Optimal feedback control as a theory of motor coordination

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The puzzle of motor coordination

Many redundant tasks are accomplished successfully despite substantial trial-to-trial variability in individual degrees of freedom:

Industrial activities Bernstein 1930 Posture Balasubramaniam et al. 2000 Locomotion Bernstein 67, Winters 98 Skiing Vereijken et al. 92 Writing Bernstein 67, Wright 90 Shooting Aratyunyan et al. 69, Scholz et al. 2000 Reaching Haggard et al. 95 Pointing Tseng et al. 2001 Grasping Cole and Abbs 86 Sit-to-stand Scholz and Schoner 99 Speech Gracco and Abbs 86 Force production Li et al. 98 Bimanual tasks Jaric et al. 2001 Via-point tasks Todorov and Jordan 2002 Table tennis Todorov and Jordan 2002 Hand manipulation Todorov and Jordan 2002

This is only possible if variability is structured so that it does not interfere with performance. (recently quantified using the "Uncontrolled Manifold" method, Scholtz and Schoner 99)

Q1: Why is variability not suppressed everywhere?

Q2: What mechanism constrains variability to task-irrelevant (redundant) dimensions?

















