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Using a robotic device to enhance upper- limb 3D proprioception

B. A. Valdés, M. Khoshnam, J. L. Neva, & C. Menon.

Objectives: Proprioception is important for performing activities of daily living and can be affected by neurological conditions and aging. As a preliminary step towards clinical application, we investigated if a robotic platform could be employed to enhance upper-limb 3D proprioception in people without disabilities.

Design: Single training session.

Setting: Research laboratory.

Participants: 6 adult participants (34±12 years) without disabilities.

Interventions: Participants reached with their dominant hand to two targets in 3D space without vision. The targets' locations resembled hand positions involved in self-feeding. At the end of each training trial, participants were able to see the end location of their hand on a monitor and move the cursor representing their hand to the exact target location. The training was comprised of 3 blocks of 8 reaching movement trials (24 reaches to each target). Improvements were measured from baseline to post-measurements trials. A third target was added to baseline and post-measurements trials to test if results would generalize to an untrained target.

Main Outcome Measure: Primary: End-position error between virtual target and cursor. Secondary: Index of curvature (straightness of hand path).

Results: When all targets were combined, reaching accuracy and the index of curvature were improved on average by 41% and 13%, respectively.

Conclusions: This preliminary study provides support to the concept of employing robots to enhance proprioceptive sense of upper-limb position in 3D space. Larger samples are required to confirm these results, and future studies should investigate how this paradigm could be adapted to be beneficial for people with disabilities.