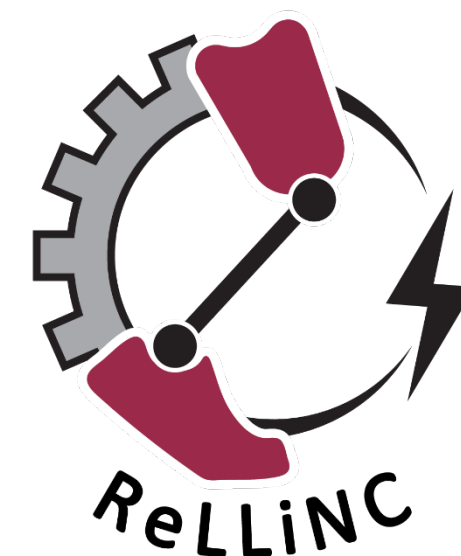


Balance and Gait Adaptation During Extended Home Use of a Sensory Neuroprosthesis in Individuals with Lower Limb Loss

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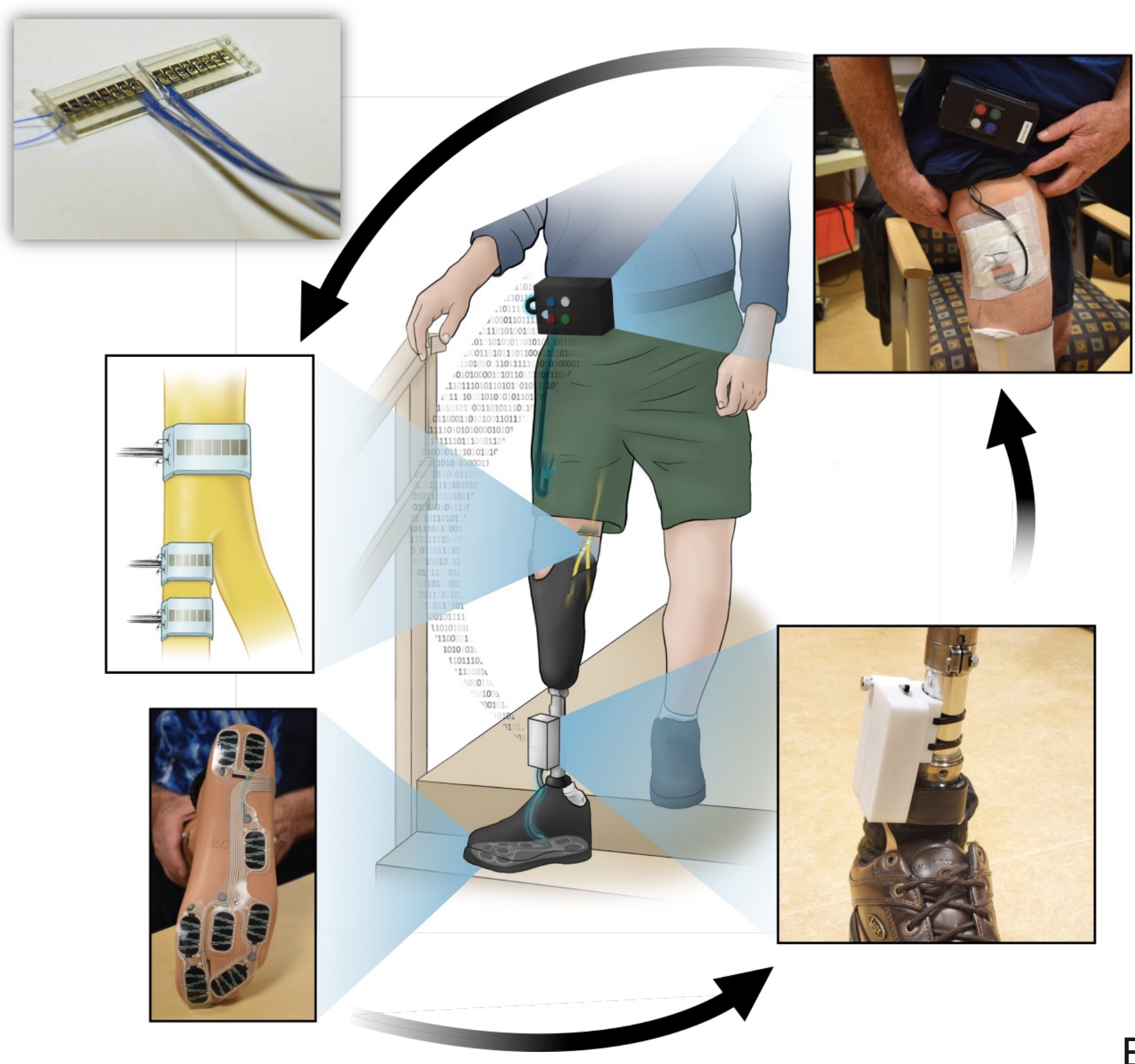


Introduction

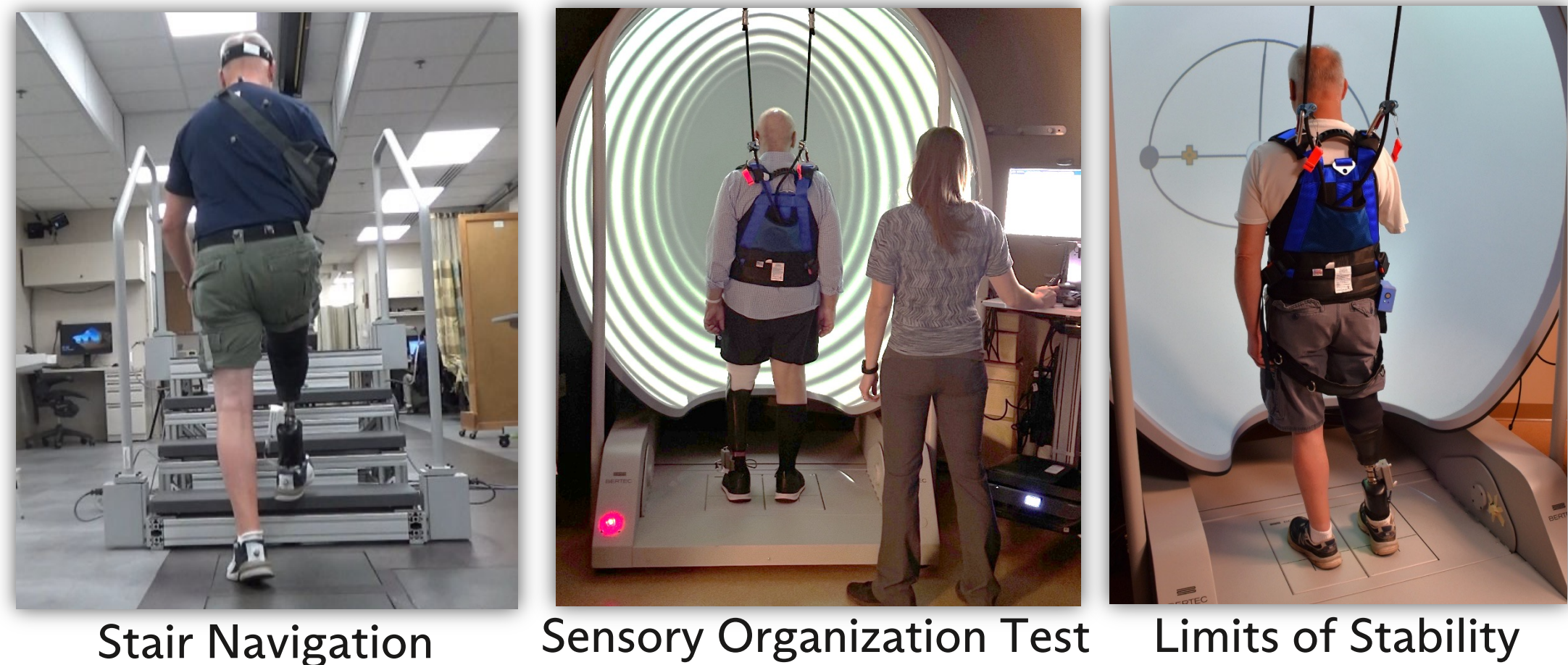
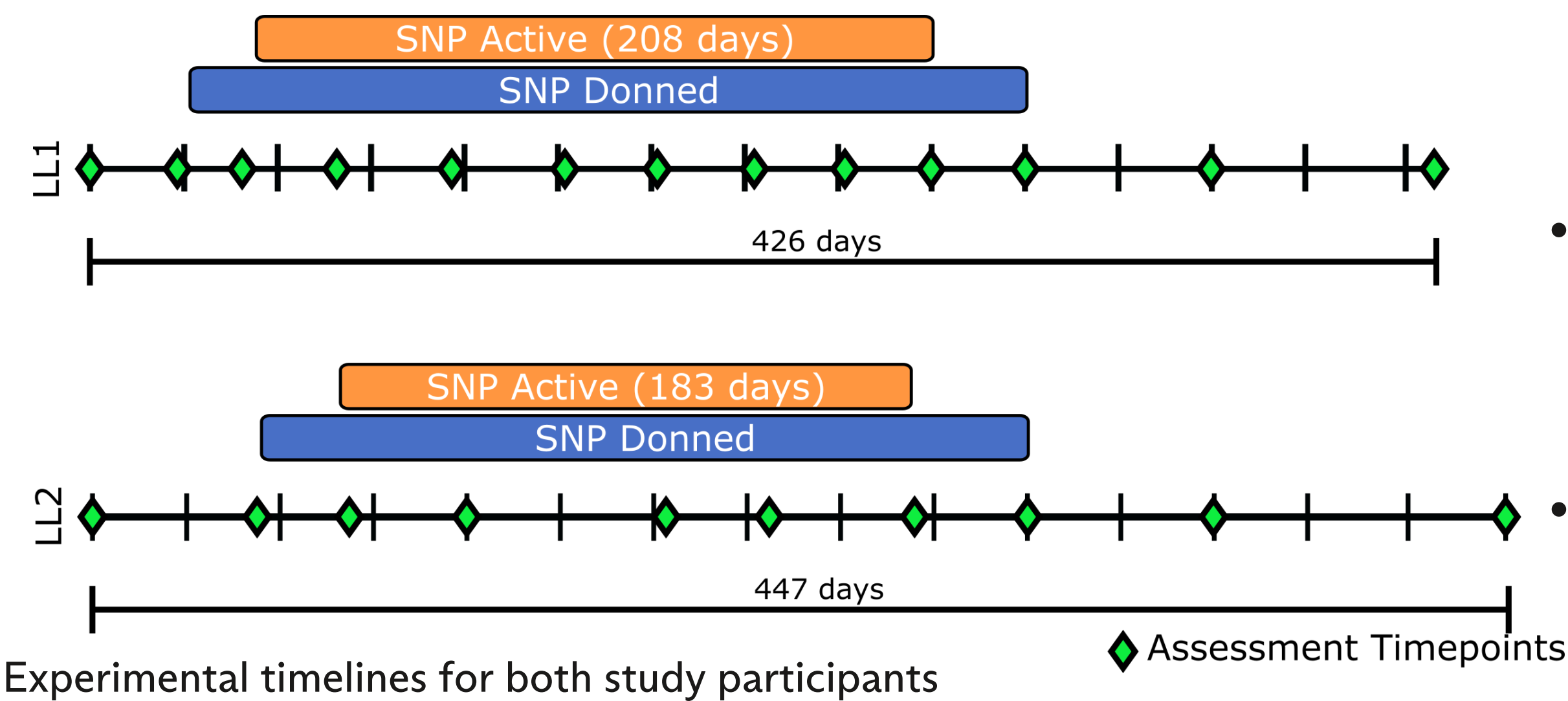
- Lower limb loss reduces somatosensory feedback from the foot, impairing gait and balance.¹
- Our Sensory Neuroprosthesis (SNP) elicits sensory feedback based on foot-floor interaction via electrical stimulation of peripheral nerve.²
- Long-term functional and perceived effects of real-world SNP use remain unclear.

Objective: Evaluate longitudinal changes in gait, balance, and perceived benefits during and after extended real-world SNP use.

Methodology



- Composite flat interface nerve cuff electrodes (C-FINEs) stimulate afferent fibers in the residual limb.
- Two participants with varying levels of lower limb loss.
 - LL1 -> Right Transtibial
 - LL2 -> Left Knee Disarticulation

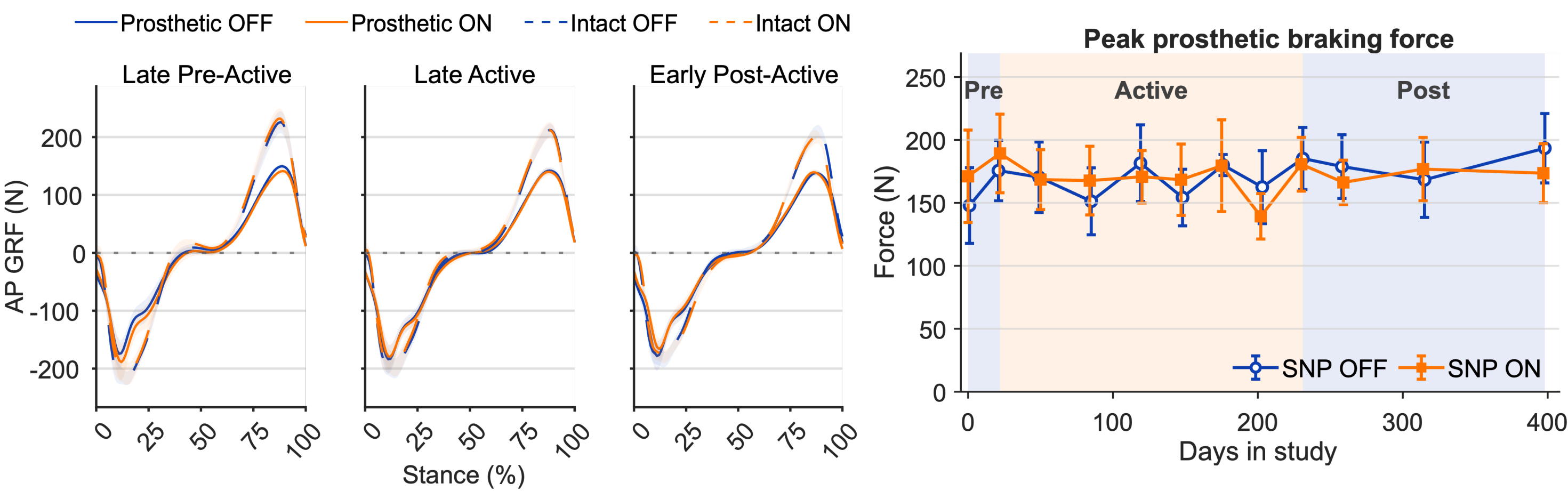


- Functional outcome measures
 - Gait -> Ground Reaction Forces
 - Static Balance -> Sensory Organization Test
 - Dynamic Balance -> Limits of Stability
- Qualitative outcome measures
 - Daily diaries
 - Semi-structured interviews

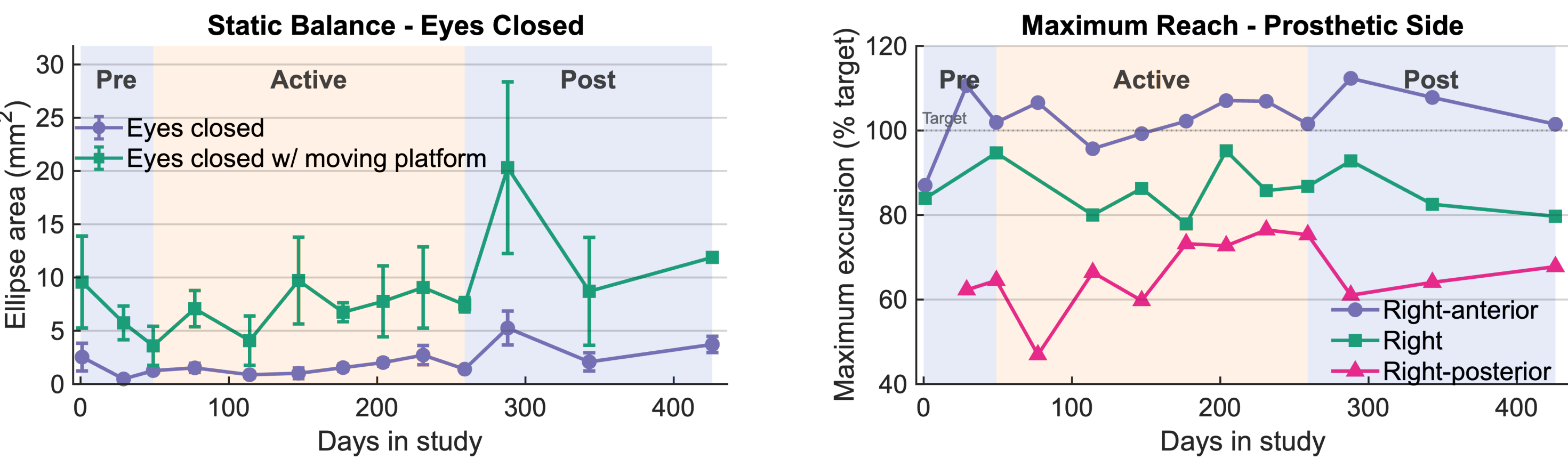
Results

LL1 – Transtibial Limb Loss

No observable changes in propulsive and braking forces with extended SNP use



Extended SNP use preferentially supported volitional postural control



SNP highlighted plantar sensation and facilitated outdoor activities

“[we try] to feel the same as this - as my intact leg. And I’m like, wow, that’s pretty doggone close.”

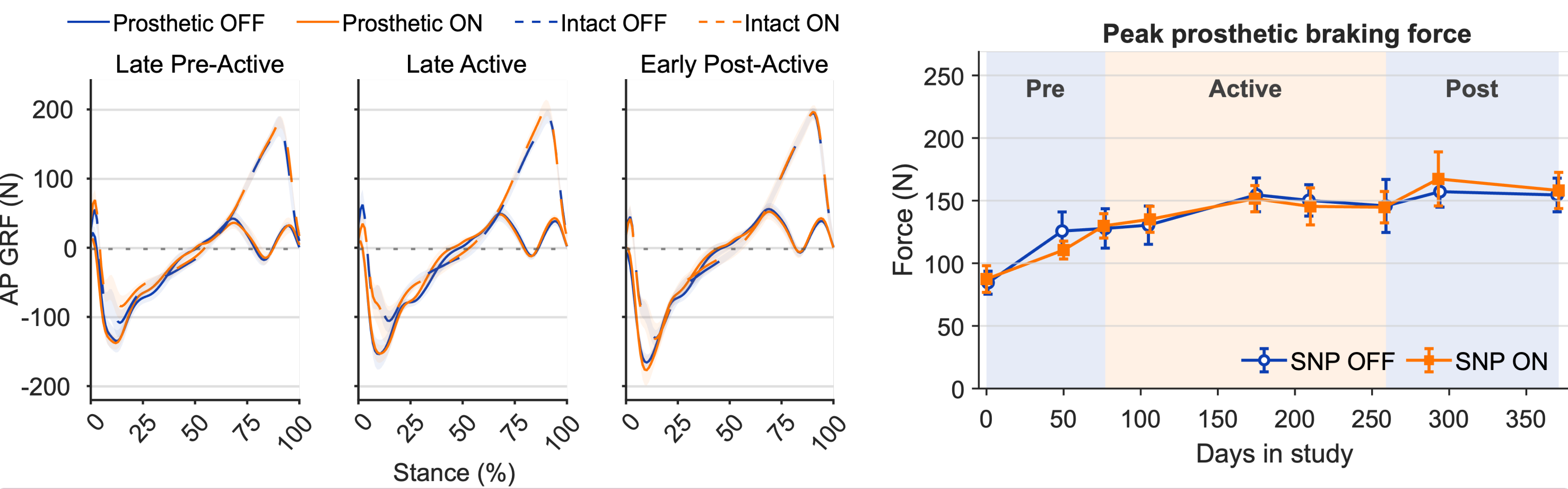
“That’s my new definition of what this system does. It highlights the bottom of your foot. [...] It tells my brain, ‘Hey, buddy, that’s there,’ more than when it’s off.”

“I was walking, you know, like, five miles a day. Hiking, I should say, in the woods.”

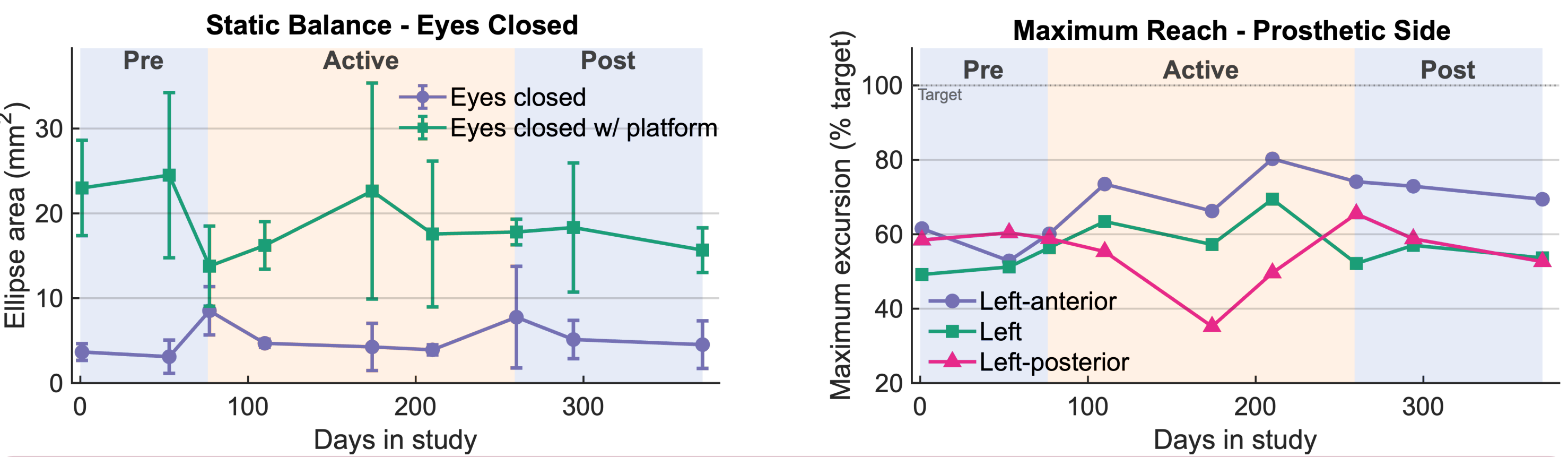


LL2 – Knee Disarticulation

Prolonged SNP use increased braking forces by prosthetic limb



Extended SNP use preferentially supported volitional postural control



SNP promoted sensory integration, enhanced walking, and reduced phantom pain

“it just feels like a tingle here, a buzz there... but if I’m walking, then it feels—my brain’s interpreting it just the same as this [intact] foot is when it’s experiencing things.”

“I wasn’t even thinking about walking. I was thinking about other things”

“when the system’s on, I don’t have any phantom pains that day”

Conclusions

- Acute SNP activation within an evaluation did not affect gait forces, whereas **longitudinal changes emerged in the participant with greater baseline impairment.**
- This suggests that extended sensory feedback **supports gradual sensorimotor adaptation** beyond immediate stimulation-dependent effects.
- The task-specific balance response suggests plantar sensory feedback may be most **effectively integrated when loading cues guide postural adjustments.**
- Perceived functional benefits may be related to the **activities participants do regularly and find meaningful.**
- Functional changes emerged after 4–8 weeks of daily SNP use and **remained generally consistent thereafter.**
- These preliminary findings **support further evaluation of long-term, real-world sensory neuroprosthesis use** in a larger cohort.

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