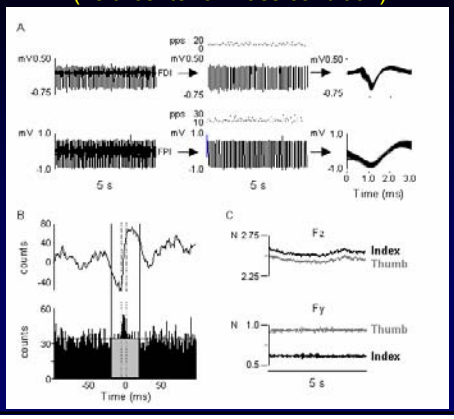
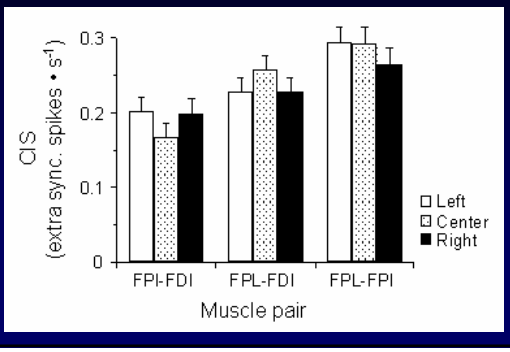
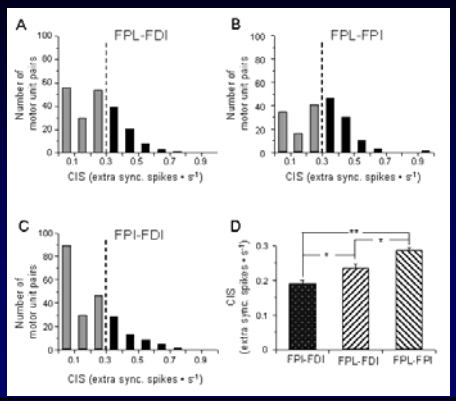
Object hold with thumb and index finger
("left" center of mass condition)



Motor unit synchrony across muscle pair is not modulated to object CM



Across-muscle motor unit synchrony was very weak.



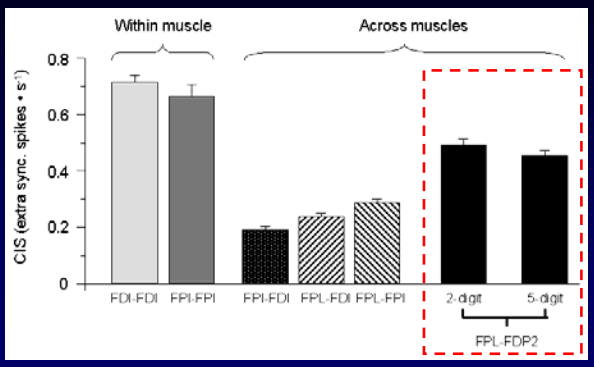
The results of our study on intrinsic muscles indicate that the strength of correlated neural input is not sensitive to modulations in the functional relation between muscles.

This finding is consistent with that found when grip type was changed. Both of these findings suggest that motor unit synchronization is not modulated to task requirements.

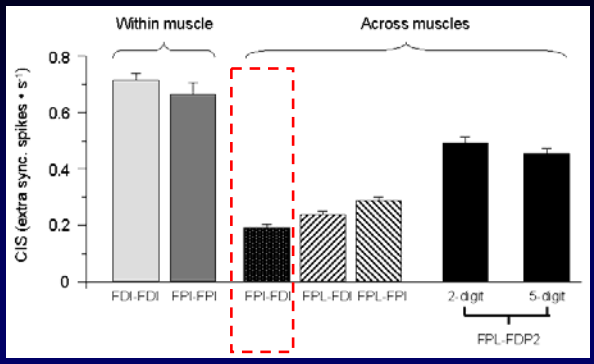
The **BIG** picture …

A comparison between these and previous results allows to gain further insight about the organization of neural inputs to hand muscles.

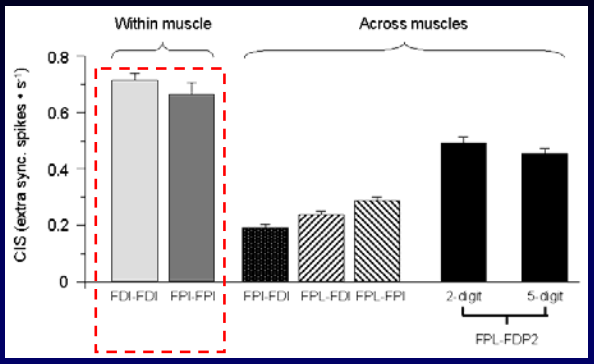
ACROSS-MUSCLE motor unit synchrony
* *extrinsic muscles* *



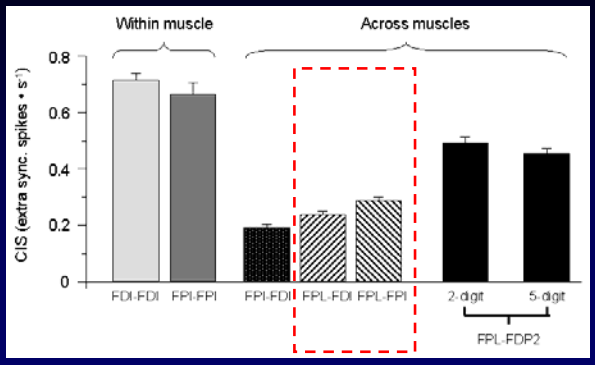
ACROSS-MUSCLE motor unit synchrony
* *intrinsic muscles* *



WITHIN-MUSCLE motor unit synchrony
* *intrinsic muscles* *



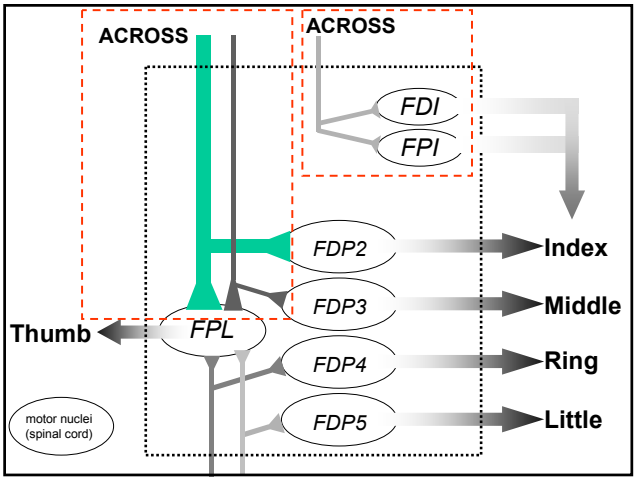
ACROSS-MUSCLE motor unit synchrony
* *intrinsic-extrinsic muscles* *



CONCLUSIONS [1]

- ACROSS-*extrinsic* muscle synchrony is much stronger (> 2-fold difference) than that ACROSS *intrinsic* muscles.

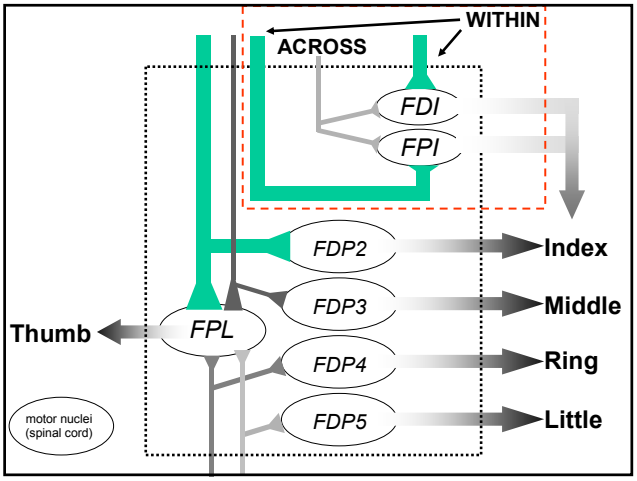
This difference might be related to the higher degree to which muscle activity of extrinsic flexors – acting on different digits - have to be coupled during manipulative actions with respect to intrinsic adductor / abductors acting on the same digit.



CONCLUSIONS [2]

- WITHIN-*intrinsic* muscle synchrony is much stronger (3-fold difference) than that ACROSS *intrinsic* muscles.

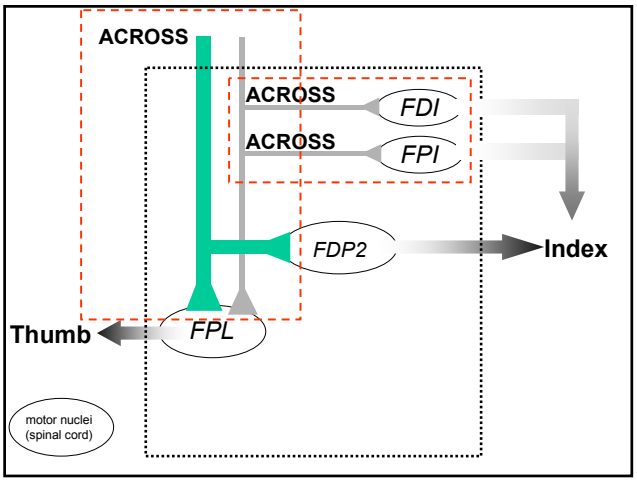
This suggests that neural inputs to motor nuclei of intrinsic muscles are distributed *to maximize coupling of motor unit activity within a muscle while minimizing coupling across different muscles*. Weak coupling of intrinsic muscles *with opposite mechanical actions* might be advantageous for fine modulation of digit force direction.



CONCLUSIONS [3]

- ACROSS-*extrinsic* muscle synchrony (FPL FDP2) is stronger than that ACROSS *extrinsic-intrinsic* muscles (FPL-FDI, FPL-FPI).

This suggests that the routing of neural inputs to motor nuclei of extrinsic muscles does not significantly overlap with routing of neural inputs to motor nuclei of intrinsic muscles.



SUMMARY [1]

* Hand control is characterized by coordination patterns (*synergies*) in the kinematic and kinetic.

* The functional coupling of the mechanical degrees of freedom of the hand might be facilitated by neural common input across motor units of different hand muscles.

SUMMARY [2]

* EMG studies have revealed that correlated neural input appears to be distributed in a muscle-pair specific fashion along a gradient that reflect the muscles' functional role.

OPEN QUESTIONS & FUTURE WORK

- *Functional consequences of correlated neural input*: modeling and experimental approaches.

- *Multi-muscle coordination for tool manipulation*: mapping between EMG coordination patterns and behavior.

- *Sensorimotor control of the hand*: integration of multiple sensory modalities for dextrous hand control.

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Coordination of finger motion and grip forces
Amparo Casares, Travis Lambert[3] (Undergraduate Interns)
Sara Winges (Master student)
Matthew Rearick (Postdoctoral Fellow)[1]

Coordination of hand muscle activity during grasping
Sara Winges (PhD student)[2]
Jamie Johnston (Postdoctoral Fellow)[1]
Kurt Kornatz (Postdoctoral Fellow)[1]

Supported by: NIH[1], NSF[2], Whitaker Foundation[3]

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Electrotactile stimulation and Sensory Substitution
Lisa Raleigh[1] (PhD student, *Bioeng*)
Jay Warren[3] **(PhD student,** *Bioeng***)**
Cecil Lozano[2] (PhD student)

Hand shaping during reach-to-grasp
Jamie Lukos (PhD student)
Caterina Ansuini (PhD student, Univ Padova)

Supported by: NSF[1], Conacyt[2], Flinn Foundation[3]

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