Therapeutic effects of large-field visual virtual immersion on balance control in unilateral vestibular patients
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To cite this version:
Olivier A.J. Martin, Denis Faure-Vincent, Jean-Dominique Gascuel, Sébastien Schmerber, Alina Voda, et al.. Therapeutic effects of large-field visual virtual immersion on balance control in unilateral vestibular patients. ISPGR 2022 - International Society of Posture and Gait Research, Jul 2022, Montréal, Canada. pp.1-1. hal-03737948

HAL Id: hal-03737948
https://hal.archives-ouvertes.fr/hal-03737948
Submitted on 25 Jul 2022

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INTRODUCTION | VR-based balance rehab. relevance?

CLINICAL TRIAL - PATIENTS

- Unilateral vestibular patients (42-80 y.o.; 3 m., 4 f.)
- Visually-induced dizziness (areflexia, chronic recurrent dizziness, vestibular neuritis)
- 8 weeks rehab. period = 1 or 2 rehab. session per week included in the patients care process
- Ethics validation (CPP - voluntary informed patients)

VISUAL STIMULI

- Large-field (panoramic) visual virtual flows
- Standardized optokinetic stimulus
- 8 Optic Flows Stim. : 3D scrolls (Up, Down) + 2D Rotations (Clockwise, Counterclockwise) + 3D Radial expansion.
- 6 flows SPEED (speed ratio from 03 to s18 A.U.)
- Scenario optimized for efficacy on patient: visual-flows constraints increase throughout the therapeutic session: flows pattern (scroll, radial and rotation), stimulation speed increased, gaze anchorage on the visual reference (with/without).

GAZE ANCHORAGE (GA)

- Visual/spatial reference
- With GA: session 1-4; Without GA: session 5-8
- With/ session 9; Without: session 10

PROTOCOL

1. INITIAL BALANCE ASSESSMENT

- Balance posturograms use visual, vestibular and proprioceptive sensory inputs as a neuro-mechanical way. [$]$
- Vestibular deficit increases a halo dependency due to the vestibular sensory suppression [3].

2. VR BALANCE ASSESSMENT

- Automatic sensory and motor compensations (visual-vestibular-motor) to reduce the patients’ visual dependence.

RESULTS | VR immersion ➔ Visual perturbation ➔ Balance restoration

DISCUSSION – CONCLUSION | Rapid VR-based rehab. benefits

At a Clinical/Rehab. level: Positive effects of the “large visual field” immersion on balance restoration

- METH. Patient-related sessions repetition + difficulty-dependent tunable scenarios + patient follow-up + methodical practice through short period (two months)

- BENEFITS. Rapid functional restoration of efficient synergistic control between balance and gaze process.

- PSYCHO. Patients’ motivation and self-confidence!

At a Neuro-functional level: “visual-vestibular-motor” adaptation occurs despite the vestibular deficits

- PROCESS. Reweighting of the visual-vestibular sensory inputs ➔ reciprocal inhibition restoration

- ADAPTATION. Reduction of the visual dependence by visual-vestibular reverse compensation

- Questions about the neural basis of the “visual-vestibular plasticity”

- Sensory adaptive threshold/gain of the VOR and/or OKN?
- Dual sensorimotor plasticity in balance restoration: Interaction MT visual area - vestibular nuclei ➔ visual-vestibular integration for motor command tuning/adjustment

CONCLUSION

- Optimized rehabilitation strategies based on simple virtual visual immersions Vs. standardized rehabilitation protocols (uncontrolled OKS) for unilateral vestibular patient

- Limit: No long-term effects (reported by patients after a six months period) requiring periodic booster sessions

- Our study corroborate the proof of concept of interactive VR-rehabilitation based on a large visual field stimulation device (experimental and clinical validation).