Supplementary Material: Optimality principles in human point-to-manifold reaching accounting for muscle dynamics

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1 POINT-TO-POINT SIMULATIONS

Point-to-point simulations were conducted similar to the point-to-manifold simulations, as described in Section 2. As target point we set $x^\star = (0.5083, -0.25)\,\mathrm{m}$. We accepted an error tolerance of $3.6\,\mathrm{cm}$, which was chosen because the original point-to-manifold experiments (as reported in Berret et al. (2011)) showed an error of $2.2 \pm 1.4\,\mathrm{cm}$ on average across subjects without visual feedback. The x-coordinate is the same as for the point-to-manifold task and corresponds to 85% of the full arm length of the model, and the z-coordinate was selected as the endpoint from the best simulated trajectory of the J_{JEE} cost function. Again, our neuro-musculo-skeletal model predicts eight different trajectories, one for each optimality principle. Figure S1 (a) shows the simulated trajectories corresponding to the best u of each cost function, which were found using Bayesian optimization. Additionally, the target point $x^\star$ with the radius of the acceptable error tolerance of $3.6\,\mathrm{cm}$ is plotted. The right subplot (Fig. S1 (b)) shows the corresponding predicted tangential velocities for each of the eight different cost functions. As shown in Figure S1 almost all predicted trajectories for the point-to-point movement show roughly straight paths and bell-shaped speed profiles similar to previous findings in the literature (e.g. Abend et al. (1982); Flash and Hogan (1985); Todorov (2004); Harris and Wolpert (1998)). This makes it almost impossible to decide which cost function is the true one based on the given task since they all have a good neurophysiological basis and predict very similar trajectories.

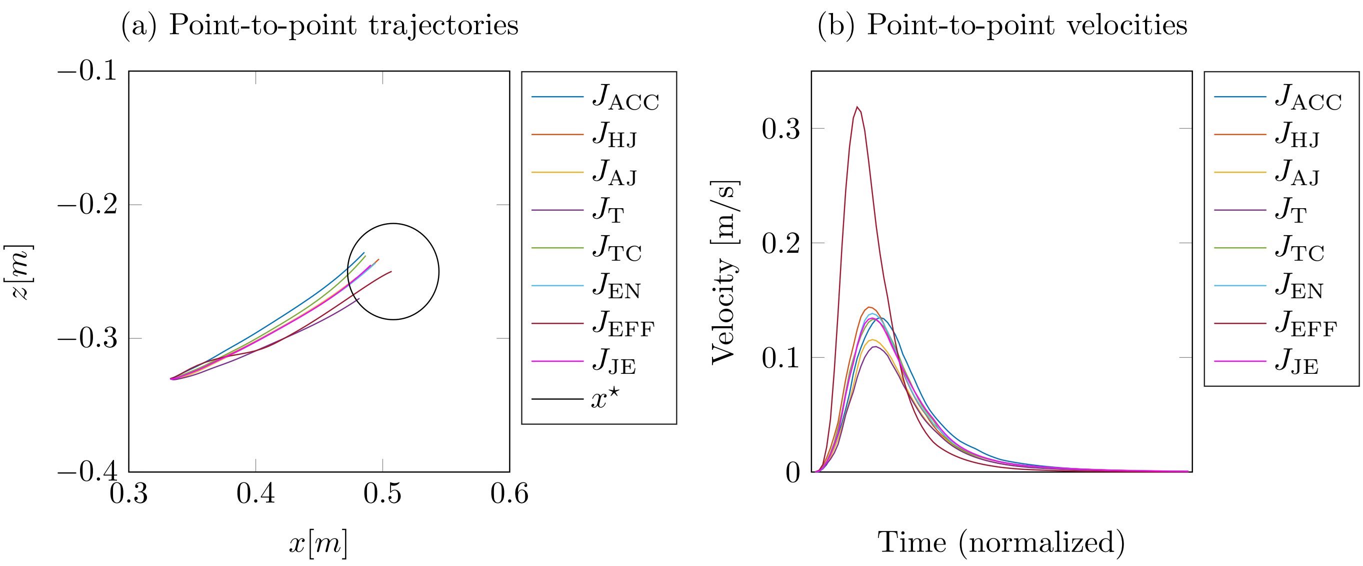

Figure S1. (a) The best predicted trajectories for the fingertip movement pointing to the target point $x^{\star}$ are shown. Eight different cost functions are compared. (b) The respective predicted tangential velocities for each of the eight different cost functions are shown.

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