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Can Expected Value Models Provide an Adequate Solution to the Joint-Level Motor Equivalence Problem?

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To study how humans resolve the joint-level motor equivalence problem, wrist, elbow, shoulder, and torso angles were recorded at the start and end of rapid positioning movements. Seven university students each made 540 horizontal movements between 30 starting positions and two targets. At the start of 1/2 of these, participants were instructed to flex or extend their wrist. Models predicting joint angle based on end-effector position confirmed prior findings of Expected Value solutions for the elbow and shoulder, extended these findings to the torso, and revealed a failure of this relationship for the wrist. However, joint angles for movements to individual targets revealed substantial systematic variability for all joints. This variability was characterized by strong inter-joint correlations and four different strategies for controlling the wrist. These results argue against an Expected Value model, and have implications for modeling work in this area.