Therapeutic effects of large-field visual virtual immersion on balance control in unilateral vestibular patients

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INTRODUCTION | VR-based balance rehab. relevance?

CLINICAL TRIAL - PATIENTS
- Unilateral vestibular patients (42-80 y.o.; 3 m., 4 f.)
- Usually-induced dizziness (arhythmia, 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) + 3D 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 : (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

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

PROTOCOL
- 1 Trial = Visual stimulation
- 5 trials / 20 sessions
- 1 Series = 8 stim. (8 trials)
- 5 different 20/30 visual flows
- 1 Session = 6 Speed
- 8 trials x 6 speed = 48 trials
- 2 Gaze anchorage cond.
  - Sec. 1 - 8 stim. (8 trials)
  - Sec. 5 - 8 stim. (8 trials) = Without GA
  - Sec. 4 - 8 stim. (8 trials) = With GA
  - 6 trials = 15 sessions
- 1 Trial = Visual stimulation
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- 1 Series = 8 stim. (8 trials)
- 5 different 20/30 visual flows
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  - Sec. 4 - 8 stim. (8 trials) = With GA
  - 6 trials = 15 sessions

DATA RECORDING AND ANALYSIS
- Balance control : Center-of-Pressure (COP) board (100 Hz) : CoP Trajectory length... (Results obtained)
- Gaze behavior (Eye-Head-body) stability : BlueGain EDG, 100Hz);
- ISCOM trajectory (preliminary results)
- (Questions/Responses [subjective estimation of “the balance comfort” in every day life tasks])

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” image on balance restoration
- METH. Patient-related sessions repetition + difficulty-dependent tuneable 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 balance in plastic restoration : Interaction MT visual area... vestibular nuclei ➔ visual-vestibular integration for motion command tuning/adjustment.

CONCLUSION


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