Simultaneous isometric torque measurement at multiple joints in the lower extremities of children and adults

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Background

- Clinical signs of reduced strength and loss of independent joint control in the lower extremities of those with cerebral palsy (CP), related to damage of the corticospinal tracts
  - Clinical measurements, such as observational tests and hand held dynamometry, can be challenging to appropriately administer, particularly when atypical patterns of movement prevent patients from isolating effort to a single joint
  - The most functionally relevant position is standing, but balance challenges make independent standing impossible for many patients.

Clinical Relevance

- Findings in children with typical development (TD) may reflect a flexible nervous system with multiple strategies to generate maximal efforts at a given joint.
- Less variability may indicate limited neural resources leading to stereotyped motor commands with narrow flexibility, as might be expected in children with CP or other neurological diagnoses.
- The ability to fully characterize the output of the neuromuscular system allows for more mechanistic investigations to further understand the source and nature of atypical motor output in CP.

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Device description

- A custom isometric device was designed and used to study the lower extremity joint torque coupling patterns and abilities in adults following a stroke (see Sanchez et al. 2017 for results).
- Two 6 degrees-of-freedom load cells give the ability to simultaneously measure efforts at the hip, knee and ankle.
- This can be accomplished in an upright posture while removing the need to balance or support one’s self by supporting the pelvis and trunk in a way that does not allow for compensations.
- Changes made to original device for use with children: Offset added to the thigh load cell (‘b’ in Figure 1), cuff insert made to accommodate smaller diameter legs
  - Trunk support adapted for smaller torsos
  - Foot plates made in smaller sizes for additional options
  - Pediatric friendly data collection protocol

Figure 1. Device schematic

Figure 2. Pediatric participant