Therapeutic effects of large-field visual virtual immersion on balance control in unilateral vestibular patients
Olivier A.J. Martin, Denis Faure-Vincent, Jean-Dominique Gascuel, Sébastien Schmerber, Alina Voda, Pascal Bellemain

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.science/hal-03737948
Submitted on 25 Jul 2022
INTRODUCTION | VR-based balance rehab. relevance ?

METHODS | The PIVVIT project (Plateforme d’Immersion Visuelle Virtuelle Thérapeutique)

RESULTS | VR immersion ➔ Visual perturbation ➔ Balance restoration

CLINICAL TRIAL - PATIENTS

• Unilateral vestibular patients (42-80 y.o.; 3 m., 4 f.)
• Visually-induced dizziness (areflexia, chronic recurrent dizziness, vestibular neuritis)
• 8 week 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) virtual visual 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 s03 to s28 A.U.)
• Scenario optimized for efficiency on patient : visual-flows constraints increase throughout the therapeutic session : flows pattern (scroll, radial, and rotation), stimulation speed increased, gaze anchoring on the visual reference (with/without).

GAZE ANCHORAGE (GA)

• Visuo-spatial reference
• With GA : session 1-4 ; Without GA : session 5-8
• [With : session 9 ; Without : session 10]

PROTOCOL

• 1 Trial = Visual stimulation
  • Mixture + Fixed - 23 min
• 1 Series = 8 stim. (8 trials)
  • 5 different 10/20-30 visual flows
• 1 Session = 6 Speed
  • 3 fixed & 3 random trials
• 2 Gaze Anchorage cond.
  • Sess. 1 - 4 : With GA
  • Sess. 5 - 8 : Without GA
• 6 trials x 8 stimuli = 48 trials

• 4 phases: Conf. / Pivv / Pivv + Feedback

DATA RECORDING AND ANALYSIS

• Balance control : Center-of-Pressure (Center of Pressure) + CoP Trajectory length ➔ Disequilibrium indicators (lost of balance control, falls)
• Gaze behaviour (Eye-Head-body) stability : BlueGain EOG, 100Hz) ➔ EOG trajectory (preliminary results)

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.
• PSYCHOL. 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 compensations
• 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).


ACKNOWLEDGMENTS. Thanks to all patients, and to the Grenoble University Hospital (CHUGA NET Clinic) – Grant DRCI (Dept. Clinical Research & Innovation) : PIVVIT Project #1045.