Degradation of Exocentric Reference in Visually-Occluded Three-Dimensional Reaching Tasks

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Motor control theory provides an acceptable claim for how the central nervous system (CNS) plans, executes, and adjusts movements online to successfully complete reaching tasks. Visual and proprioceptive feedbacks provide the principal mechanisms by which the CNS ascertains necessary information of target location for motion planning. Without vision, the central nervous system (CNS) must rely on motor memory and/or proprioceptive feedback to determine target locations and build a spatial reference. In the present study, the method by which the CNS plans is inferred from observing end-effector trajectories and pointing errors.

A 6-DOF motion platform was used to simulate terrain-induced ride motion, where ten participants performed rapid, three-dimensional, reaches with and without visual occlusion. After determining target location, participants closed their eyes and began the reach after delayed signal of 0, 1 or 2 sec. Reach instructions included successfully reaching identical circular targets with the right index fingertip as fast as possible, requiring the simultaneous solution of opposing constraints of the speed-accuracy tradeoff. Targets were located within arm length and presented on touch-panel displays located forward, lateral, and forward at 45 degree elevation. Touch-panels were used to measure off-axis spatial error and movements were recorded by a motion capture system.

Two correlated observations were apparent, related to delays to movement onset: 1) increased variability in pointing error with increased onset delays, and 2) increased and systematic directional errors correlated with vibration and onset delay. These data suggest that the participants' exocentric reference of the target is degrading with time, and systematic directional errors resulting from platform vibration suggests that the CNS may switch from an exocentric, pseudo-visual reaching task to an egocentric, proprioception-based reach.

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