Selective sensory strategies in the regulation of upright balance in older adults can be entrained through exposure to sensory conflicts

Nicoleta Bugnariu PhD, PT and Joyce Fung PhD, PT

School of P & OT, McGill University and Jewish Rehabilitation Hospital
CRIR Research Center, Montreal, Canada

McGill

Hôpital Juif de réadaptation
Jewish Rehabilitation Hospital

CRIR
Centre de recherche interdisciplinaire en réadaptation du Montréal métropolitain

Background

- **Conflicting visual and somatosensory stimuli can modulate automatic postural responses in healthy adults** (*Vidal et al. 1982 , Keshner et al. 2004)*
- **Imbalance can arise from:**
  - **age-related sensory-motor declines**
  - **inability to resolve sensory conflicts**
  - **inability to select pertinent sensory information**
- **Balance regulation may be more affected in older adults who rely heavily on vision** *(Keshner et al. 2004)*

Rationale

- **The aging CNS that is slower to adapt** *(Bugnariu & Sveistrup 2005)* **may benefit from intense task-related practice and exposure to varied environments**
- **VR offers a safe and varied environment to practice balance tasks** *(Keshner & Kenyon 2004, Sveistrup 2004)*

Aim

To study the effects of repeated VR exposures on the capability of the aging CNS to resolve sensory conflicts

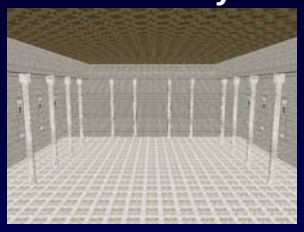
Methods

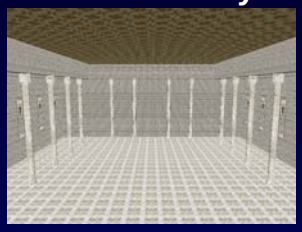
- Healthy older adults (65-75 yrs) were tested for standing balance while immersed in a virtual environment (VE) for 1 hour during which a total of 72 visual and/or surface ramp perturbations of 8° (36°/s) were randomly presented.
- Visual perturbations were induced by sudden movements of a VE viewed through a helmet-mounted display, and combined with or without surface perturbations presented in a direction (pitch/roll/yaw) that was either identical or opposite to the visual perturbation.

Perturbations

Visual only | **Surface only**

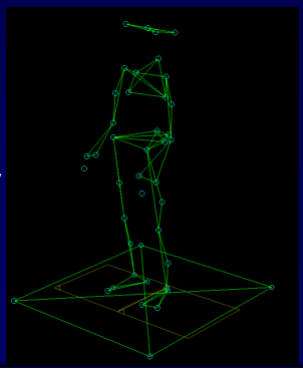
VE pitch down

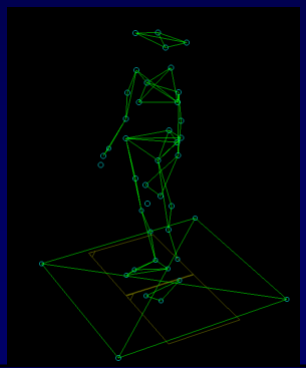




VE stationary

Surface stationary



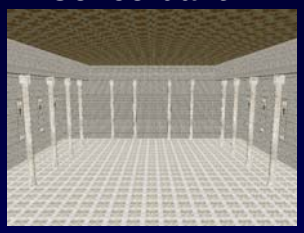


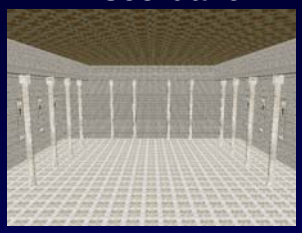
Surface pitch down

Perturbations

Concordant | **Discordant**

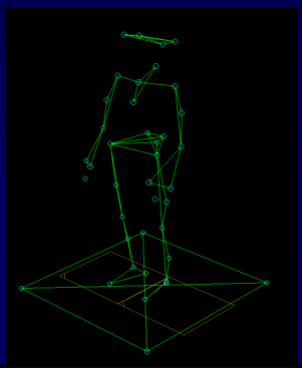
VE pitch down

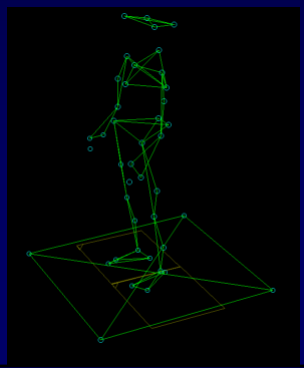




VE pitch down

Surface pitch up





Surface pitch down

Outcomes

- The EMG responses of eight bilateral postural muscles,
- Center of pressure (CoP)
- Centre of mass (CoM)
- Number of steps taken to regain balance

- Functional balance and mobility (*EPESE*, *Guralnick et al. 2000)*:
  - gait velocity
  - ability to maintain tandem stance
  - timed sit-to-stand

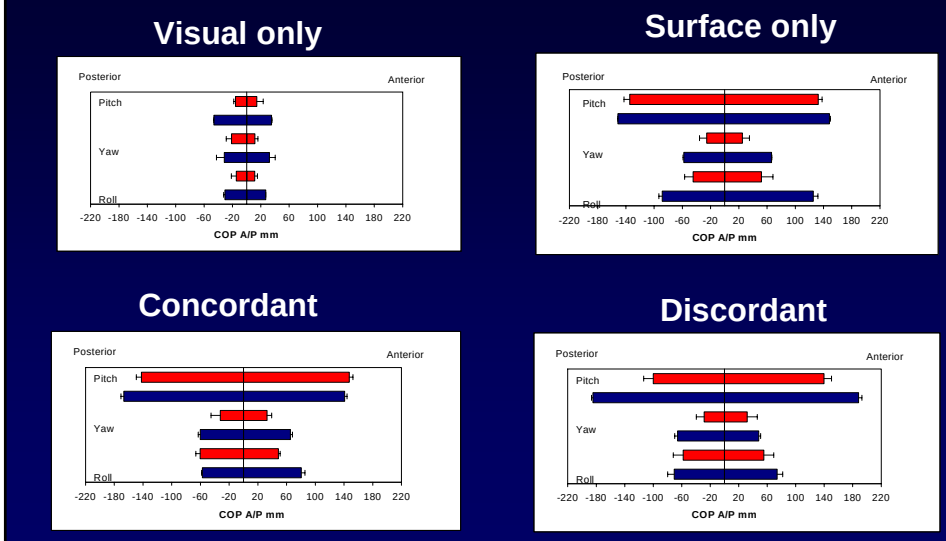
Results

Older adults took less steps after repeated exposures to sensory conflicts

Subject age	Steps in first 10 trials	Steps in last 10 trials
65	2	0
66	3	1
68	2	1
71	3	1
72	3	2
75	2	0
76	2	1
78	3	2

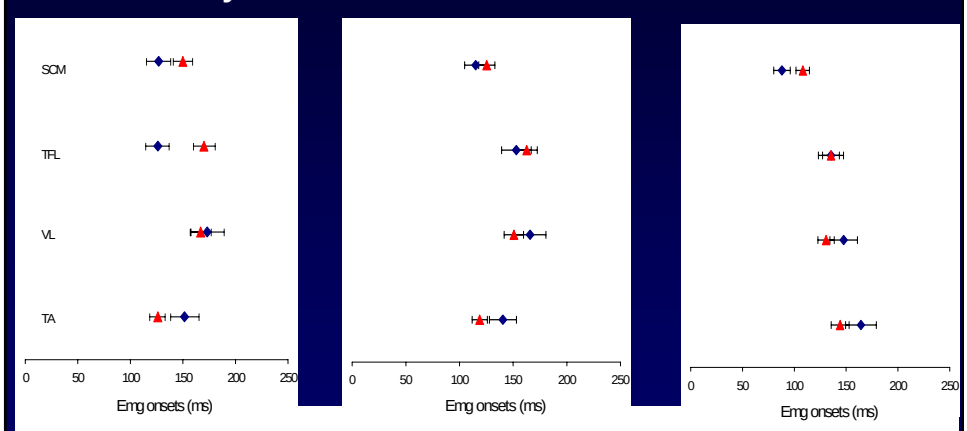
*** $p < 0.0001$**

CoP excursions decrease after repeated exposures to sensory conflicts



First 10 trials Last 10 trials

EMG response latencies decrease after repeated exposures to sensory conflicts



Group mean ± std for muscles onset latencies following pitch rotations (toes-up)

First 10 trials Last 10 trials

Ability to maintain tandem stance improves after repeated exposures to sensory conflicts

Subject age	Tandem stance score pre trials	Tandem stance score post trials
65	4	4
66	4	4
68	2 (semi tandem)	3
71	2 (semi tandem)	3
72	2 (semi tandem)	3
75	3	4
76	4	4
78	2 (semi tandem)	3

*** $p < 0.05$**

Conclusions

- Even with a one-hour immersion in VE and exposure to sensory conflicts, it is possible for the CNS to recalibrate, adapt and improve balance capability in older adults
- A training program of longer durations is needed to confirm sustainable long-term effects
- Preventive and rehabilitation balance programs for older adults should include sensory selection strategies training with VE

Acknowledgements

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