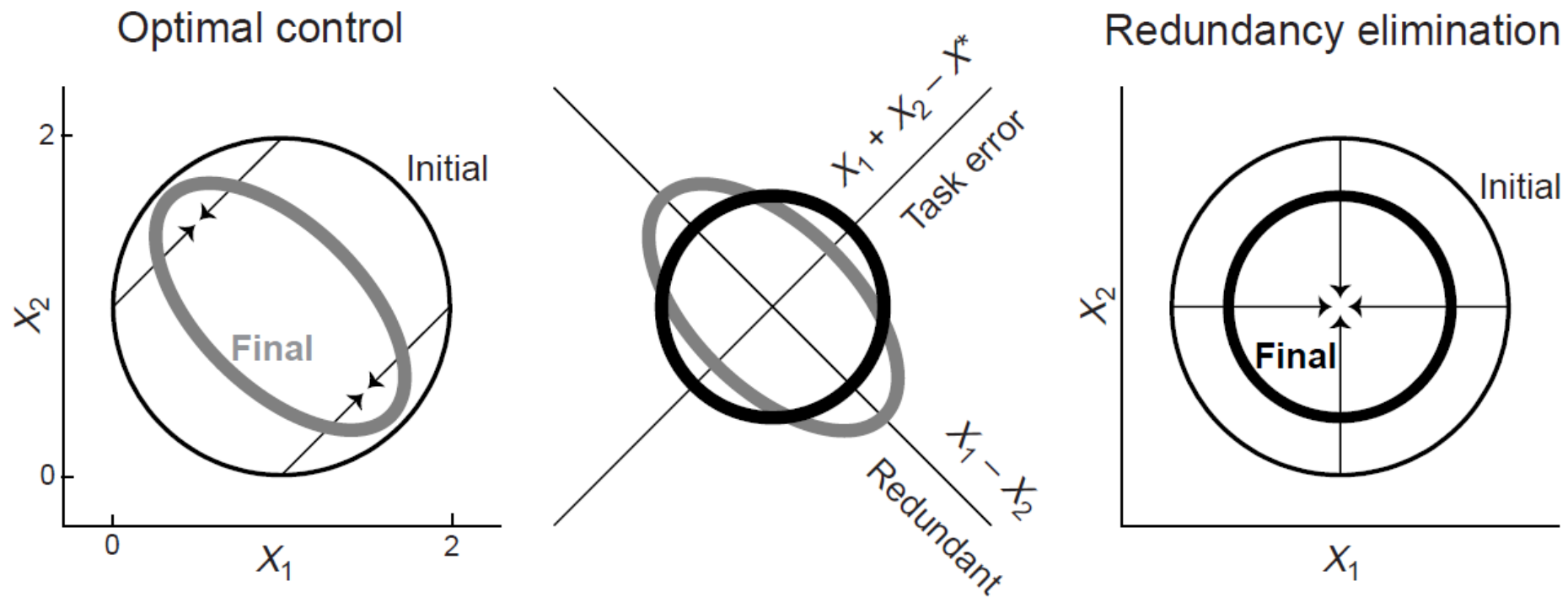


Spinal stretch reflexes support efficient hand control

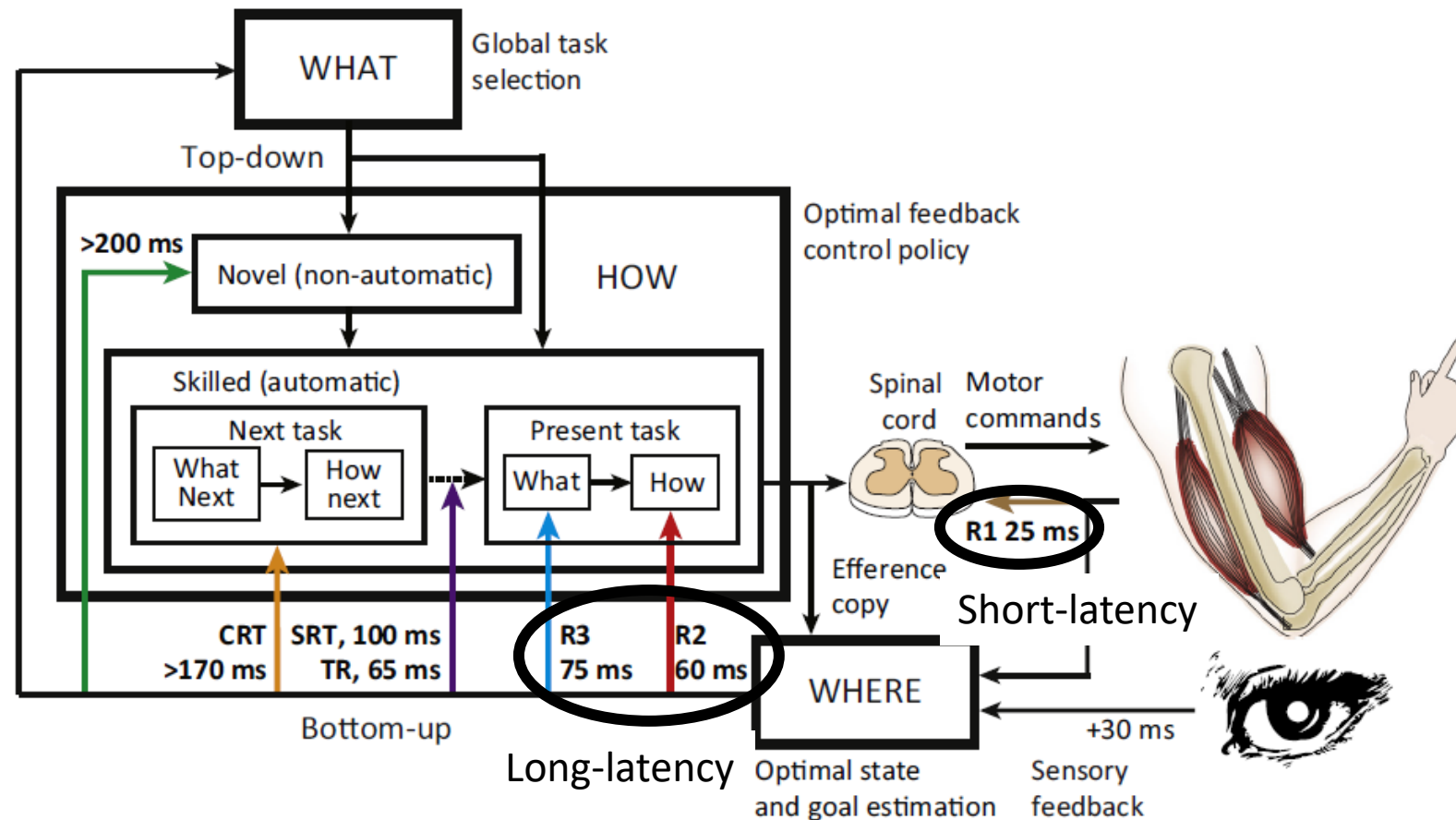
Jeffrey Weiler ^{1,2,3*}, Paul L. Gribble ^{1,2,3} and J. Andrew Pruszynski ^{1,2,3,4*}

Optimal feedback control

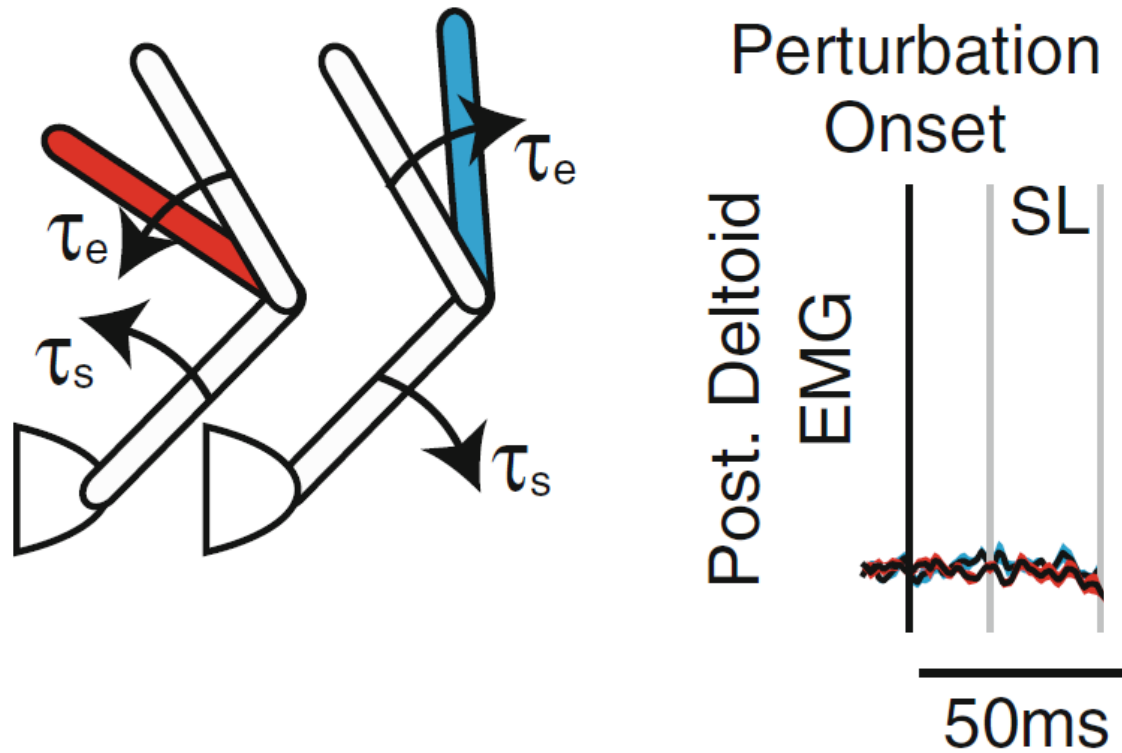
- Task-specific adaptations to perturbation and uncertainty



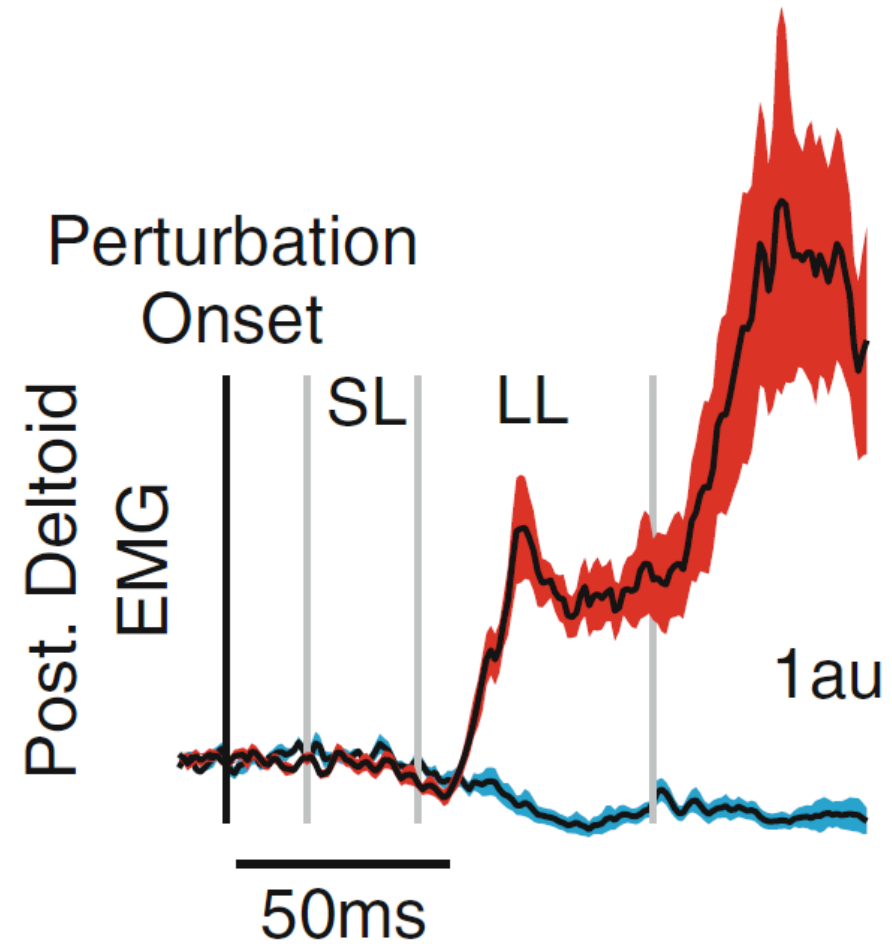
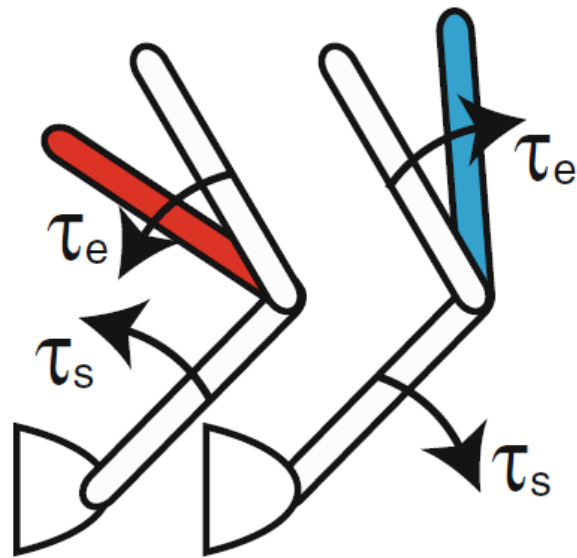
Hierarchy of motor control phenomena



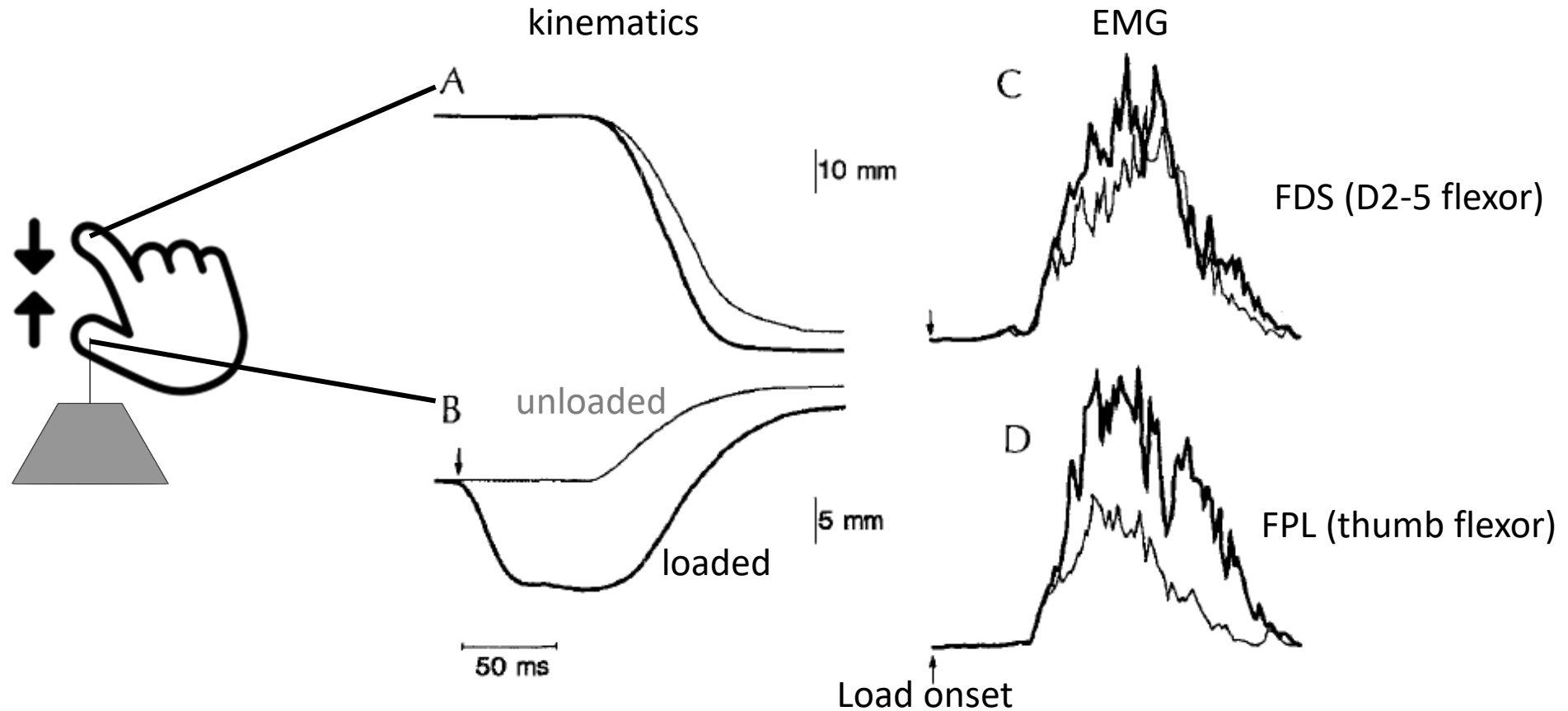
Short-latency: muscle-restricted



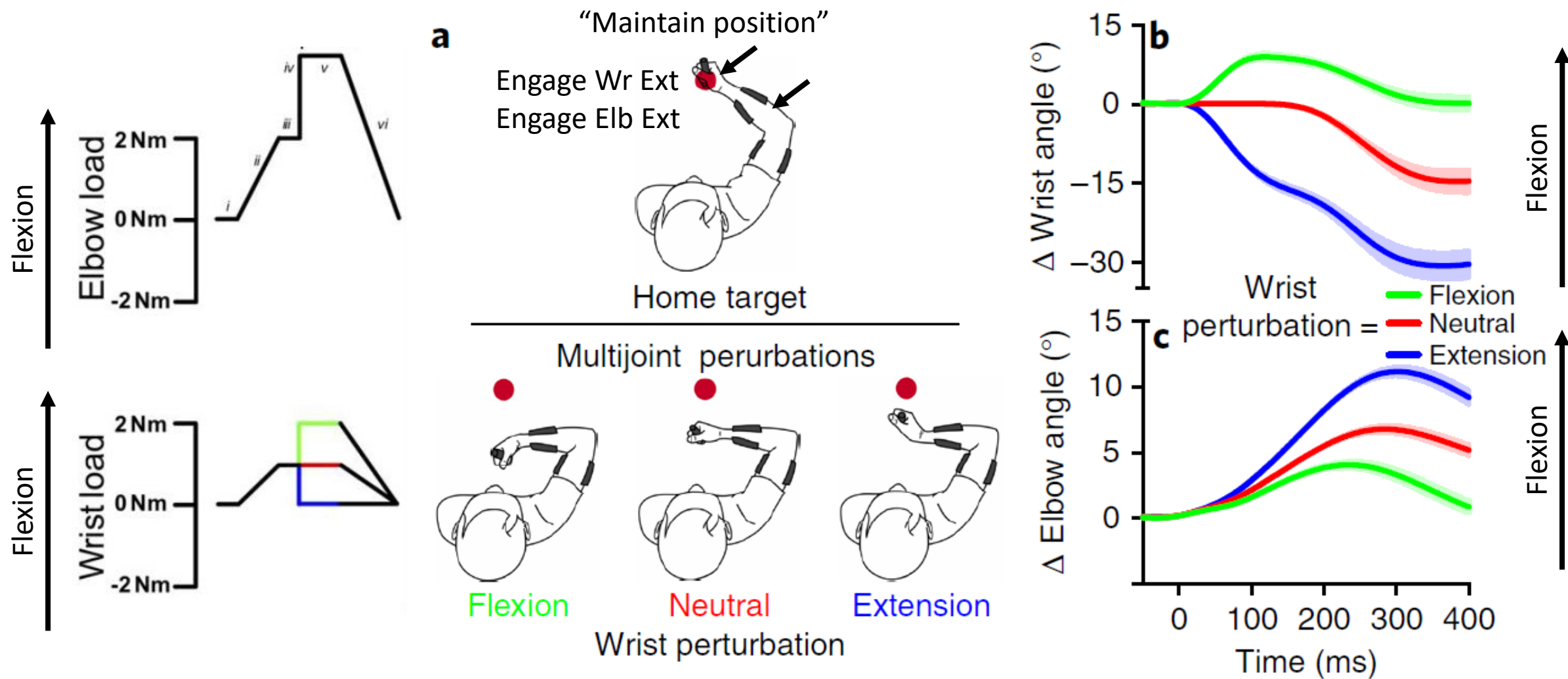
Long-latency: higher-level



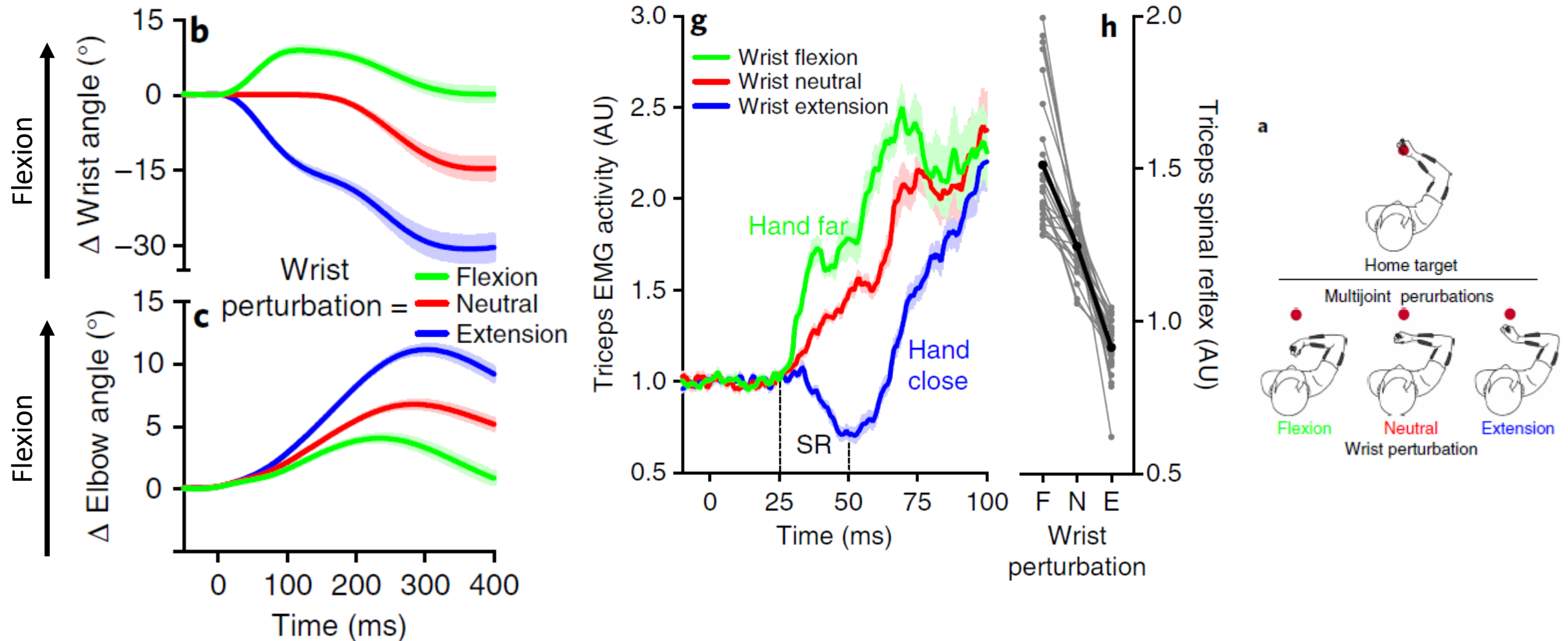
Does this hold further distal?



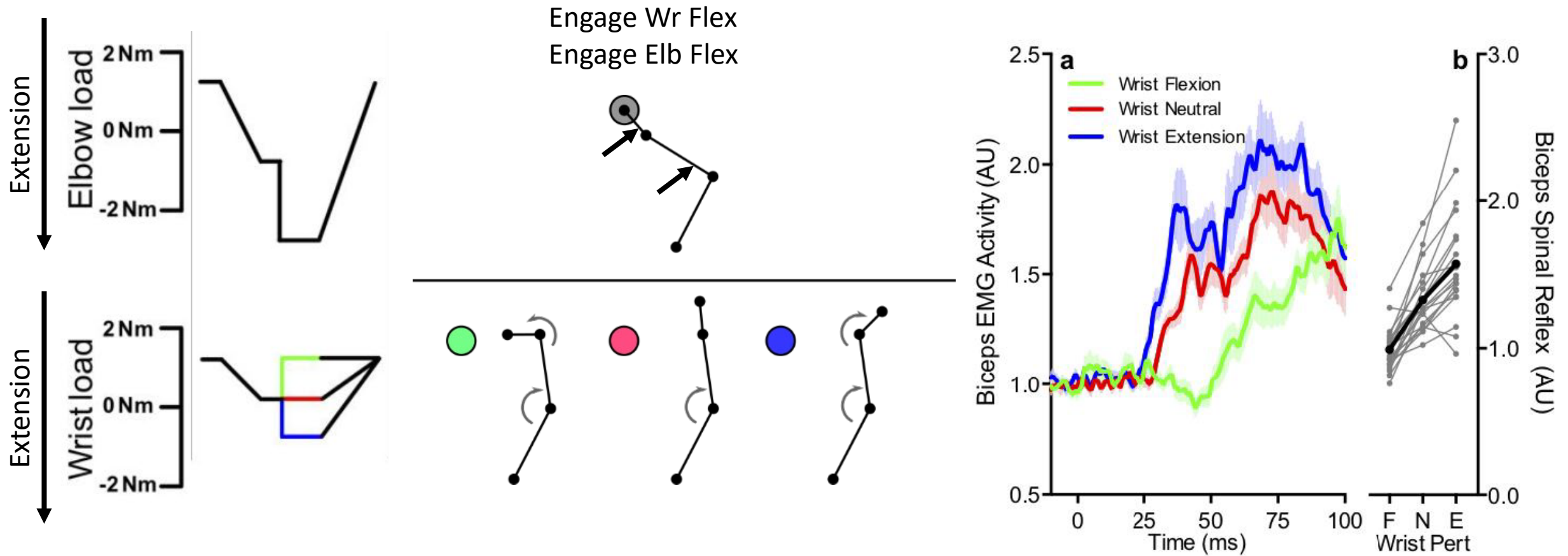
Experiment



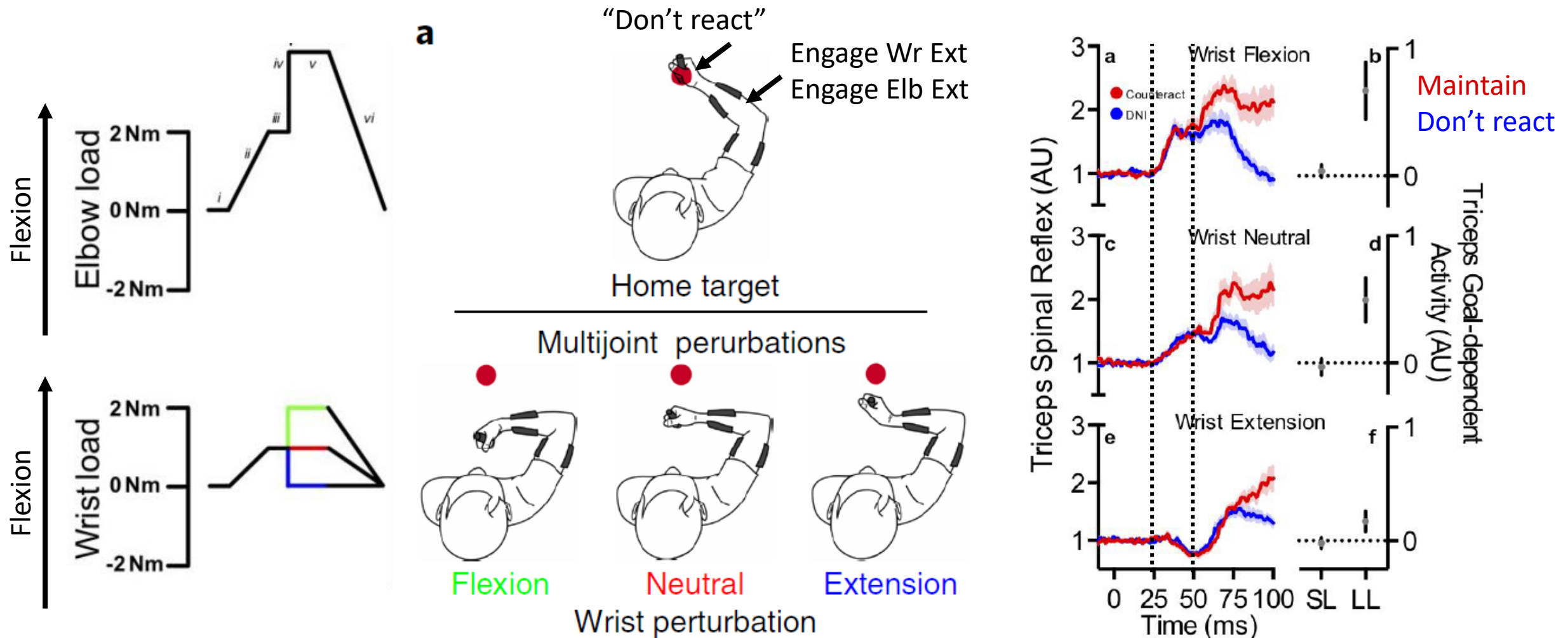
Result: fast reflex is tuned to goal, not muscle



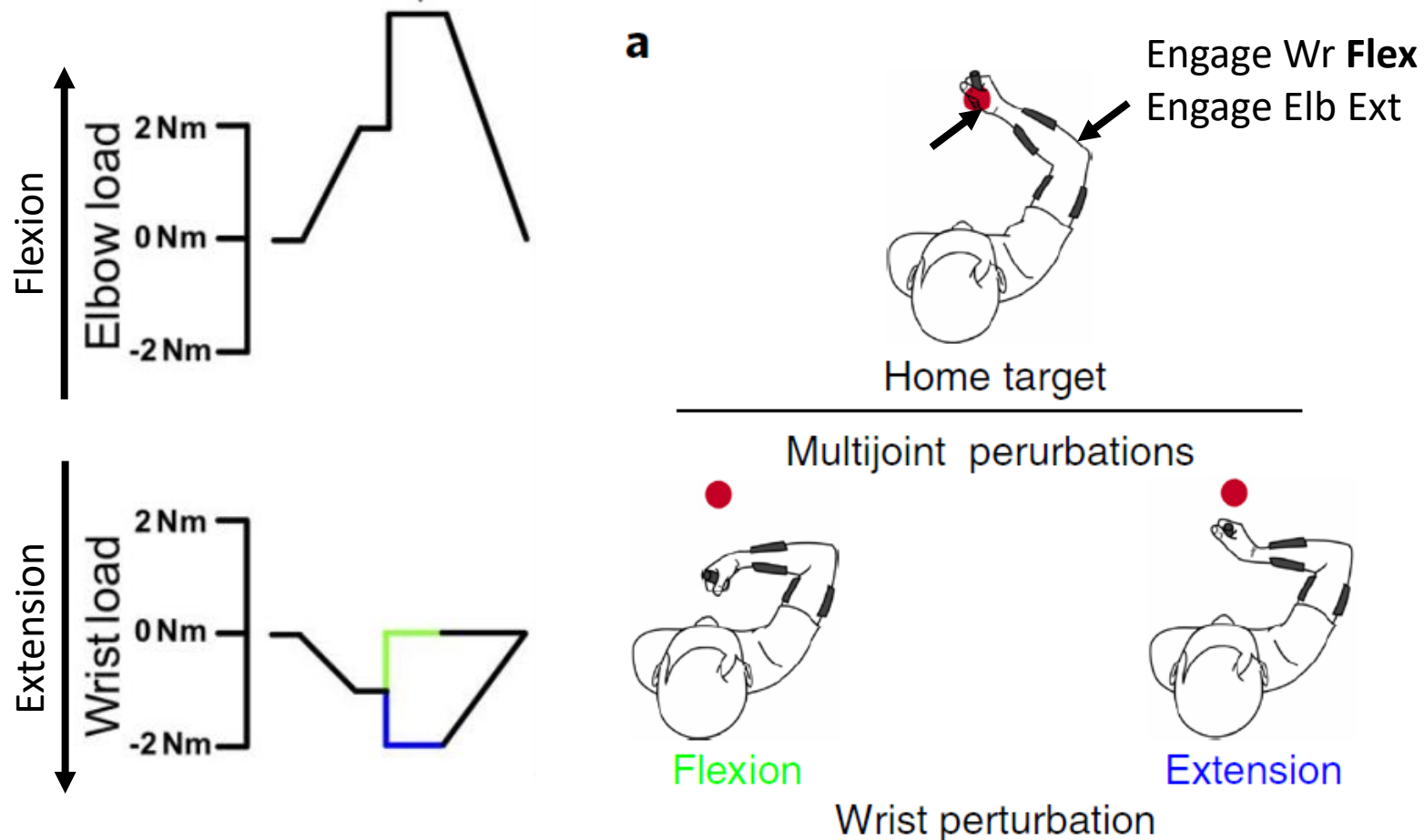
Flexor reflex follows similar rules



Goal modulation at the periphery? Another experiment:



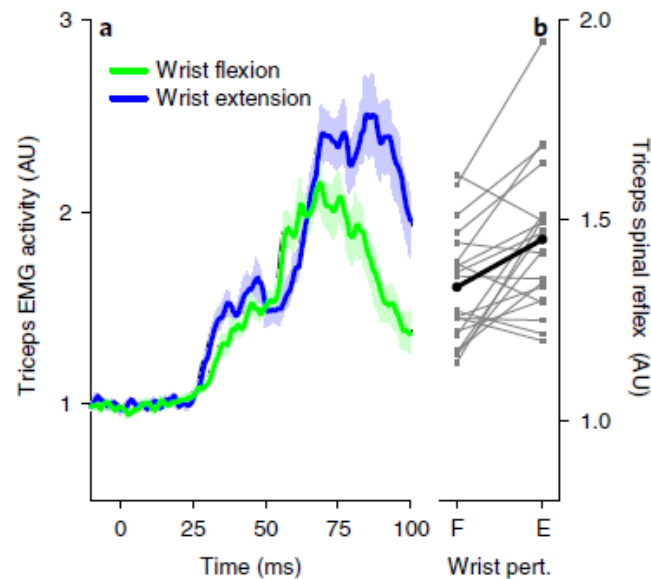
Testing for dependence on spindle sensitivity



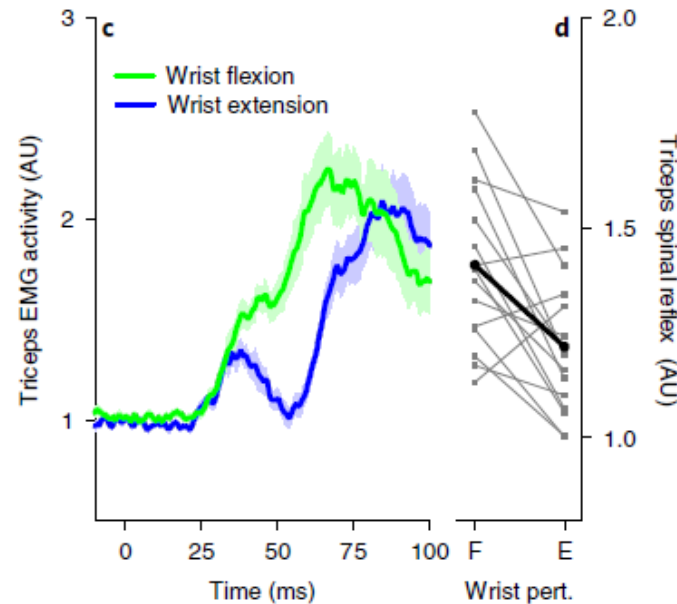
Spindle sensitivity seems to dictate reflex tuning

(Putatively)

De-sensitized wrist extensor spindles
(applied extension load)

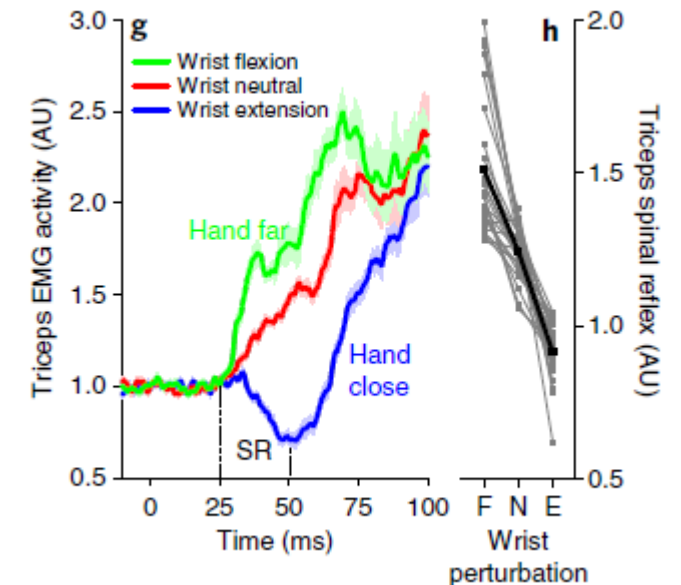


Normal sensitivity
(no applied load)

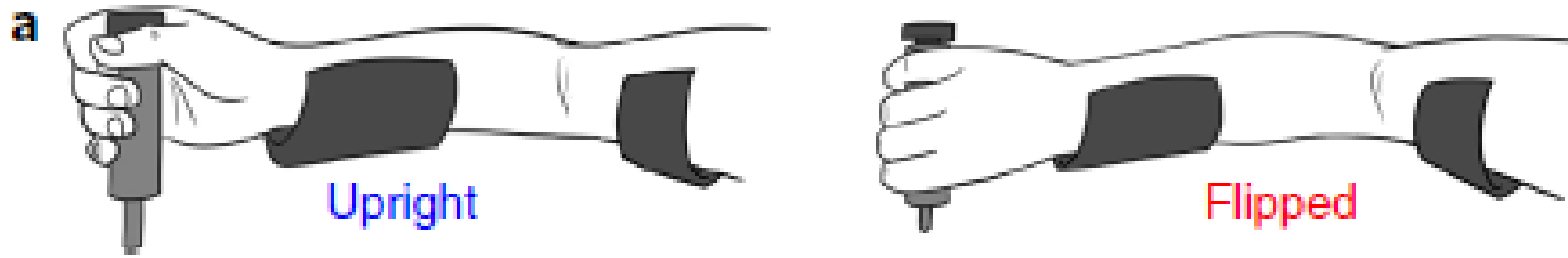


(Putatively)

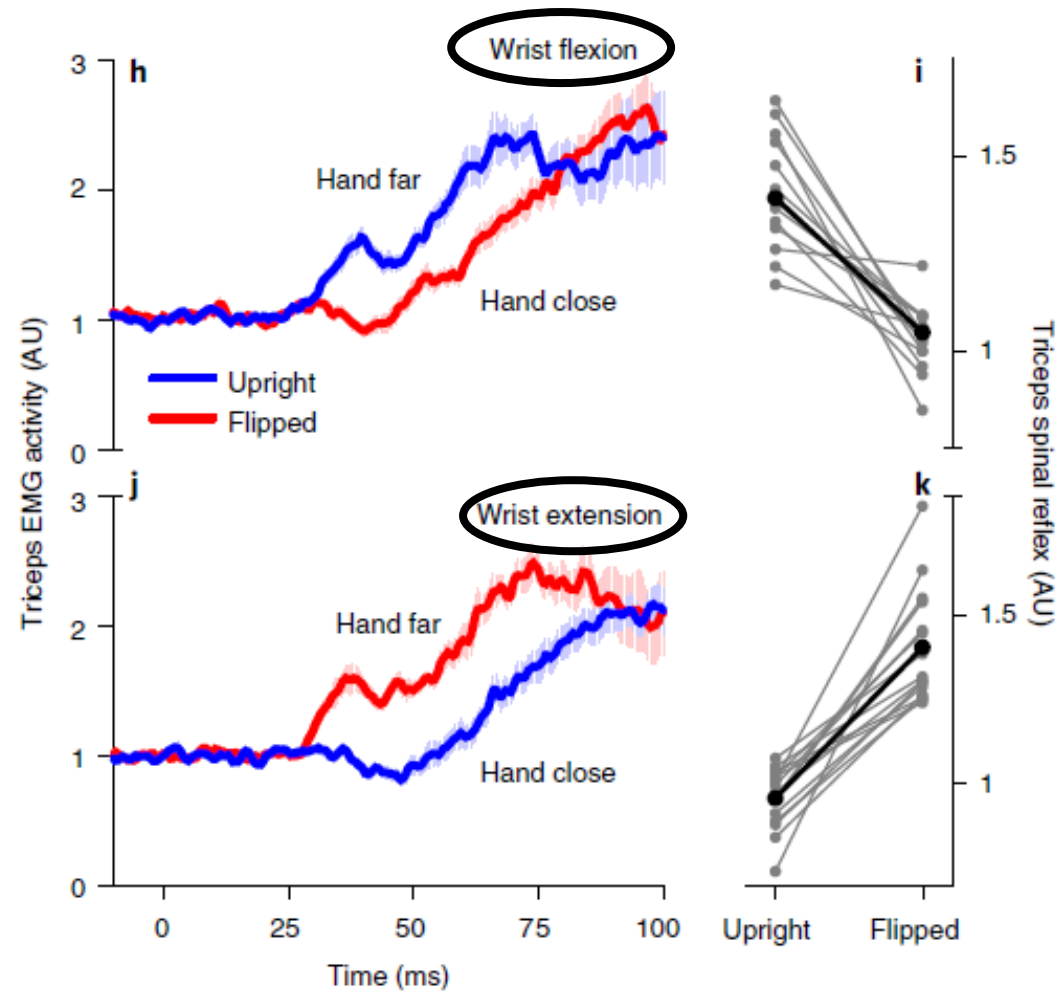
Hyper-sensitized wrist extensor spindles
(applied flexion load)



Wait: is this hard-wired to specific muscles?



Reflex re-maps for different arm orientations



Conclusions

- Spinal reflexes seem to act in extrinsic space in the distal upper limb
 - This contrasts with what is seen in the proximal limb
 - This result may hold for reflexive digit movements?
-
- Spinal reflexes: more sophisticated than we thought?
 - Spinal reflexes: most sophisticated for hands than shoulders?