Gait Retraining Outside the Lab

Ben, Michelle, Quincy

654.1 million

people over 40 with **knee osteoarthritis** worldwide

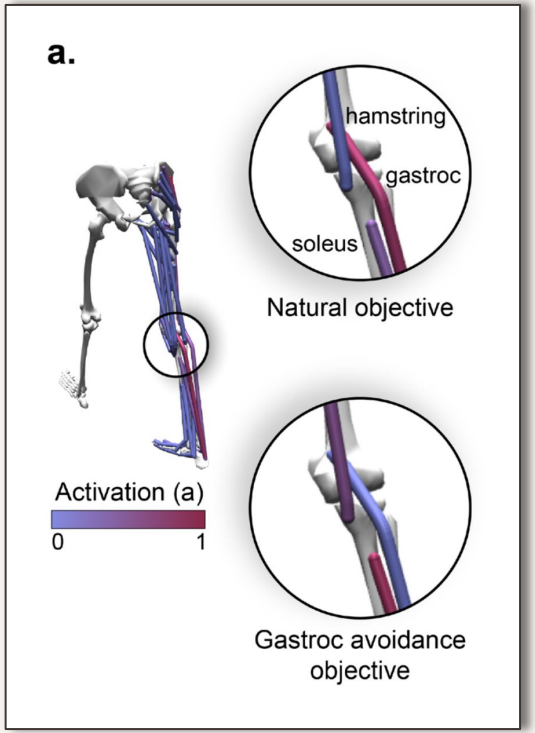


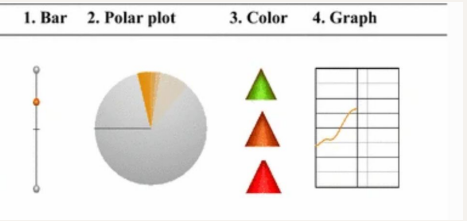
Figure 1a from Uhlrich, et al. 2022

Simulations

- Useful to:
  - Find new strategies for reducing knee loading
  - Evaluate experimental results
- Prior study used simulations to develop a calf muscle re-coordination strategy
  - Decrease gastrocnemius activation, increase soleus

Gait Retraining to Decrease Knee Loading

Visual



Van den Noort, et al. 2015

Haptic

Chen, et al, 2017

Auditory

Brown, et al, 2015

Electrical Stimulation

Cionic Neural Sleeve. *Robinson, et al. 2022*

Proposed Study

Initial step to enable out of the lab gait retraining

We will develop and test a wearable device that trains people to reduce their gastrocnemius activation with haptic feedback.

01

Using wearable haptic feedback, individuals will be able to learn new muscle coordination strategies

02

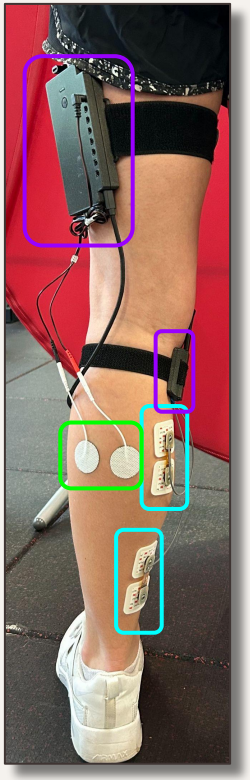
The new muscle coordination strategies will lower gastroc activation

03

Reduced gastroc activation will reduce knee contact forces

Study Methods

Wearable Development

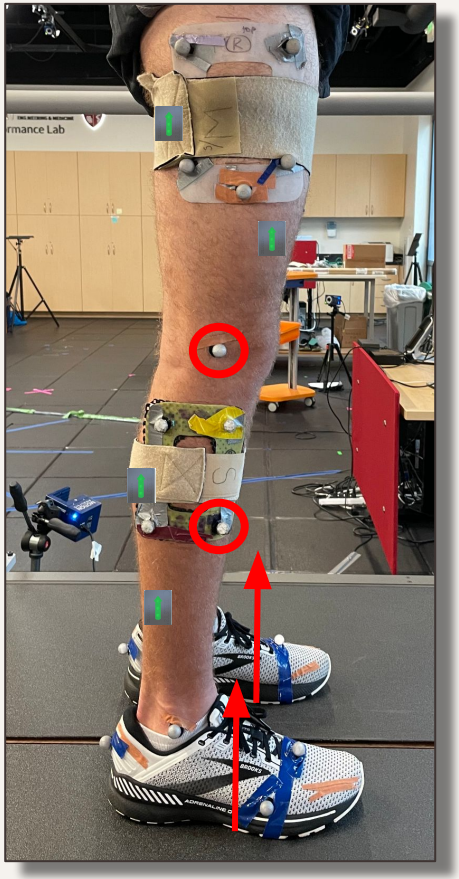


- EMG on gastroc and soleus
- IMU
- Haptic feedback mechanism
  - Goal: walk to feel no vibrations
  - 2 buzz: less than 10% reduction of gastroc activation
  - 1 buzz: reduced by 10-30%
  - None: reduced over 30%

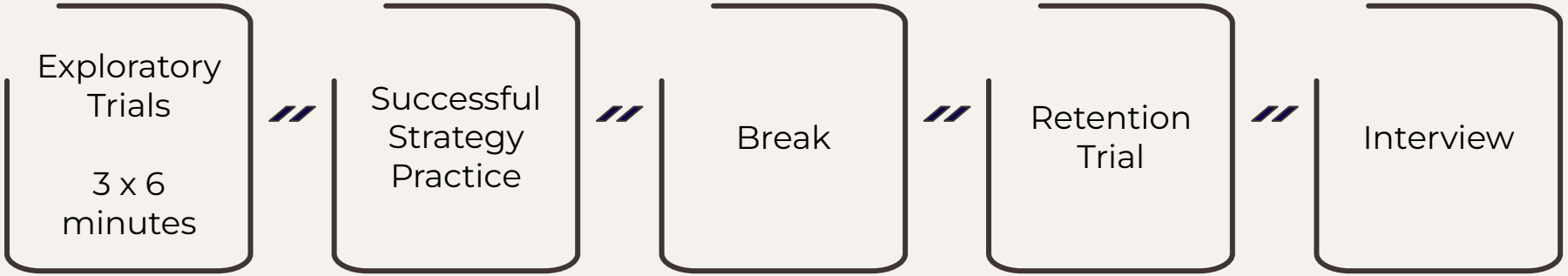
Data Collection

Equipment

- Motion capture and OpenCap for validation
- Instrumented treadmill
- Wearable haptic device
- Additional EMG electrodes



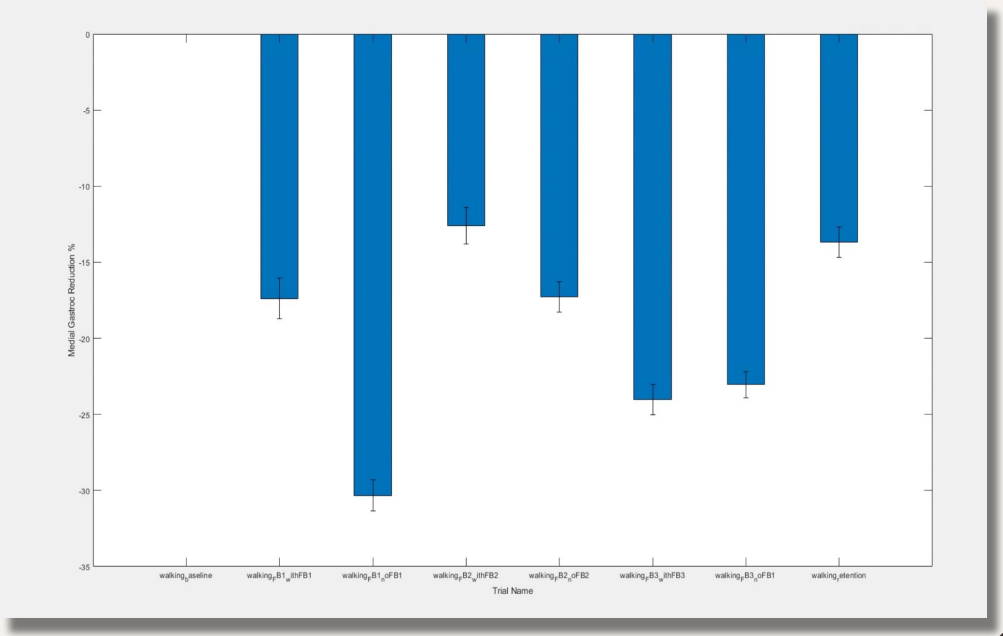
Data Collection Protocol



Power Analysis

- $N_{\text{number of subjects}} = (Z_{\alpha} + Z_{\beta})/d$
- $d = (\mu_x - \mu_y)/\sigma$
- For $\alpha = 0.95$ & $\beta = 0.95$, **N = 10** can distinguish 1σ difference in gastroc activation

Example Results


Medial Gastroc Reduction %
0
-5
-10
-15
-20
-25
-30
-35
walking_baseline
walking_pB1_withFB1
walking_pB1_noFB1
walking_pB2_withFB2
walking_pB2_noFB2
walking_pB3_withFB3
walking_pB3_noFB1
walking_attention
Trial Name

Limitations & Future

Outside the Lab

- OpenCap not validated for gait kinematics and posture
- Only one retraining session
  - Short time scale
  - No follow up
- Enumerate gait adaptation strategies

Thank You

Extra thanks to...
Scott Ulrich (Mentor)

Wearable Device (Cionic)