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Elders' experience with augmented gaze: preliminary observations

Introduction

Among the Virtual reality (VR) applications for elders, virtual biking has to potential to significantly contribute to healthy aging (Anderson-Hanley *et al.*, 2011; Pedroli *et al.*, 2018; Arlati *et al.*, 2019; Høeg *et al.*, 2021; Rutkowski *et al.*, 2021; Ortet *et al.*, 2022). Virtual biking is an exertion game (exergame) that combines physical activity with digital multisensory experience, where users pedal on a cycle ergometer while wearing a Head-Mounted Display (HMD) showing a 360-degree environment of a bike ride.

Not being oriented to agonistic activity, elders may appreciate other aspects of virtual biking, such as for example the pleasure to look around for curiosity. However, many elders may not be able, or willing, to easily or frequently or widely turn their head around because of possible neck or torso motor difficulties (Ramiro *et al.*, 2015), or simply because the normal habit during biking is to look straight ahead. Therefore, a system that enables users to immersively explore large portions of the visual field with small head turns (augmented gaze, i.e., amplified visual rotation contingent to head rotation) should facilitate active visual exploration (Ragan *et al.*, 2017).

However, the potential benefit of an improved "visual usability" conferred by augmented gaze should be evaluated against possible negative side-effects, as the visuo-motor mismatch deriving from the amplification of the visual reafference of head rotation may not be well accepted (Fernandez-Ruiz *et al.*, 2000; Seidler, 2006; Seidler *et al.*, 2010; Golding, 2016; Howard & Van Zandt, 2021). Thus, the purpose of this preliminary study is to investigate whether augmented gaze can be utilized to increase the visual field of regard of older adults without discomfort (Jang *et al.*, 2016).

Methods

Participants. Ten participants (3 males, mean age 88.2 ± 4.9 years) took part to the study. They were recruited through convenience sampling inside an assisted

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living facility ("RSA San Giuseppe", Milan, Italy), where the study was conducted. The study was approved by the Milan University ethical committee.

Procedure. Participants were seating on a chair or a (stabilized) wheel-chair and had to pedal on a cycle ergometer while wearing an HMD (HTC Vive) displaying a pre-recorded biking clip under immersive conditions. The videoclip speed was not synchronized with the cycling cadence. Two biking video clips were used, both showing a bike ride through Copenhagen. Footage (3D, 4K@30fps) was taken with a 360-degree camera (Insta 360 Pro 2) mounted on the frontal seat of a trishaw bike. Participants were administered three sessions of virtual biking on three consecutive days (max 9 minutes each). Each session had a different visuo-motor gain (henceforth gain): 1.0, 2.0 or 3.0. The former represents the natural gain (visual rotation mapped 1:1 to head rotation), whereas the other two gains implement augmented gaze, obtained by linearly amplifying head rotation to yield 2-fold and 3-fold visual rotation, respectively. In this study, only the horizontal rotational component was amplified with augmented gaze (yaw, world coordinates). At the end of each session, participants rated overall satisfaction, motivation, sense of presence, and perceived safety. All responses were given on a 5-point numerical rating scale, and the questions were formulated as follows: 1) "How much did you like this experience?"; 2) "How much would you repeat this experience?"; 3) "How much did you feel like being really biking outdoors?"; 4) "How much did you feel safe during virtual biking?", where 1 represented no sensation at all and 5 represented full sensation, the other ratings indicating intermediate levels. For each participant and each gain condition, the four individual ratings were averaged into a global user experience index.

Data analysis. The user experience index was analysed through a mixed-models approach, with gain, age and gender as fixed factors, and participants as random factor (intercept and slope). The index distributions at each gain value did not depart significantly from normality, as assessed with the Shapiro-Wilk test.

Results

Participants appeared to be quite happy to perform the task, as inferred from informal conversations. This positive impression was confirmed by the satisfaction, motivation, presence, and safety ratings, which were on average very high (3.87±1.008 SD, 3.87±1.252 SD, 3.87±1.479 SD and 4.03±1.217 SD, respectively). Crucially, gain did not significantly affect the global user experience index, and neither did participants' age and gender (**Tables 1** and **2**).

Table 1. Global user experience index as a function of gain. Means and standard deviations across subjects are reported.

	Gain = 1.0	**Gain = 2.0**	**Gain = 3.0**
M	3.767	3.833	4.000
S.D.	1.112	1.009	1.066

Table 2. Results of the mixed-models analysis on the global user experience index. Upper bound and Lower bound are the 95% confidence limits.

	Slope	Lower bound	Upper bound	T-stat	Degrees of freedom	P-value
AGE	0.023	-0.097	0.144	0.400	26	0.693
GENDER	-0.368	-1.624	0.889	-0.601	26	0.553
GAIN	0.117	-0.190	0.423	0.782	26	0.441

Discussion

Despite the small sample size of this preliminary study, which obviously limits the strength of evidence, user experience ratings (satisfaction, motivation, sense of presence and perceived safety) were on average very high, thus pointing to high acceptance of this virtual biking experience by elders. The lack of effect of age and gender on the user experience index go in the same direction: they do not seem to weaken acceptance of virtual biking. Unfortunately, we could not find other result in literature on these effects (also pertaining to gain) with elderly subjects and future research will need to expand upon the matter. The lack of age effect is worth noting because, despite the increasing number of studies where VR is used with older adults, the age of the tested participants is not always very high, and only few studies tested VR applications inside assisted living facilities. Considering our participants' sample, this study represents a high-end reference.

Another consideration is that no clear signs of user experience worsening emerged with augmented gaze (gain > 1). Even though a larger sample may ultimately turn out to detect a statistically significant effect, it appears that it would be a weak effect. This is important because it is not known how elders react to a strong visuo-motor mismatch such as augmented gain (Fernandez-Ruiz *et al.*, 2000; Seidler, 2006; Seidler *et al.*, 2010; Golding, 2016; Howard & Van Zandt, 2021). Our data argue for a lack of impact, or a minor impact, of augmented gaze on elders' subjective acceptance. Whether this relatively good acceptance of augmented gaze, as opposed to its potential rejection, depends on elders' tendency to optic flow sensory seeking (de'Sperati *et al.*, 2022), a decreased general sensitivity in the older population (Engel-Yeger & Rosenblum, 2021), or a genuine appreciation of the advantages of augmented gaze in terms of increased "visual usability", should be the focus of future studies.

Abstract

Research on elders' acceptance of virtual technologies is much needed. Here we studied the user experience of elders (N = 10, mean age = 88.2 years) during virtual biking, an exergame where participants pedal on a cycle ergometer and wear a Head-Mounted Display that provides them an immersive experience of a bike ride. We tested the effects of

augmented gaze on user experience. Augmented gaze is a condition in which horizontal head turns yield amplified visual shifts, which is assumed to facilitate visual exploration. User experience was measured by asking participants to rate satisfaction, motivation, sense of presence and sense of safety. We found a very good acceptance of virtual biking and no signs of negative effects of augmented gaze. These preliminary observations suggest that augmented gaze may be a viable optimization of elders' experience with certain virtual reality applications.
Keywords: Healthy aging, Virtual biking, Augmented gaze, Technology acceptance.

References

Anderson-Hanley, C., Snyder, A.L., Nimon, J.P. & Arciero, P.J. (2011) Social facilitation in virtual reality-enhanced exercise: competitiveness moderates exercise effort of older adults. *Clinical Interventions in Aging*, 6, 275-280.

Arlati, S., Colombo, V., Spoladore, D., Greci, L., Pedroli, E., Serino, S., Cipresso, P., Goulene, K., Stramba-Badiale, M., Riva, G., Gaggioli, A., Fserrigno, G. & Sacco, M. (2019) A Social Virtual Reality-Based Application for the Physical and Cognitive Training of the Elderly at Home. *Sensors (Basel)*, 19.

de'Sperati, C., Granato, M. & Moretti, M. (2022) If You Are Old, Videos Look Slow. The Paradoxical Effect of Age-Related Motor Decline on the Kinematic Interpretation of Visual Scenes. *Frontiers in Human Neuroscience*, 15, 783090.

Engel-Yeger, B. & Rosenblum, S. (2021) Executive dysfunctions mediate between altered sensory processing and daily activity performance in older adults. *BMC geriatrics*, 21, 132.

Fernandez-Ruiz, J., Hall, C., Vergara, P. & Diiaz, R. (2000) Prism adaptation in normal aging: slower adaptation rate and larger aftereffect. *Brain Res Cogn Brain Res*, 9, 223-226.

Golding, J.F. (2016) Motion sickness. *Handb Clin Neurol*, 137, 371-390.

Høeg, E.R., Bruun-Pedersen, J.R., Cheary, S., Andersen, L.K., Paisa, R., Serafin, S. & Lange, B. (2021) Buddy biking: a user study on social collaboration in a virtual reality exergame for rehabilitation. *Virtual Reality*, 1-18.

Howard, M.C. & Van Zandt, E.C. (2021) A meta-analysis of the virtual reality problem: Unequal effects of virtual reality sickness across individual differences. *Virtual Reality*, 1-26.

Jang, W., Shin, J.H., Kim, M. & Kim, K.K. (2016) Human field of regard, field of view, and attention bias. *Comput Methods Programs Biomed*, 135, 115-123.

Ortet, C.P., Veloso, A.I. & Vale Costa, L. (2022) Cycling through 360 degrees Virtual Reality Tourism for Senior Citizens: Empirical Analysis of an Assistive Technology. *Sensors*, 22.

Pedroli, E., Greci, L., Colombo, D., Serino, S., Cipresso, P., Arlati, S., Mondellini, M., Boilini, L., Giussani, V., Goulene, K., Agostoni, M., Sacco, M., Stramba-Badiale, M., Riva, G. & Gaggioli, A. (2018) Characteristics, Usability, and Users Experience of a System Combining Cognitive and Physical Therapy in a Virtual Environment: Positive Bike. *Sensors*, 18.

Ragan, E.D., Scerbo, S., Bacim, F. & Bowman, D.A. (2017) Amplified Head Rotation in Virtual Reality and the Effects on 3D Search, Training Transfer, and Spatial Orientation. *IEEE Transactions on Visualization and Computer Graphics*, 23, 1880-1895.

Ramiro, S., van Tubergen, A., Stolwijk, C., van der Heijde, D., Royston, P. & Landewe, R. (2015) Reference intervals of spinal mobility measures in normal individuals: the MOBILITY study. *Ann Rheum Dis*, 74, 1218-1224.

Rutkowski, S., Szary, P., Sacha, J. & Casaburi, R. (2021) Immersive Virtual Reality Influences Physiologic Responses to Submaximal Exercise: A Randomized, Crossover Trial. *Front Physiol*, 12, 702266.

Seidler, R.D. (2006) Differential effects of age on sequence learning and sensorimotor adaptation. *Brain Res Bull*, 70, 337-346.

Seidler, R.D., Bernard, J.A., Burutolu, T.B., Fling, B.W., Gordon, M.T., Gwin, J.T., Kwak, Y. & Lipps, D.B. (2010) Motor control and aging: links to age-related brain structural, functional, and biochemical effects. *Neurosci Biobehav Rev*, 34, 721-733.

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