Effects of postural stability on the transfer of learned movement control strategies

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1. Introduction

Familiar, predictable movements are preceded by anticipatory postural adjustments (APAs): activation of postural muscles and center-of-pressure (CP) movement, prior to movement onset; help maintain postural equilibrium against impending shift in dynamics. Very low stability conditions can cause APAs to be reduced, due to biomechanical constraints [1]. Very high stability can also cause APAs to be reduced, if not needed to maintain equilibrium [2].

Research question: Are learning and transfer of postural control affected by varying stability, with non-extreme stability conditions?

Hypotheses
Learning: Groups will show similar CP control, but different stance widths will require different muscle activation strategies [3].
Transfer: Subjects will transfer same learned CP control from one stance width to the next, by modifying muscle activity to account for new stance.

2. Experiment

Subjects: 12 healthy young adults (6 per group)

Task: make reaching movements to a target while grasping handle of force-generating robotic arm. Target and handle-controlled cursor are displayed on monitor.

3. Arm control

Arm control measures were similar between groups and remained similar after transfer.

Learning and transfer of arm movement task were not affected by postural stability.

4. Posture control

Learning: CP control was similar between groups at end of Learning 1 (APA p=0.067, RPA p=0.789)⁺. Muscle activity differed between groups due to biomechanical configuration.

Transfer: W group transferred similar CP control to start of Learning 2 (APA p=0.203, RPA p=0.108); changed muscle activity for new stance. N group increased CP control (APA p=0.040, RPA p=0.012)⁺; no change in muscle activity.

Why did groups transfer differently?

W group saw decrease in stability; they were motivated to maintain appropriate CP strategy, and changed muscle control to do so. N group saw increase in stability; original strategy was not ideal but was sufficient; they were not motivated to change muscle control.

APA and RPA (based on perpendicular CP velocity, normalized by foot length) vs. time. Note: for tangential direction, positive is forward (direction of reaching movement); for perpendicular direction, positive is leftward (direction of force field). Differences in transfer are denoted by (+) between groups and by (*) within group.

5. Conclusions

Learning of postural control is not affected by stability, as long as control remains within biomechanical limits.

Transfer of postural control between stability contexts is affected by relative change in stability.

What does this mean? In rehabilitation, must consider context in which learning/training occurs, as well as future contexts for task performance.

References

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