Joint Speed Discrimination and Augmentation for Prosthesis Feedback

Eric J. Earley[1,2], Reva E. Johnson[3], Levi J. Hargrove[1,2], Jon W. Sensinger[4]

[1]Northwestern University, Chicago, IL; [2]Shirley Ryan AbilityLab, Chicago, IL; [3]Valparaiso University, Valparaiso, IN; [4]University of New Brunswick, Fredericton, NB Canada

Summary

Few attempts to provide sensory feedback for prostheses (e.g. position, force) have been successful when patients could see tasks
This suggests feedback is too uncertain compared to vision, and is simply being ignored

To understand how to provide feedback in parallel with vision, we must understand visual uncertainty

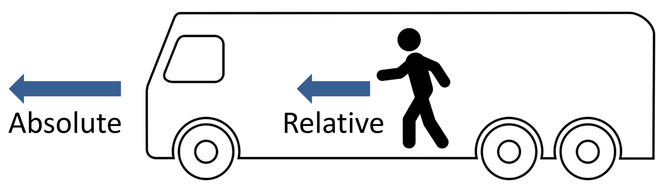
We ran a series of psychophysics experiments to investigate visual speed perception
Our work identifies joint speed is the most uncertain speed perceived by vision, especially for varying reference frames (such as shoulder movement)
We also demonstrate a joint-based sensory feedback paradigm capable of significantly reducing joint speed uncertainty when paired with vision

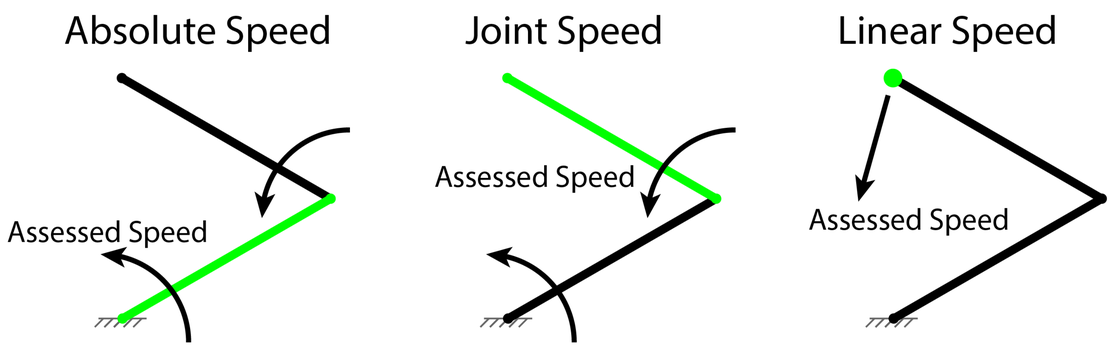
This suggests providing joint speed feedback may improve robotic prosthesis control, even in the presence of vision

Experiments

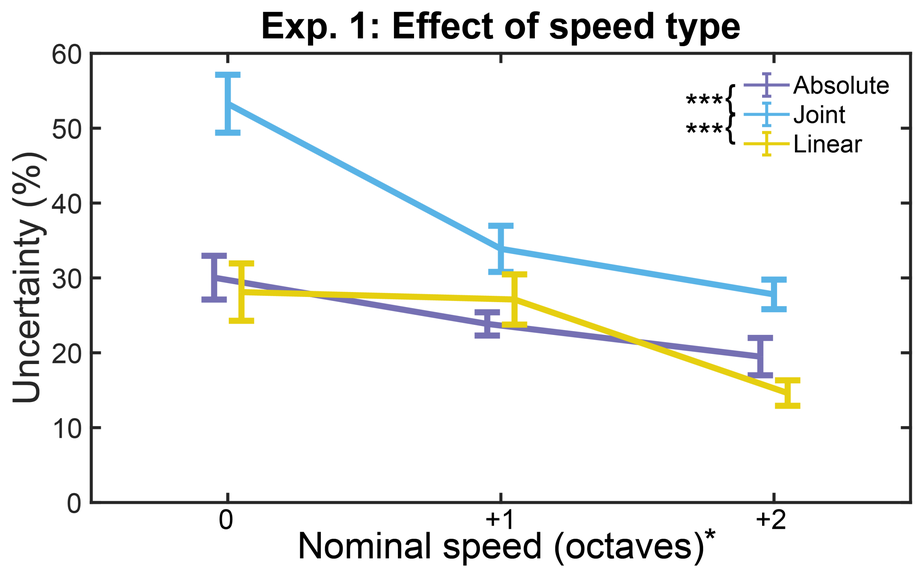
1. Absolute vs. Joint Speed Perception

Motivation: Determine how speed discrimination differs between speed types





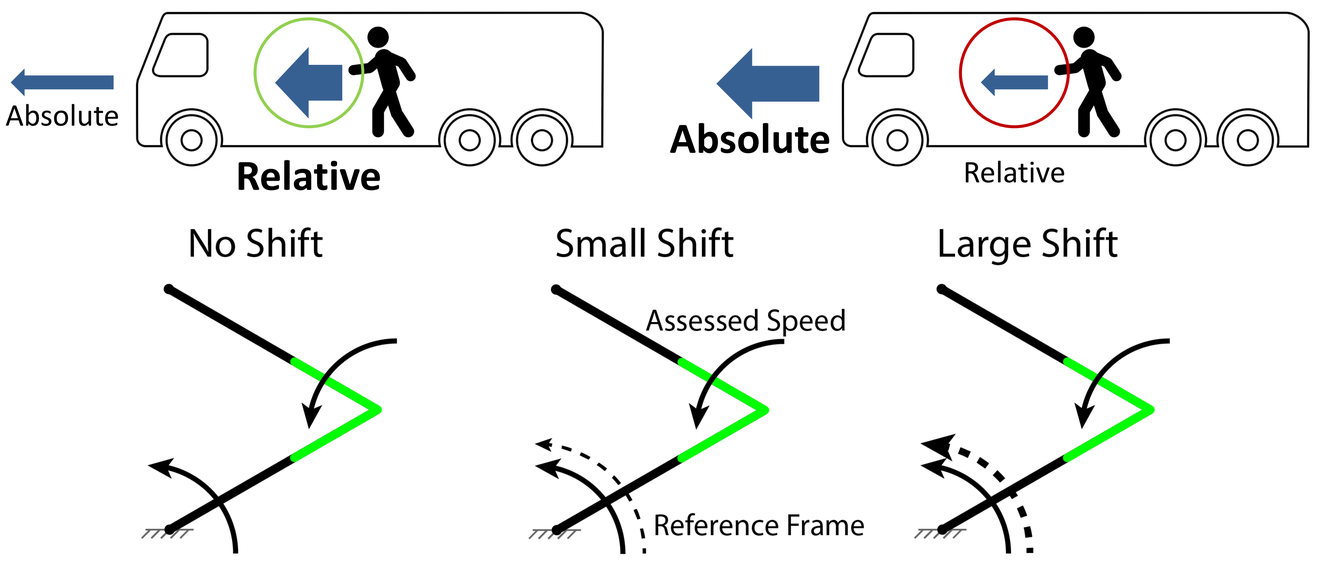
Results

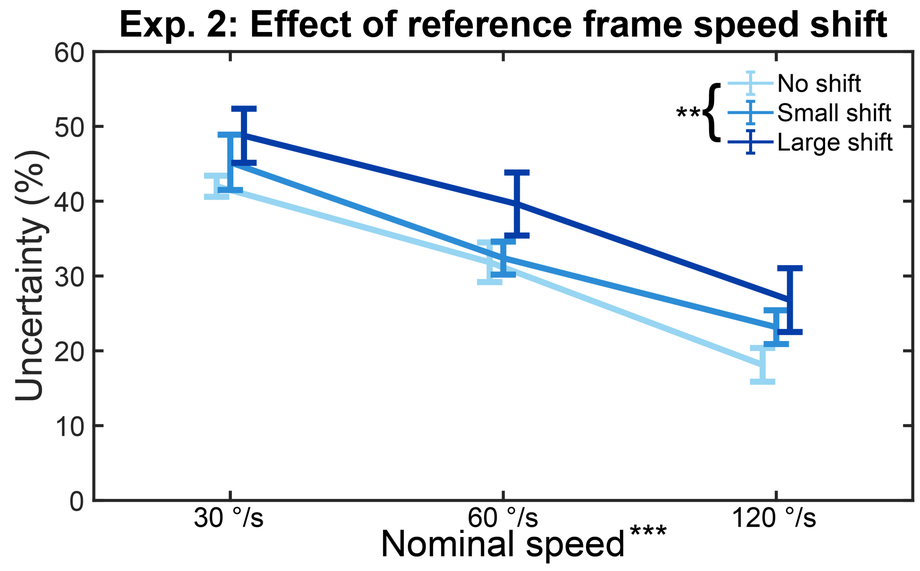


- Egocentric and Cartesian speeds perceived with low uncertainty
- Joint speed uncertainty is highest with elbow moving slowly compared to shoulder

2. Effect of Reference Frame on Joint Speed Perception

Motivation: Determine how changes in reference frame speed affects joint speed uncertainty

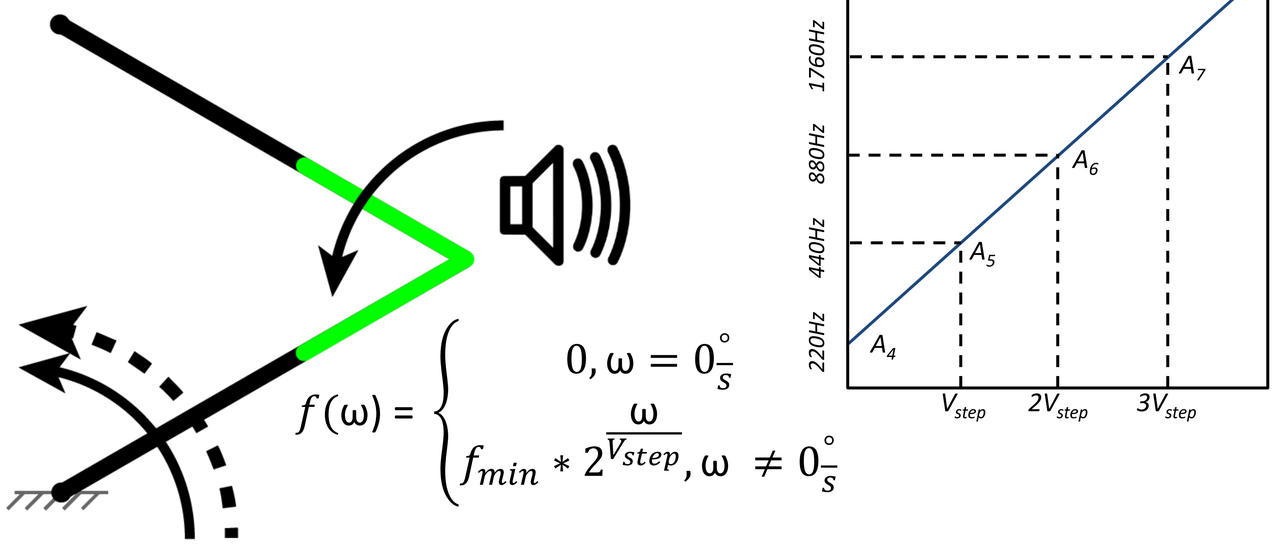


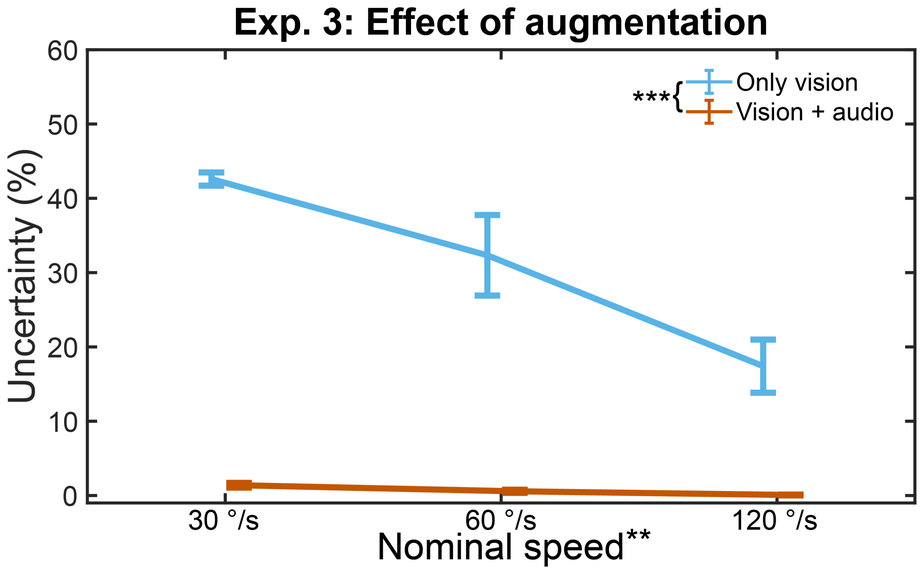


- Uncertainty is highest with large differences in shoulder speed
- Faster shoulder speed resulted in overestimation of elbow speed

3. Augmented Speed Perception

Motivation: Improve joint speed perception in concert with vision using supplementary feedback





- Augmenting vision with audio feedback significantly improved speed perception
- Augmented feedback was largely speed invariant

Contact Information:
Eric Earley ericearley@u.northwestern.edu

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