Relationship between age, postural balance and cybersickness during repeated exposure to virtual reality

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Key points

- Sensorimotor aging and VR HMD
- Cybersickness and postural sways outcomes
- Standing with HMD on a force platform while exposed 5 times to the same VE
- Higher cybersickness with repetition not correlated to age
- Decreased postural sways starting from the second repetition
- Significant negative correlation between postural oscillations and cybersickness at the 5th exposure.
- Towards postural stiffening also known as "VR lock"?

BACKGROUND

Immersive Virtual Reality (VR) systems are attracting particular interest to modify postural dynamics at least in the short term (Fransson et al., 2019; Litleskare, 2021). The visuo-vestibular conflicts created are used to reduce the risk and the fear of falling in the elderly (Phu et al., 2019). Sensory-motor aging is characterized by larger body excursions. Indeed, Wiesmeier, Dalin & Maurer (2015) have shown that sways were more important in the anteroposterior axis in the elderly. Moreover with advancing age, a slowing down of sensory reweighting occurs during disturbances, notably visual (Eikema, et al . 2012).

According to Weech, Calderon & Barnett-Cowan (2020), an increase in postural oscillations would show a greater flexibility of the postural regulation system as well as a better ability to adapt to sensory disturbances. Individuals able to dissociate their postural oscillations from visual disturbances would be the most likely not to develop cybersickness. However cybersickness does not seem to increase with age (Dilanchian, Andringa and Boot, 2021; Saredakis et al., 2020). Cybersickness remains one of the major barriers to using VR systems. Studying the effects of aging on postural oscillations and cybersickness could enrich reflections on the interest of using virtual reality systems to stimulate sensory-motor adaptation.

PURPOSE

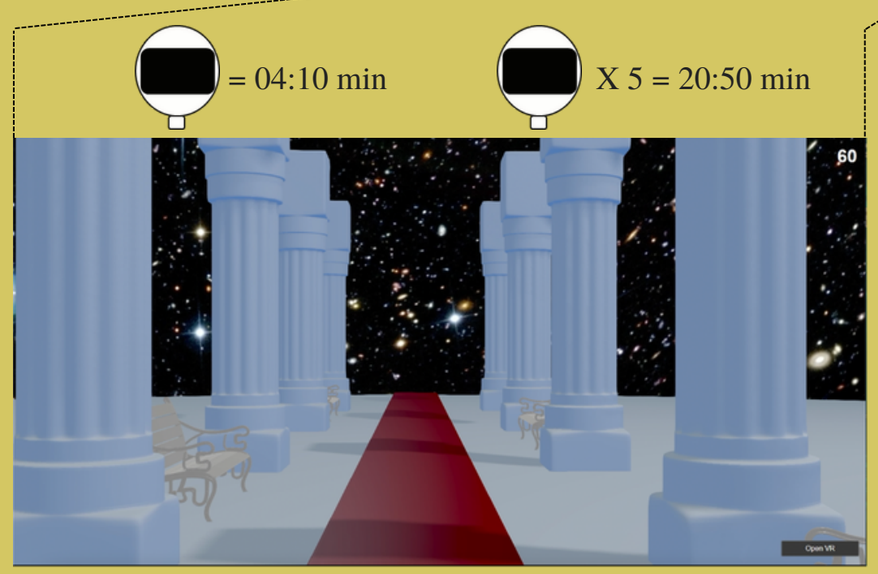
To investigate the effects of sensorimotor aging on balance and cybersickness when using immersive virtual reality.

METHODS & MATERIALS

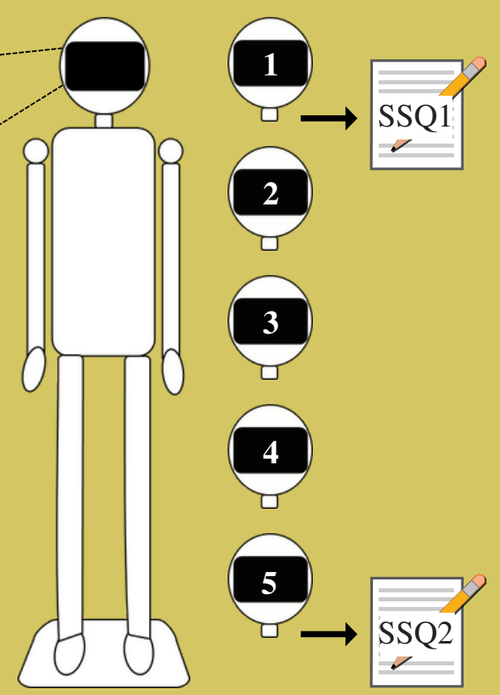
75 participants
Age 21 to 86
M: 42.40 SD: 17.82

Oculus Rift (CV1)

Wii Balance Board



Scan the VE with Halo AR app to see an accelerated video of the virtual environment



Independent variables

Age
Repeated exposure number x 5

Dependent variables

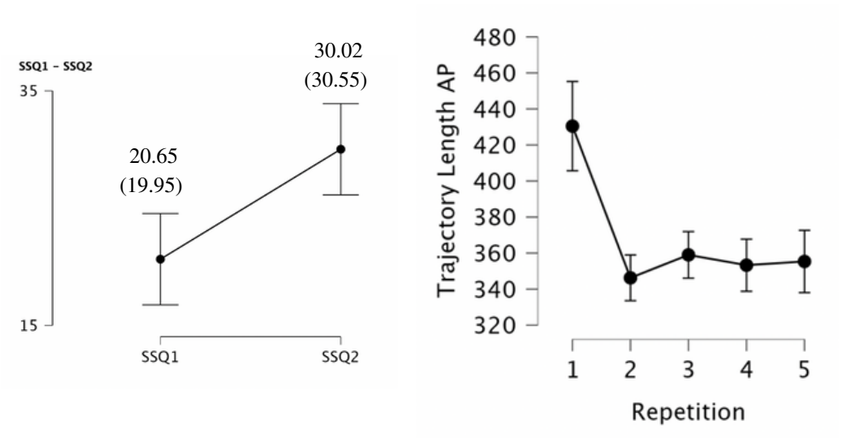
Center of pressure trajectory length in the Anterior-Posterior (AP) axis

Cybersickness severity scores
Simulator Sickness Questionnaire 1 & 2 (SSQ)
Kennedy et al., 1993

RESULTS

Repetition

Cybersickness and postural sways



Posture with cybersickness

Length AP and SSQ1: r(75) = -0.07, p = n.s.
Length AP and SSQ2: r(75) = -0.24, p < .05

Age correlations

... with the control measure

(mean of 5 x 30 seconds without vection in the VE)
Length AP: r(75) = 0.28, p < .05

... with cybersickness

SSQ	r	*p*
1	-0.13	n.s.
2	-0.13	n.s.

... with posture for each repetition

Postural parameter	Repetition	r	*p*
Length AP	1	0.33	< .01
	2	0.39	< .001
	3	0.39	< .001
	4	0.36	< .01
	5	0.33	< .01

Postural adaptation score

Length AP (5) - Length AP (1)

... correlated with age

Length AP: r(75) = -0.12, p = n.s.

Cybersickness score

SSQ2 - SSQ1

... with postural adaptation score

Length AP: r(75) = -0.05, p = n.s.

DISCUSSION

Increase in body excursions were larger with age, particularly in the antero-posterior axis (Wiesmeier, Dalin & Maurer, 2015). Yet the elderly did not seem to be more affected by cybersickness, although sensory reweighting is slower with age. However a postural adaptation took place with the effect of repetition (Fransson et al. , 2019) and this from the second repetition. Cybersickness severity is not related to postural sways at the first exposure but it is at the 5th exposure. Postural oscillations in the anteroposterior axis decrease with an increase in cybersickness. This postural stiffening phenomenon could correspond to that of "VR lock" (Dennison & D'Zmura, 2017). Neither the postural adaptation score nor the cybersickness score is related to age. Does VR have an impact on sensory reweighting, especially with aging? Is VR beneficial for training postural dynamics?

CONCLUSION

Cybersickness severity increased with repetition while postural sways in the anteroposterior axis decreased with repetition.

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