Postural representations of the hand in primate sensorimotor cortex

James Goodman
Bensmaia Lab
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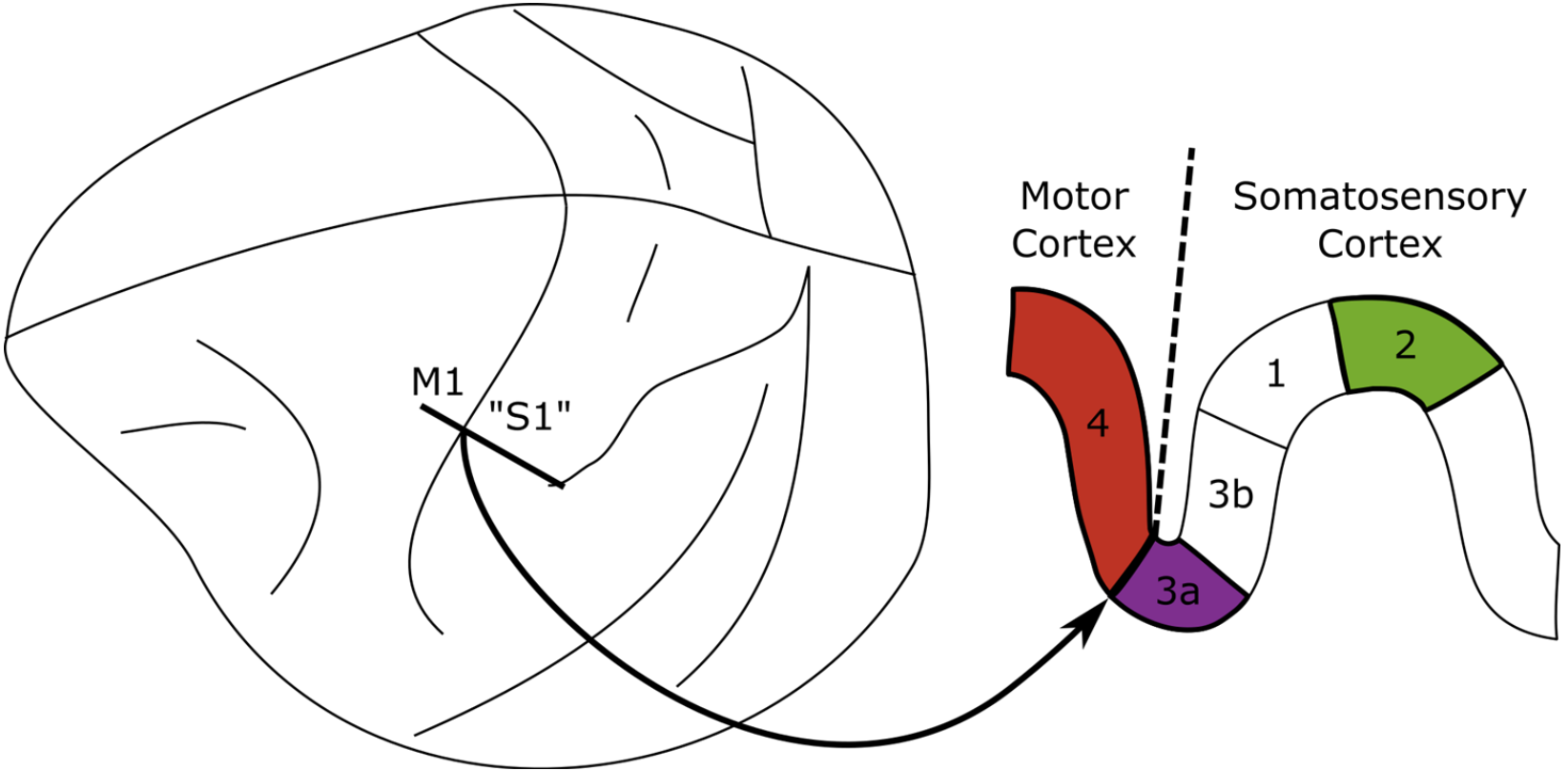
The versatile hand

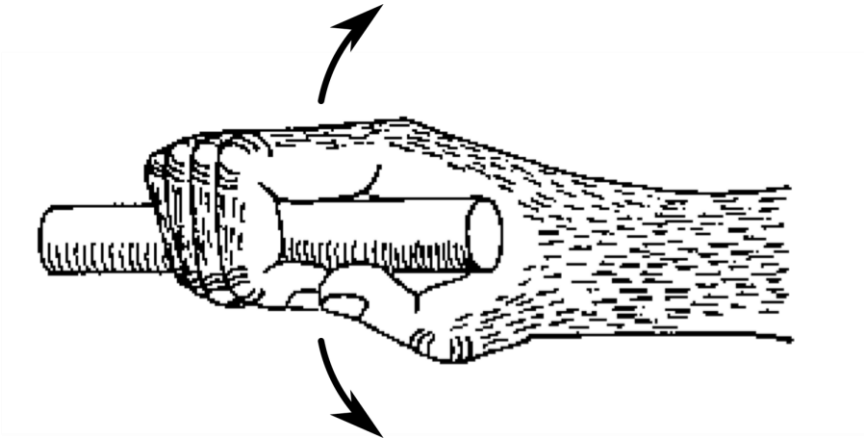
The sense of proprioception

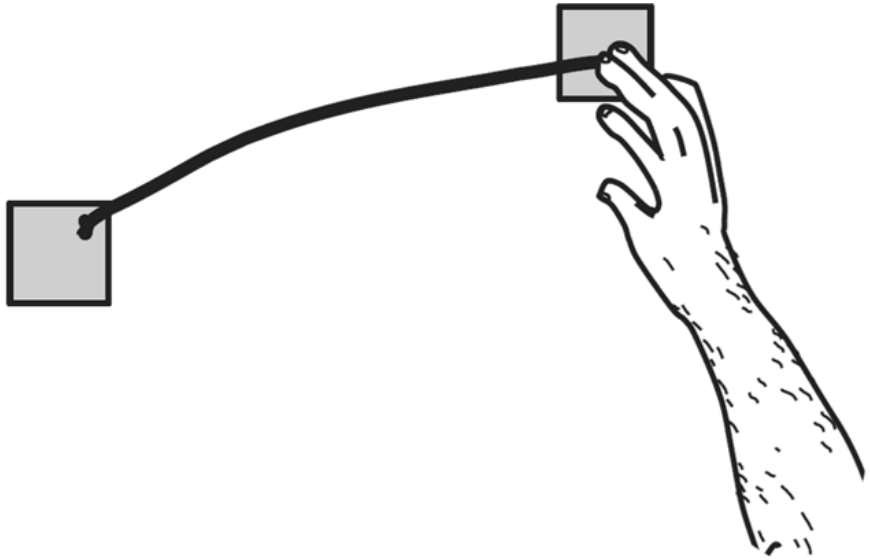
Hands need sensory feedback

Sensory and motor cortex



Most neural coding research

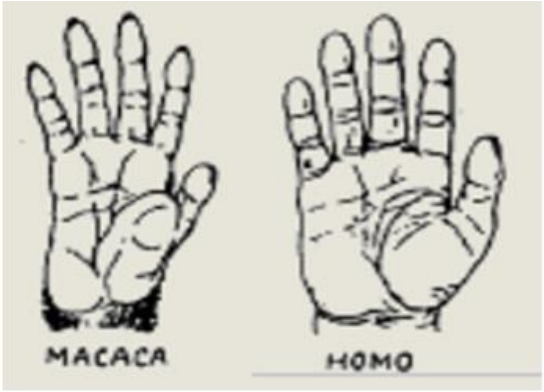




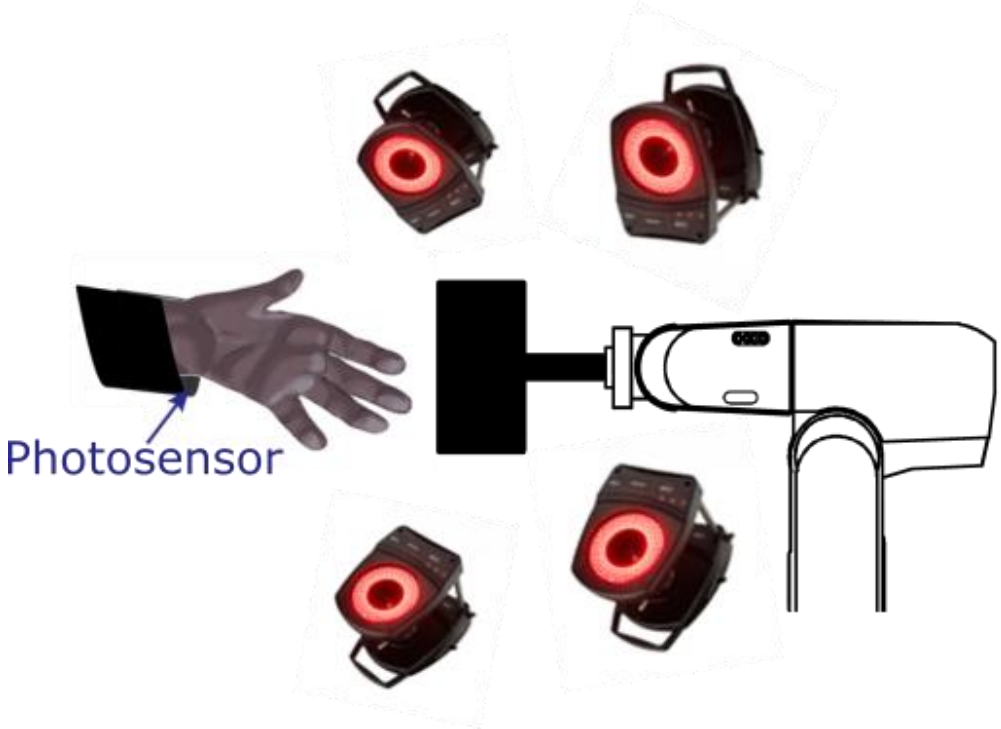
Is it the same for the hand?

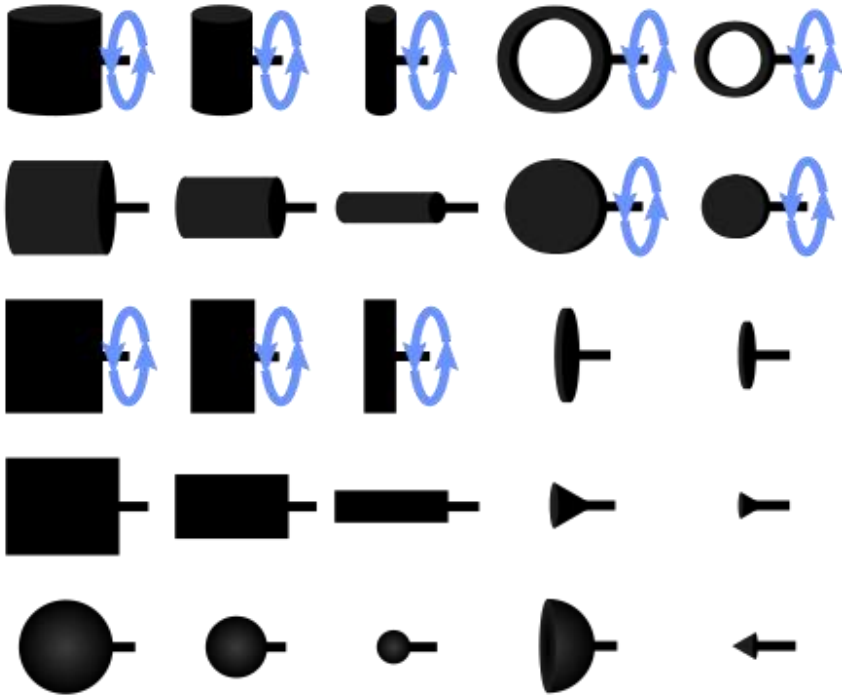
Experiment

Monkeys have versatile hands

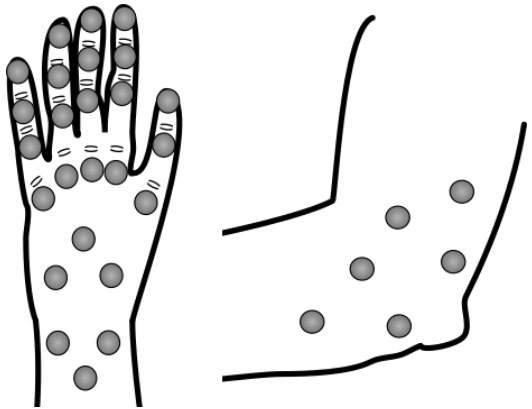


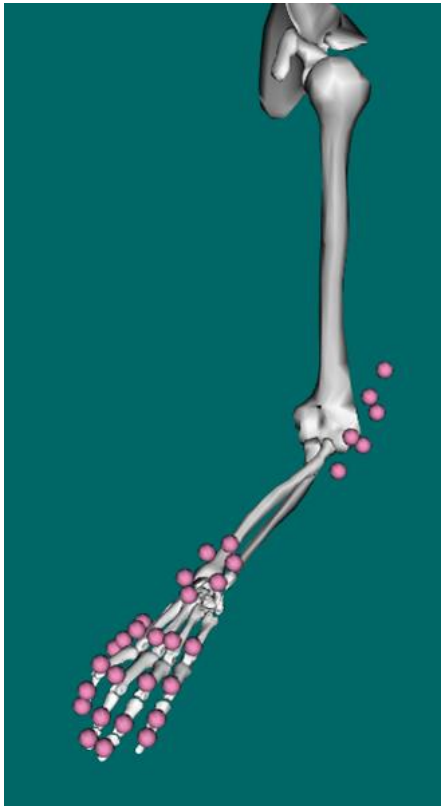
Behavior



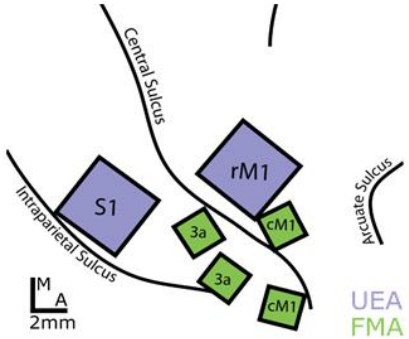


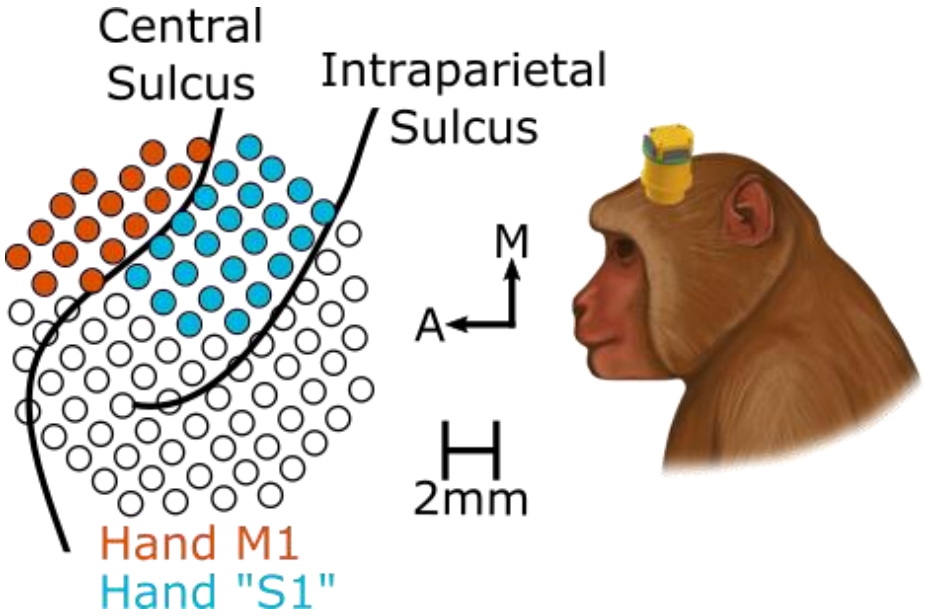
Hand movement recordings





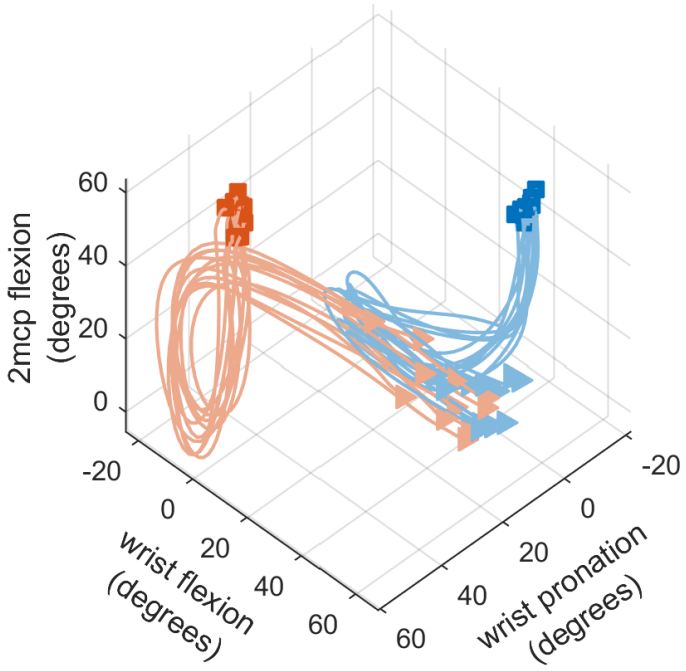
Cortex implants

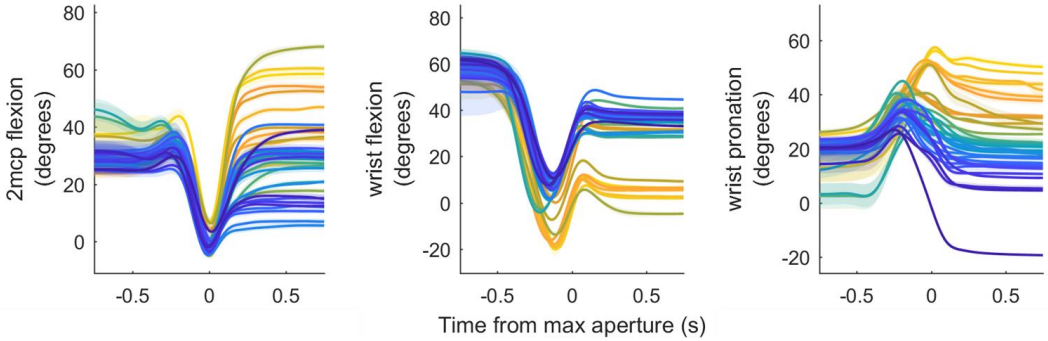




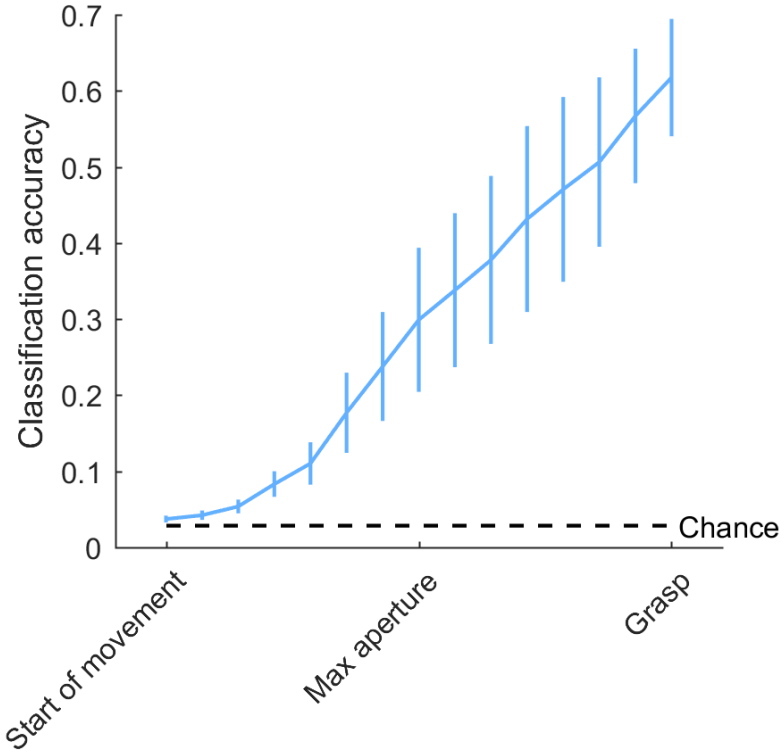
Task in action

Hand movement variety

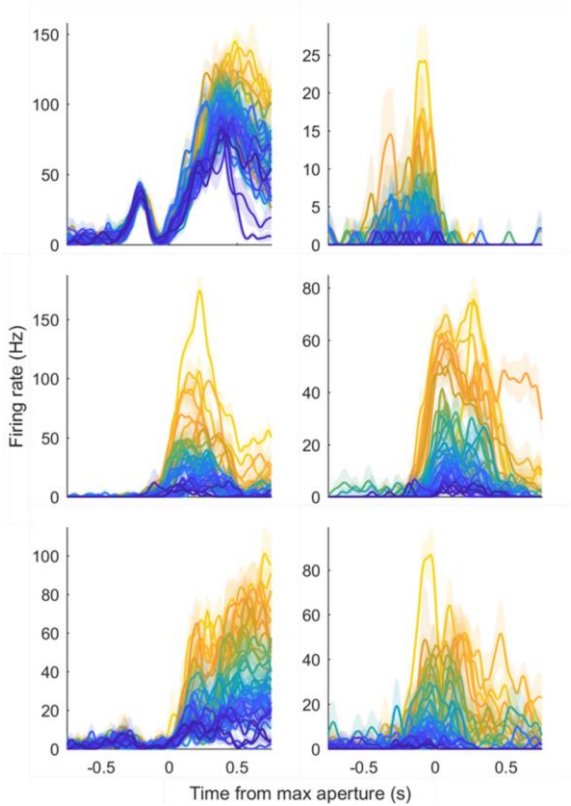




Hand movement variety

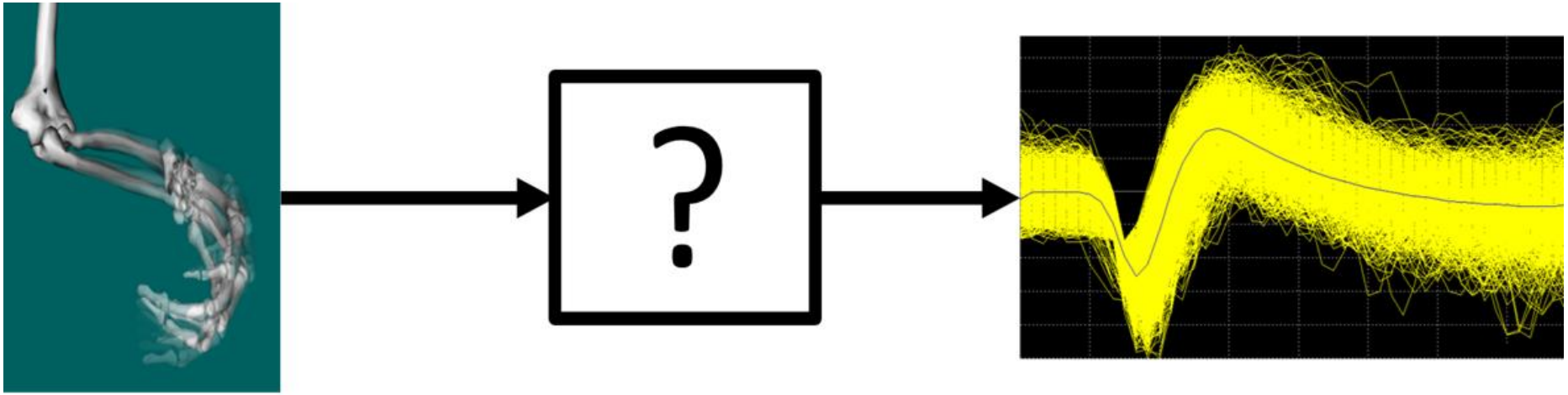


Neural response variety

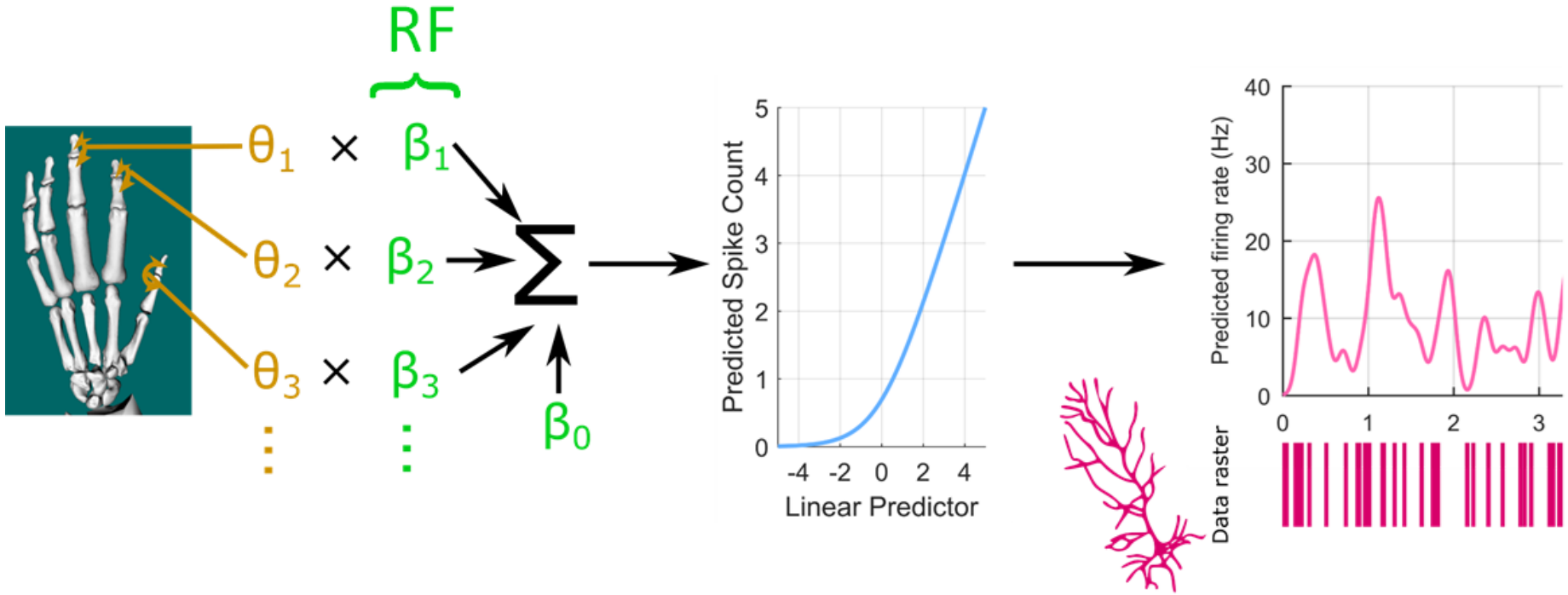


Analysis and Results

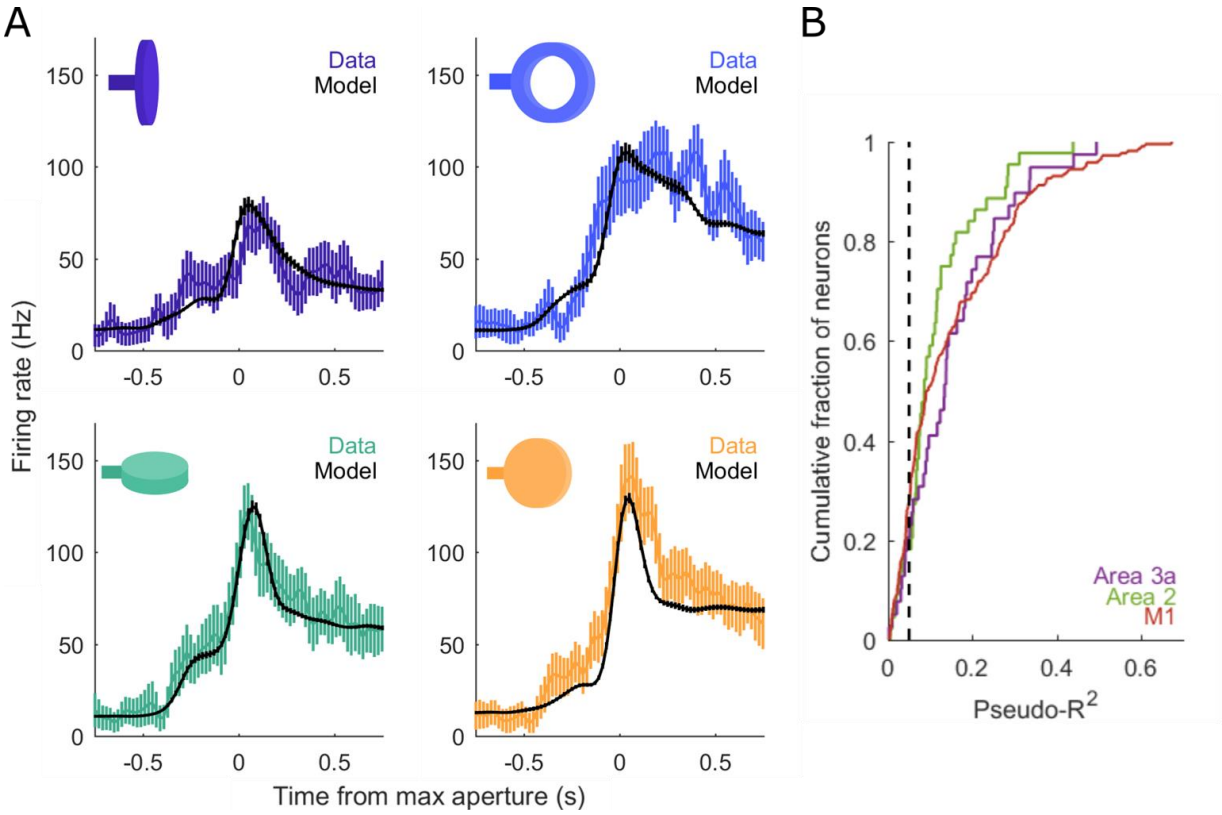
Finding a neural code



Generalized linear model

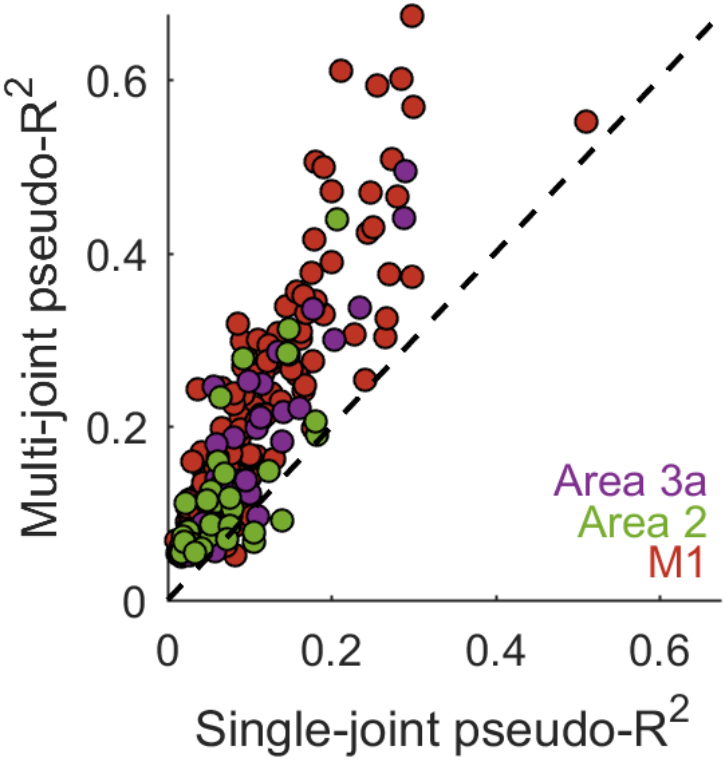


Goodness-of-fit

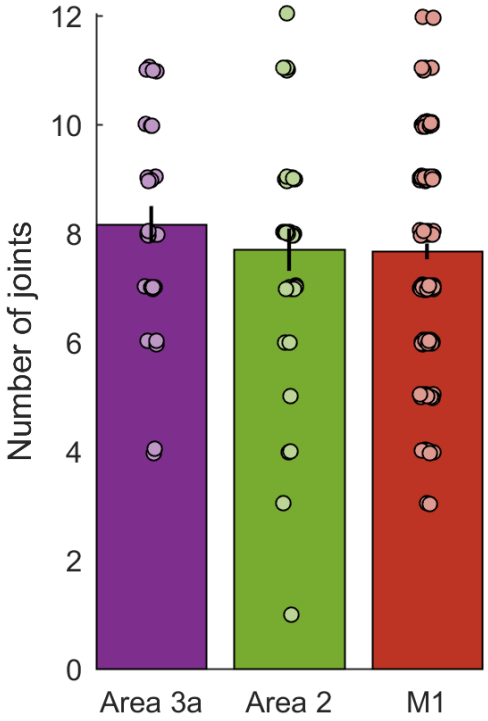


Receptive field (RF) sizes

RFs are larger than a single joint

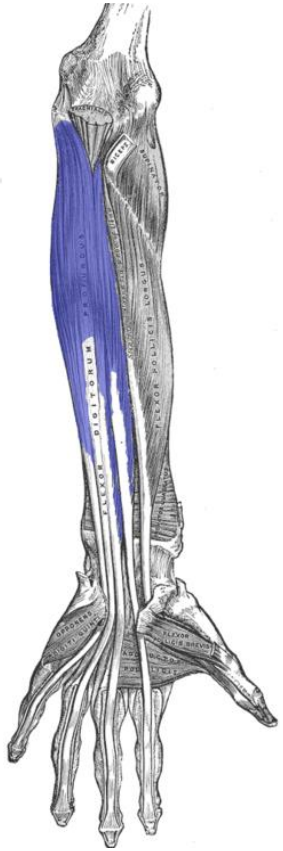


RFs are large

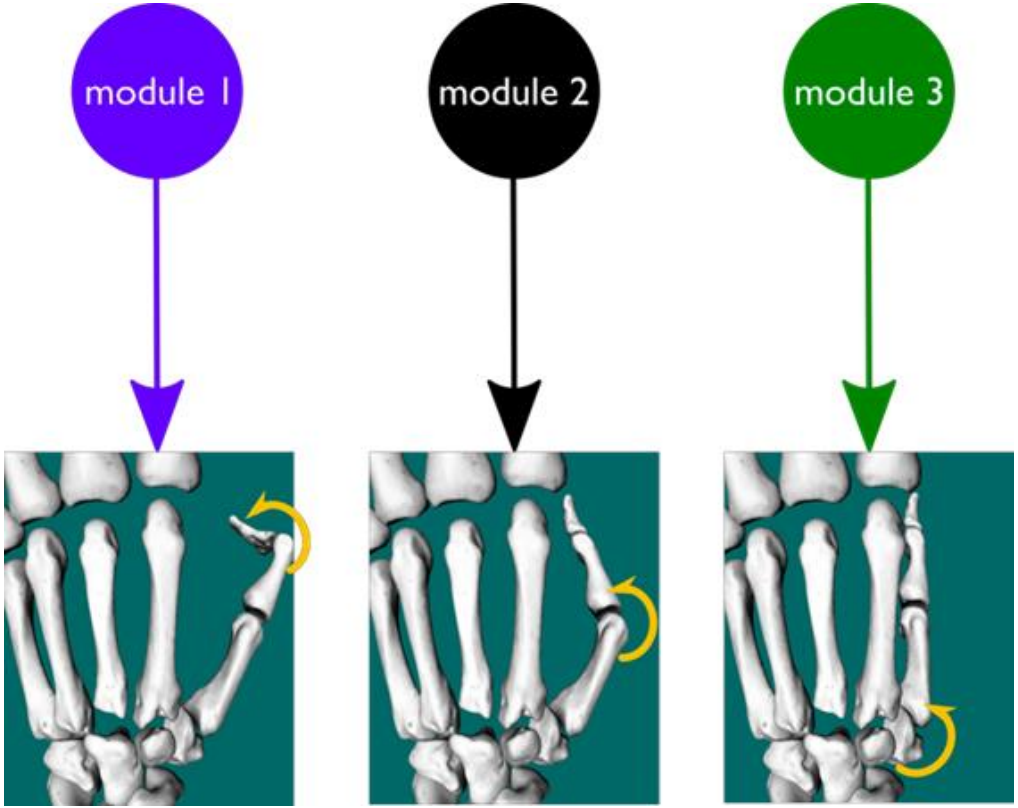


Other possible codes

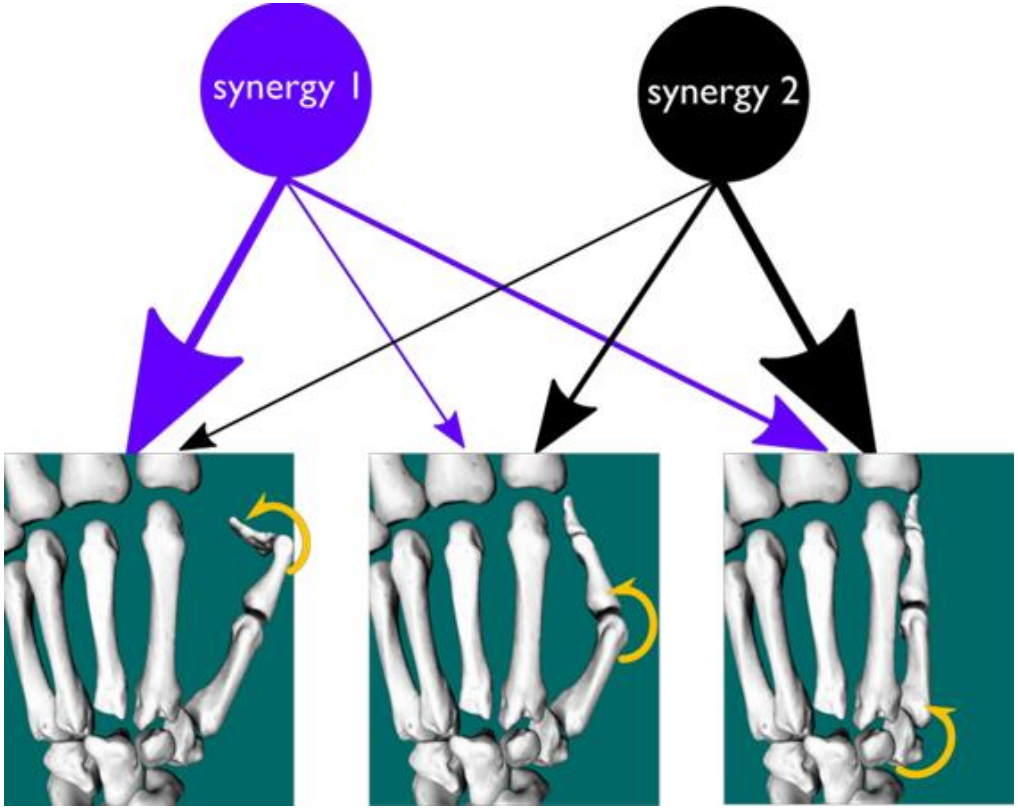
Muscles


BRACHIALIS
BRACHIORADIALIS
EXTENSOR CARPI RADIALIS LONGIOR
EXTENSOR CARPI RADIALIS BREVIOR
EXTENSOR DIGITORUM
EXTENSOR DIGITI MINIMI
EXTENSOR CARPI ULNARIS
ANCONEUS
FLEXOR CARPI ULNARIS

Synergies



Synergies

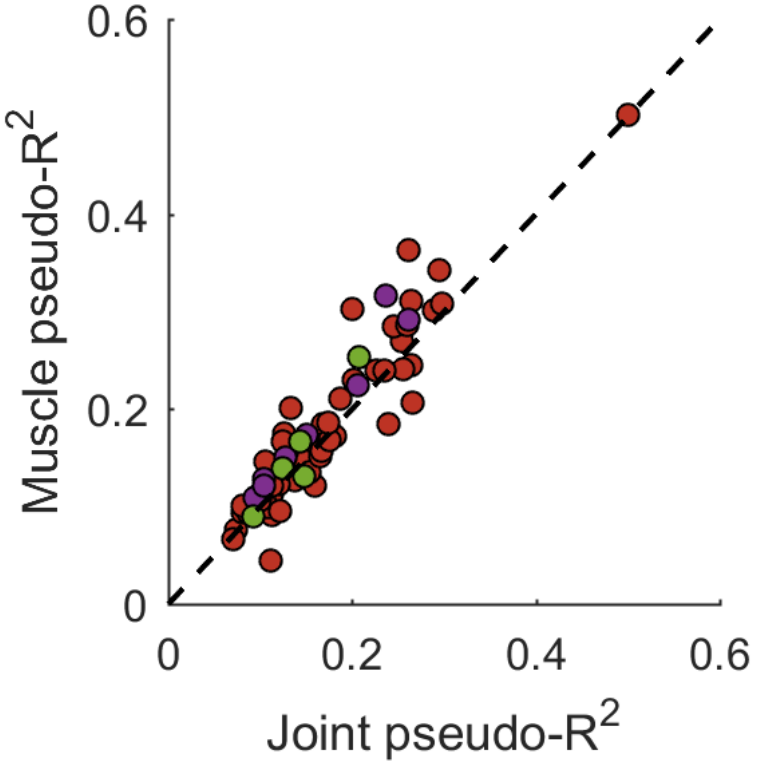


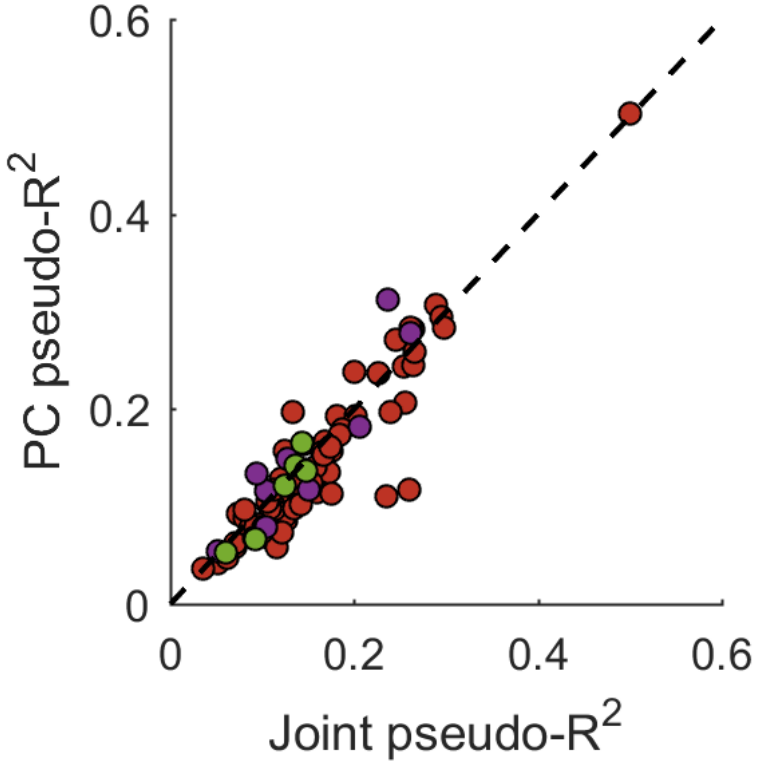
What could a “good code” mean?

- “Labeled line”?

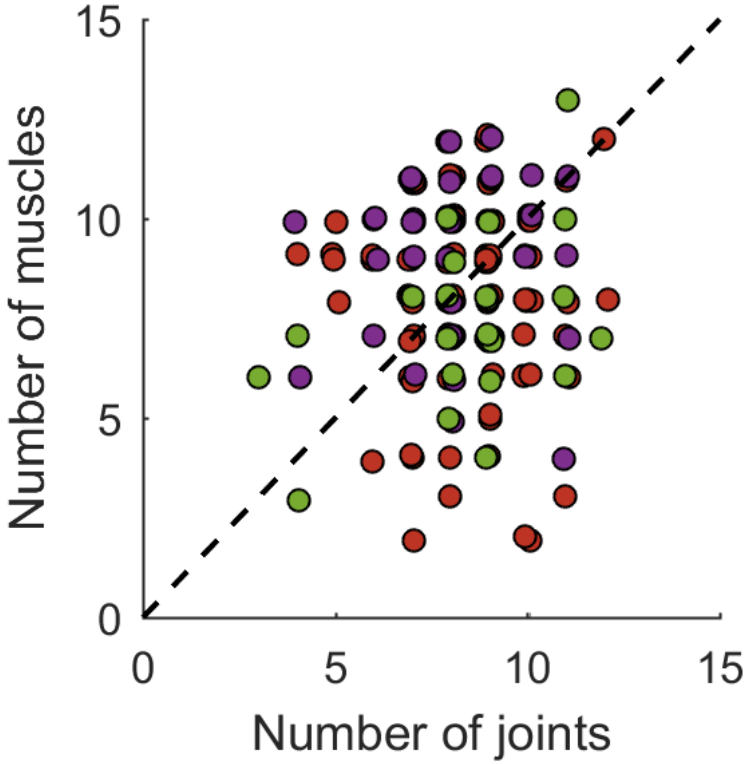
- Neurons track fewer muscles or synergies

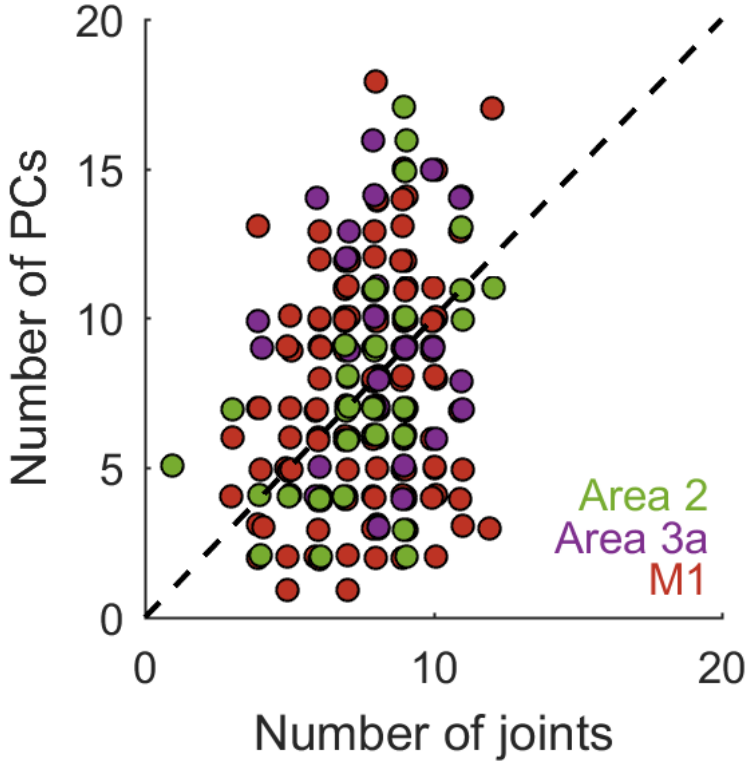
Single muscles or synergies: barely a difference





Multiple muscles or synergies: no fewer



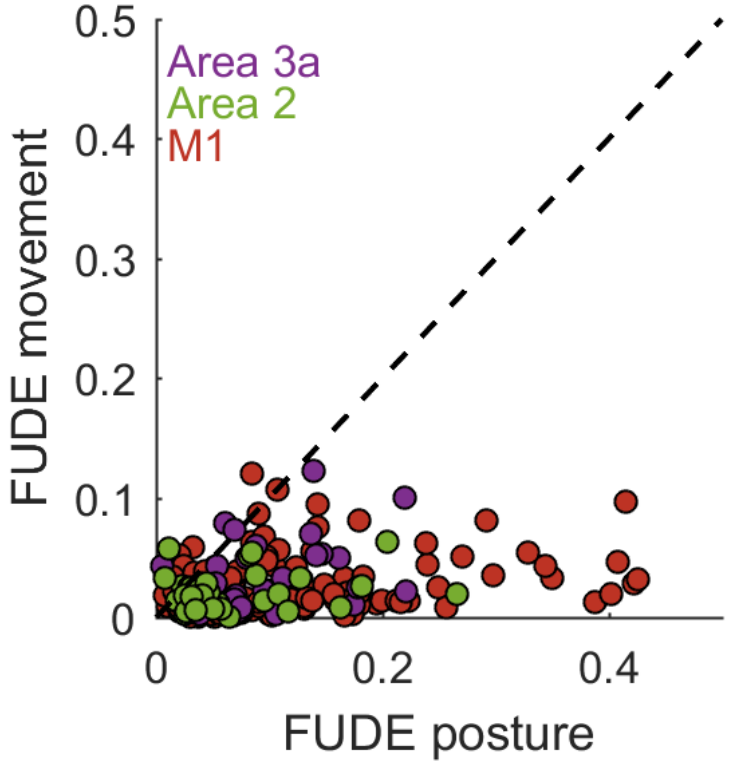


Postures vs. Movements

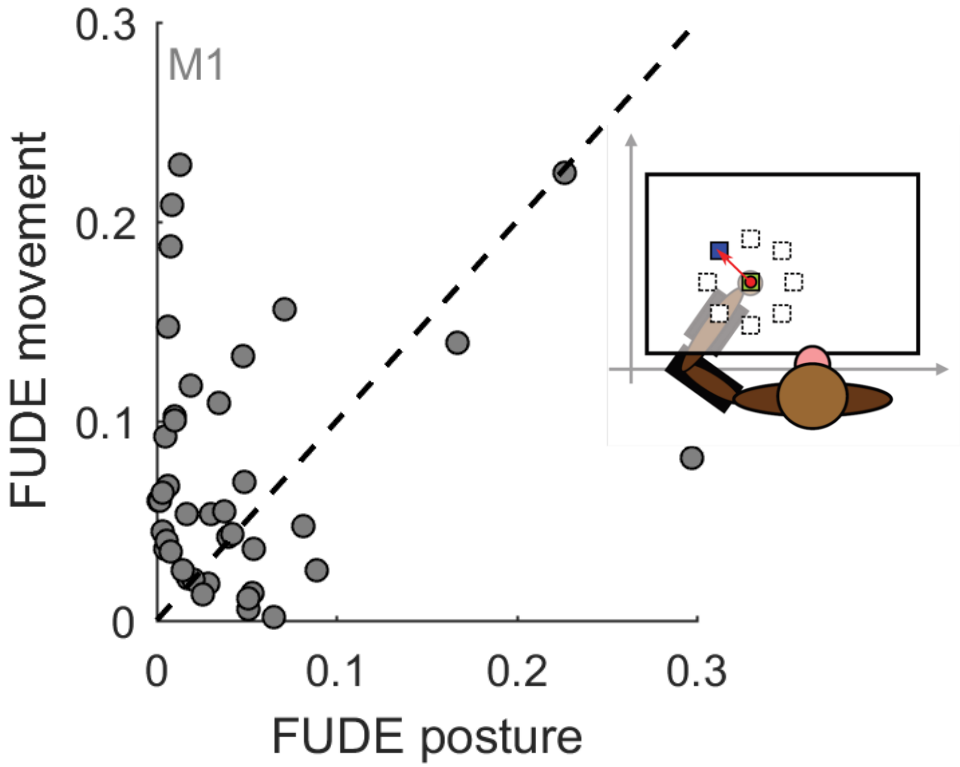
Fraction of unique deviance explained (FUDE)

$$\mathrm{FUDE}(X|Y) = 1 - \frac{dev(X,Y)}{dev(Y)}$$

Neurons prefer postures over movements



During reach, movements are preferred



Discussion and Conclusions

Summary of results

- Large RFs
- No simple preferred coordinate frame
- Posture, not movement
- Sensory and motor are similar

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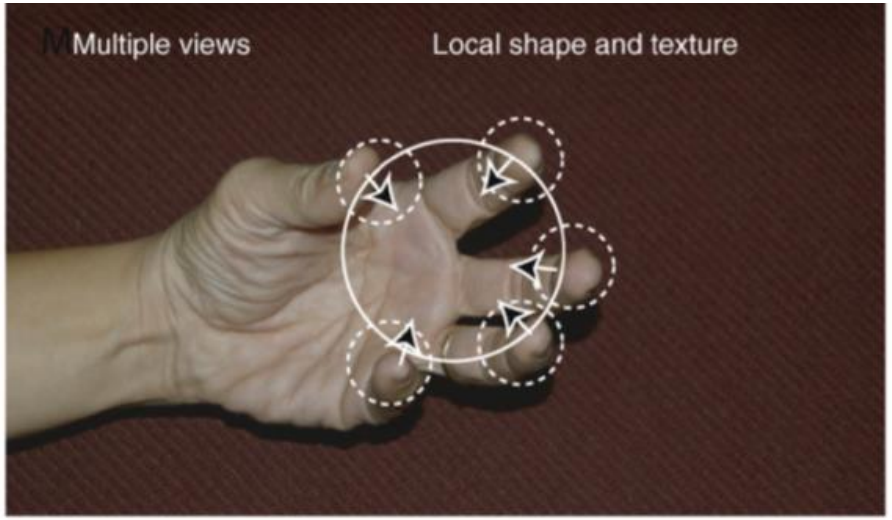
Stereognosis



Summary of results

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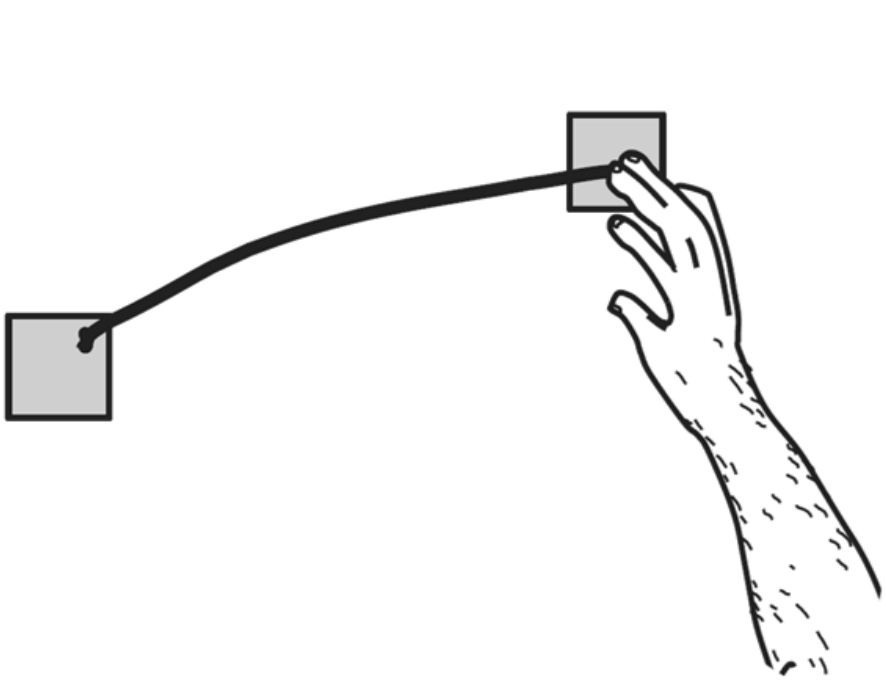
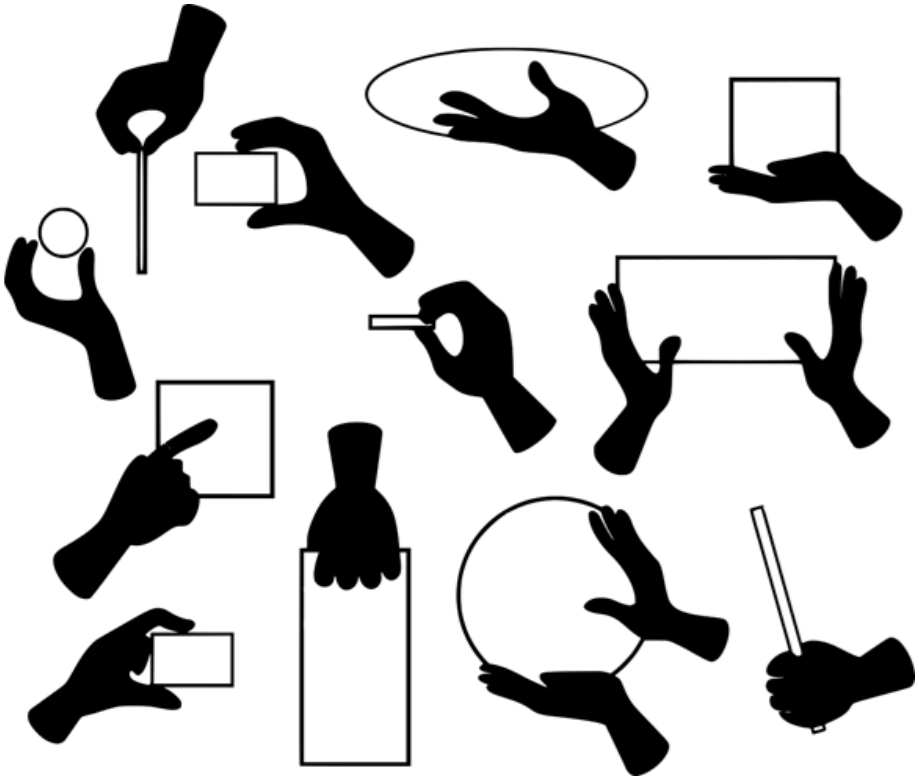
Arm and hand are different





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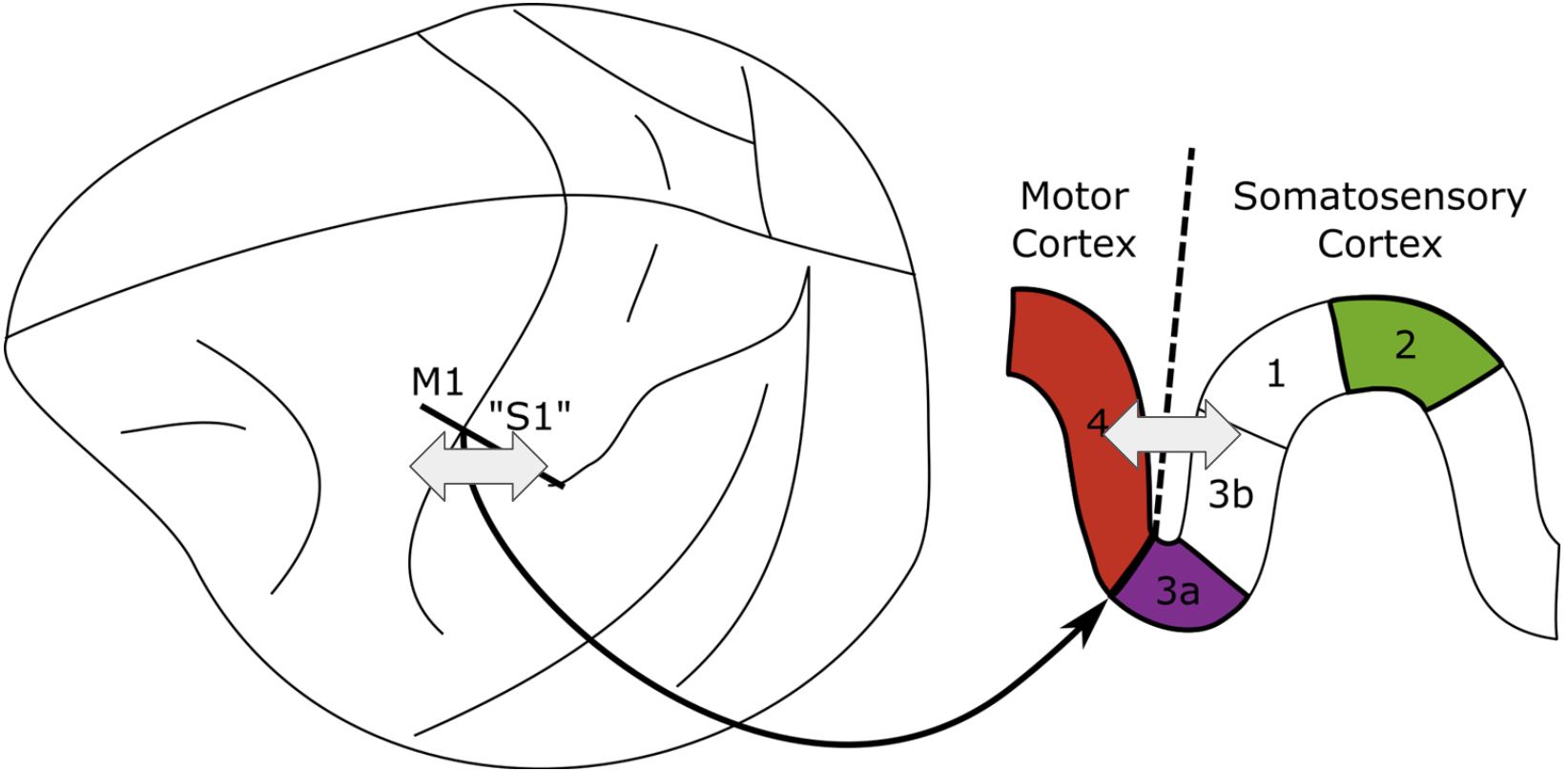
Sensory-motor communication



Thank you