

Expertise-Dependent Modulation of Muscular and Non-Muscular Torques in Multi-Joint Arm Movements during Piano Keystroke

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The problem of skill-level-dependent modulation in the joint dynamics of multi-joint arm movements is addressed in this study using piano keystroke performed by expert and novice piano players. Using the measured kinematic and key-force data, the time varying net, gravitational, motion-dependent interaction (INT), key-reaction (REA), and muscular (MUS) torques at the shoulder, elbow, wrist, and metacarpophalangeal (MP) joints were computed using inverse dynamics techniques. INTs generated at the elbow and wrist joints, but not those at the MP joint, were greater for the experts as compared with the novices. REA at the MP joint, but not at the other joints, was less for the experts as compared with the novices. The MUSs at the MP, wrist, and elbow joints were smaller, and that at the shoulder joint was larger for the experts as compared with the novices. The experts also had a lesser inter-strike variability of key striking force and key descending velocity as compared with the novices. These findings indicated that the relationship among the INT, REA, and MUS occurring at the joints of the upper-extremity differed between the expert and novice piano players, suggesting that the organization of multi-joint arm movement is modulated by long-term motor training toward facilitating both physiological efficiency and movement accuracy.

Key words: motor control, multi-joint movement, expertise, non-muscular force, pianist.