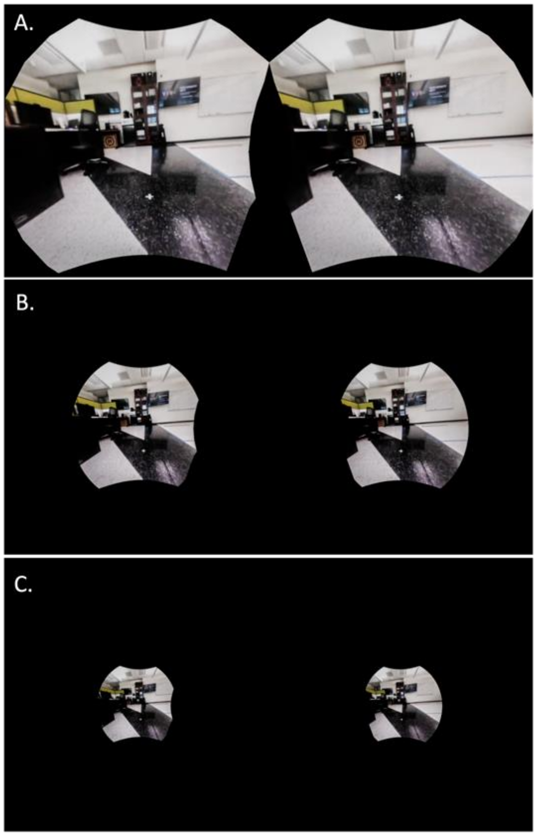
Note. Vestibulo-ocular (VOR) gain is normally in sync, but when the image is minified, a decreased eye velocity is required relative to head velocity.

Patients with vestibular disease commonly experience visual symptoms such as oscillopsia and motion sickness. Dizziness and vertigo affect approximately 18% of adults in population-based studies (Neuhauser, 2016). The synergistic interaction between the visual system and vestibular system is required for optimal visual acuity while in motion, with the vestibulo-ocular reflex playing a key role in gaze stabilization. Over the past 10 years, several epidemiological studies have examined the prevalence of vestibulo-ocular diseases by specific disorder and by symptom. The prevalence of dizziness has an increased correlation with age, and is twice as prevalent among women (Neuhauser, 2016). Beyond dizziness, imbalance is another disorder of the vestibulo-ocular system that can impair quality of life. Patients with vestibular dysfunction who reported symptoms of dizziness had a twelve-fold increased incidence of falls, which can be catastrophic for older individuals (Agrawal et al., 2009).

Dynamic visual acuity (DVA) has been observed to be decreased in astronauts after returning to a 1G environment, which can be a large risk for interplanetary missions when astronauts must continue to carry out mission-specific tasks after landing in a different gravitational environment (Waisberg, 2023c). Simulation of these scenarios of decreased DVA can help with astronaut training and understanding of these effects prior to their mission. In previous NASA-funded studies, minifying lenses (fixed 50% decrease) have been utilized to simulate the vestibulo-ocular state of returning astronauts due to gravitational transitions, although this has never yet been performed in XR (Rosenberg, 2017). The XR framework produces a minified image, which can be adjusted to increase the level of vestibular dysfunction to be induced (Figure 2). This can be utilized for both astronaut training and also for clinicians to understand the vestibular dysfunction from a patient's perception (Figure 3). When the visual field of a participant is minified, the subject's eye velocity becomes incongruent with their head velocity (Sehizadeh, 2005). This may result in symptoms such as oscillopsia and retinal slip may occur following head movement. XR also allows the level of minimization to be adjusted; as greater levels of minimization are used, vestibulo-ocular adaptation requirements increase. This level of simulated vestibulo-ocular impairment can be finely adjusted to match the level experienced by patients with vestibular disease to further understand how they perceive the world.

Figure 2

Minified Extended Reality, Showcasing Different Levels of Minimization



Note. Levels of minification include A. none, B. 50% minimized, and C. 75% minimized.

Figure 3

Individual Experiencing Minified Extended Reality

Note. Our framework works with the majority of VR/AR headsets and can be set up with minimal expertise to ensure ease-of-use for clinicians.

With populations aging worldwide, diagnosis and understanding the patient perception of vestibular disease becomes even more important as individuals aged 50 and over are most likely to present to a doctor for dizziness (Agrawal et al., 2009). A diagnosis of vestibular disease is currently a complex process, requiring a neurology specialist, detailed clinical history, neurologic investigations, medical investigations, and neuro-otologic investigations. Understanding the patient perception of vestibular disease with virtual reality can be useful for a clinician to fully comprehend the visual symptoms that a patient is experiencing. The various benefits of such system in the clinical setting are yet to be explored, but a deeper understanding of the patient's symptoms and potentially new-founded empathy are anticipated.

This work is a component of a developing NASA-funded, head-mounted multimodal visual assessment framework to assess for subtle changes in astronaut vision (Ong et al., 2022a, 2022b; Waisberg, 2022a). As part of this work, we have developed a novel XR-based dynamic visual acuity (DVA) assessment in virtual reality (Waisberg, 2022b). DVA assessment has been previously shown to be a fast and effective way to detect peripheral vestibular dysfunction.

XR serves as a promising tool to help further understand patient perception of disease and may one day serve as a useful countermeasure for both individuals on Earth and in space. By clinicians simulating the patient perception of disease in extended reality, clinicians can gain useful insights into the experiences of their patients. Continued research will be required to examine how these insights translate to increases in the level of clinician empathy.

Compliance with Ethical Standards: This article does not contain any studies with human participants performed by any of the authors.

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Conflict of Interest: None

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