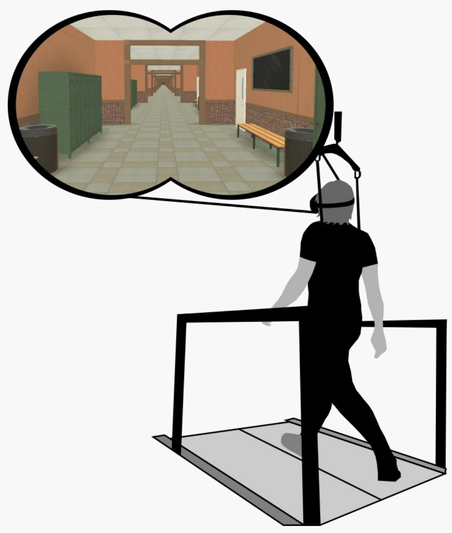
Self-Paced Walking in Two VR Systems: Secondary Analysis of Gait Acclimation to Visual Perturbation

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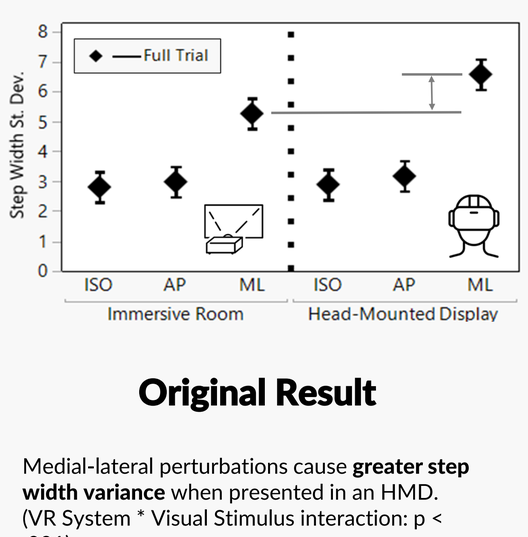
People walking through **virtual reality** do not adapt to unpredictable visual perturbations within 6 minutes.



Immersive Room

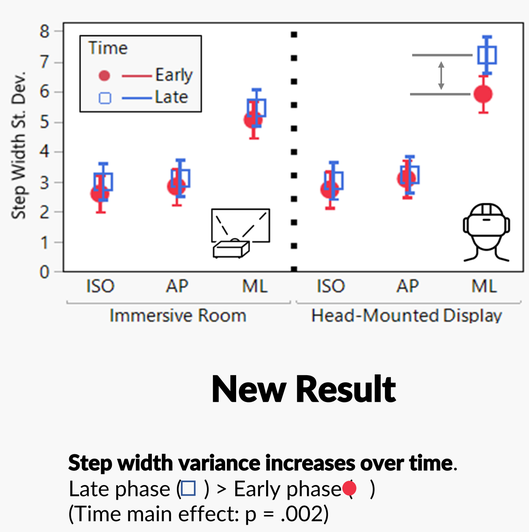


Head-Mounted Display



Original Result

Medial-lateral perturbations cause **greater step width variance** when presented in an HMD.
(VR System * Visual Stimulus interaction: $p < .001$)



New Result

Step width variance increases over time.
Late phase (□) > Early phase(●)
(Time main effect: $p = .002$)

All previous findings remain.



Medial-Lateral Visual Perturbation

Background

- **Treadmill walking in a virtual environment** allows for safe visuomotor challenges in a gait rehabilitation setting.
- We recently found that **visual perturbations are especially disruptive to gait when presented in a head-mounted display** as compared to in a projector-based "immersive room". (Wilson et al., 2025)
- Follow up question: **"Does the greater variance dissipate as the trial progresses?"** If so, that implies people adjust to the stimulus quickly, lessening the clinical application of the visual perturbation.

Method

- A variable of "**Time**" was added to the analysis.
  - "Early" steps = steps 21-220
  - "Late" steps = final 200 steps

New mixed linear effect model:

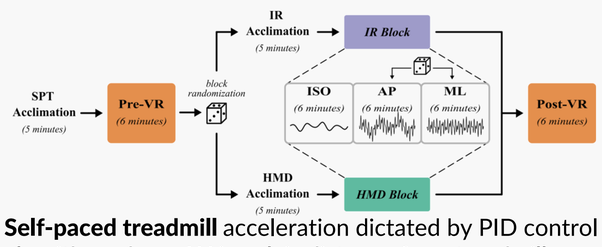
Fixed effects:
- VR System (Immersive Room, Head-Mounted Display)
- Visual Stimulus (Isometric, AP perturbation, ML perturbation)
- **Time** (Early, Late)

Random effect:
- Subject

Outcome variables:
- Velocity, step length, step time (*mean, st. dev*)
- **Step width**, margin of stability (*mean, **st. dev***)
- Joint angles (*min, max, range*)

Data Collection

- **16 participants** (9 F, age 30.2 ± 6.5, no neuromotor disfunction, no regular VR users) completed 6-minute walking trials under varying visual conditions.

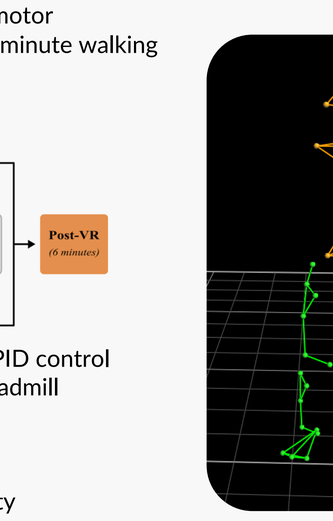


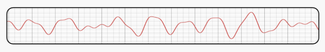
- **Self-paced treadmill** acceleration dictated by PID control algorithm where ΔX is pelvis distance from treadmill centerline:

$$a_{treadmill} = K_p \Delta X + K_d \frac{\Delta X}{\Delta t}$$

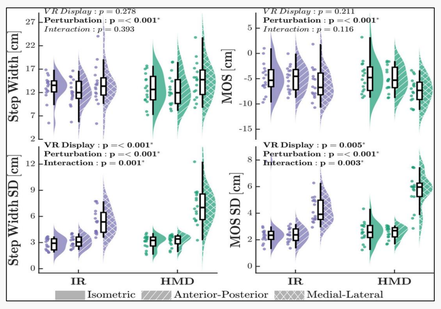
- **Visual perturbation** distance where A = velocity

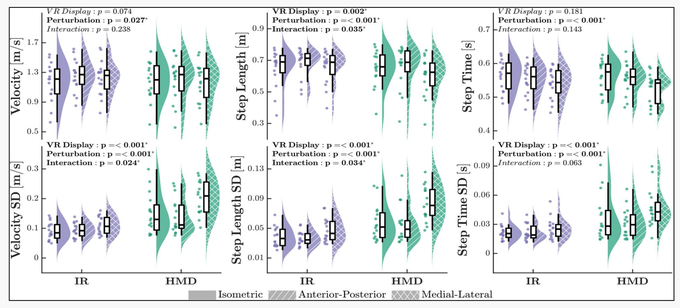
$$D(t) = A[sin(0.16 * 2\pi t) + 0.8sin(0.21 * 2\pi t) + 1.4sin(0.24 * 2\pi t) + 0.5sin(0.49 * 2\pi t)]$$





Primary Analysis





- **Balance measures:**
  - Step width st. dev
  - ML margin of stability

$$XCOM = P_{COM} + \frac{V_{COM}}{\sqrt{g/L}}$$

$$MOS = BOS - XCOM$$

Wilson et al. 2025
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