Ability to Predict Perturbation Timing Does Not Impact Center-of-Mass Displacement in Below-Knee Prosthesis Users and Controls

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Introduction

- Despite a high fall prevalence (Miller 2001), factors that underlie postural control in lower limb prosthesis users have not been sufficiently explored.
- Knowledge of lateral perturbation timing evokes a proactive margin-of-stability increase on prosthetic limb side of below-knee (BK) prosthesis users (Major 2018)
- The consequences of *a priori* knowledge and proactive strategies on body center-of-mass (CoM) motion following a perturbation have not been characterized.

Aim: Assess effects of *a priori* knowledge (direction, timing) of a lateral perturbation on response of able-bodied and BK prosthesis users.

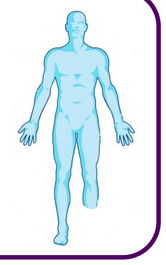
- **H1: When directed towards impaired limb, prosthesis users would display increased CoM displacement during perturbation exposure.**
- **H2: When timing is known, prosthesis users would display reduced peak CoM displacement following perturbation onset.**

Methods

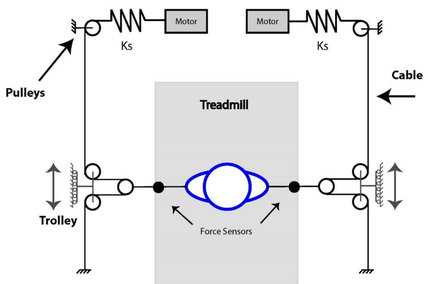
Participants

13 Able-Bodied
(29±11 yrs, 65±10 kg, 1.7±0.1 m)

6 Unilateral BK Prosthesis Users
(48±8 yrs, 70±11 kg, 1.7±0.1 m)

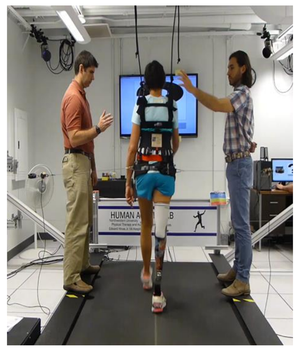


Cable Robot



- **Lateral Perturbation**
- **12% Body Weight**
- **400 ms Exposure**
- **Optically-Tracked CoM**

(Wu 2017, Brown 2017)



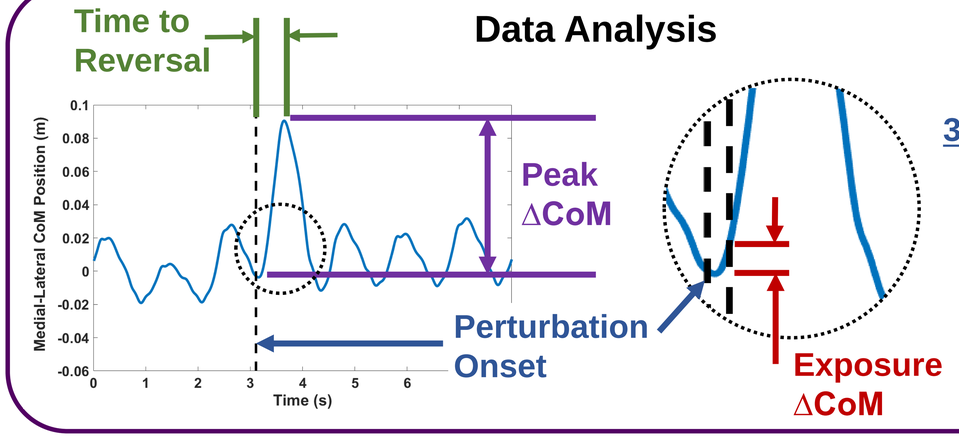
a priori Knowledge

Direction (Right/Left)

+/-

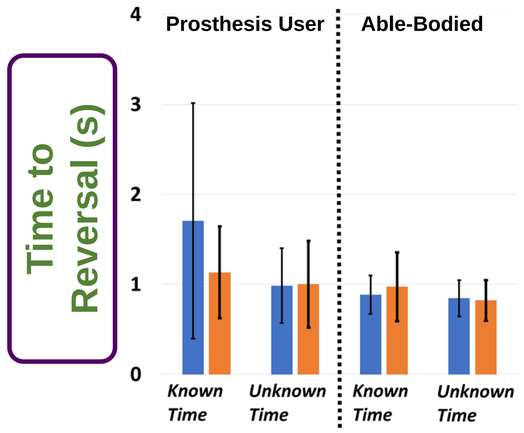
Timing (Known/Unknown)

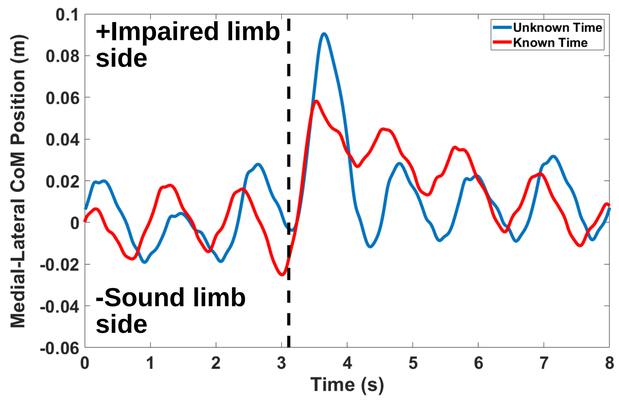
Data Analysis

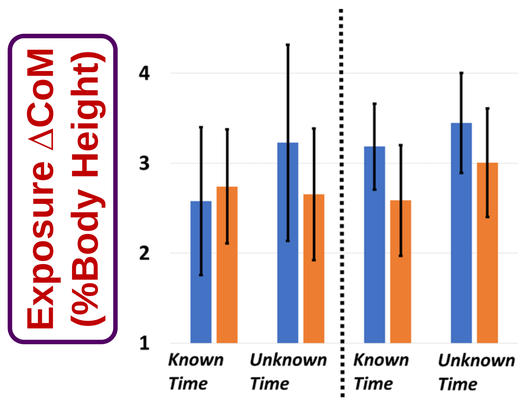


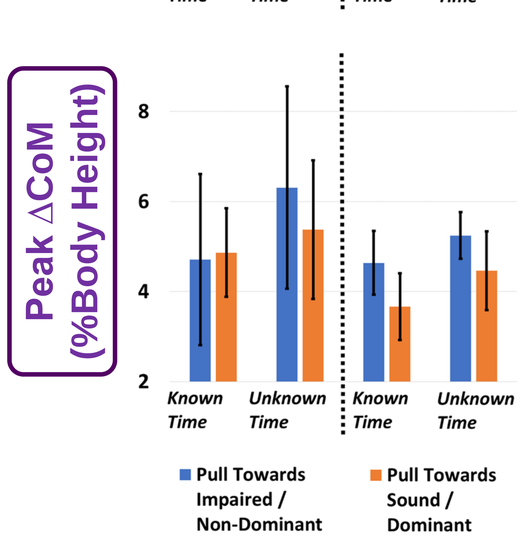
3-way ANOVA
Direction x Timing x Group (α=0.05)

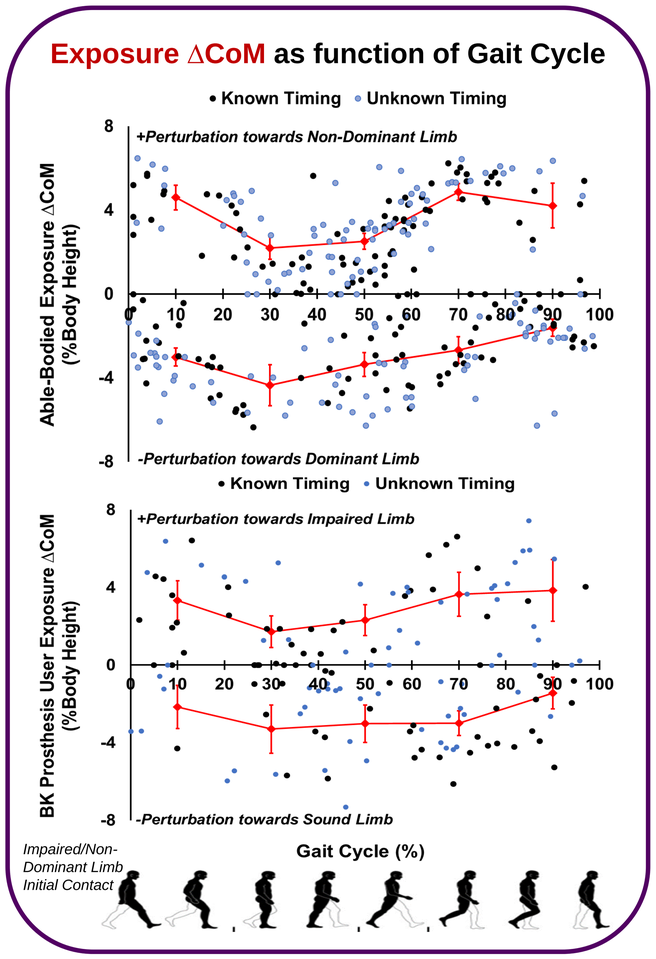
Results











Discussion

- **H1 supported:** Perturbation towards the impaired/non-dominant limb increased Exposure ΔCoM (p=0.033), with no difference between groups or timing conditions.
- **H2 supported:** Knowledge of perturbation time reduced Peak ΔCoM (p=0.010) but increased time to reversal (p=0.043), with no difference between groups or direction.
- For unknown timing, a trend towards greater Peak ΔCoM but rapid return to center, whereas known timing generates less Peak ΔCoM by delayed response ('riding it out')
- Emerging pattern for influence of gait cycle phase and perturbation direction, but not timing, on Exposure ΔCoM which resembles CoM velocity temporal profile.

References

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Major MJ, et al. *Sci Rep,* 8: 1863, 2018.
Miller WC, et al. *Arch PM&R,* 82: 1031-7, 2001.
Wu M, et al. *PLoS One,* 10: e0132707, 2015.

Acknowledgements

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