# Evidence Refuting the Common Input Notion for Synchronization of Motor Unit Firings

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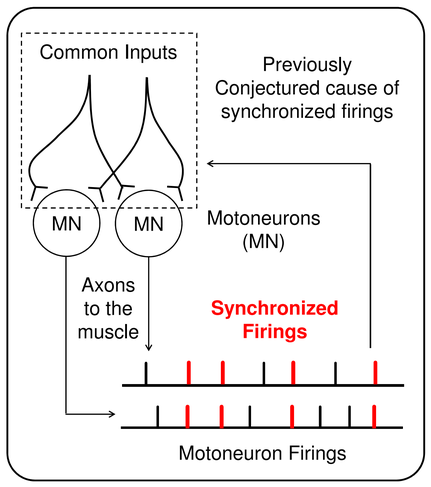
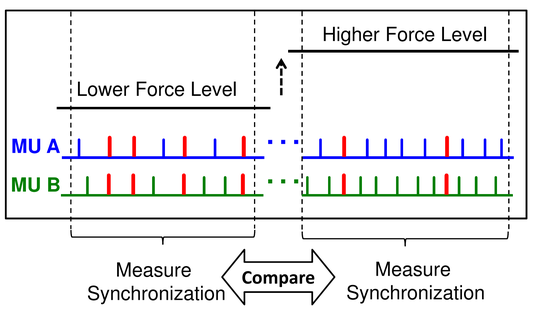
## Hypothesis in Question – "Common Input"

- Previous studies have claimed that synchronized firing instances are caused by common presynaptic inputs shared between pairs of motoneurons – a notion referred to as the "common input".
- Based on this notion, synchronization has been used to quantify the physical connections received by motoneurons of the same muscle and between those innervating different muscles.
- However, De Luca et al (1993), De Luca and Kline (in review), among others have found no evidence to support the common input notion.
- Therefore we set out to empirically test if common inputs are the likely cause of synchronization.



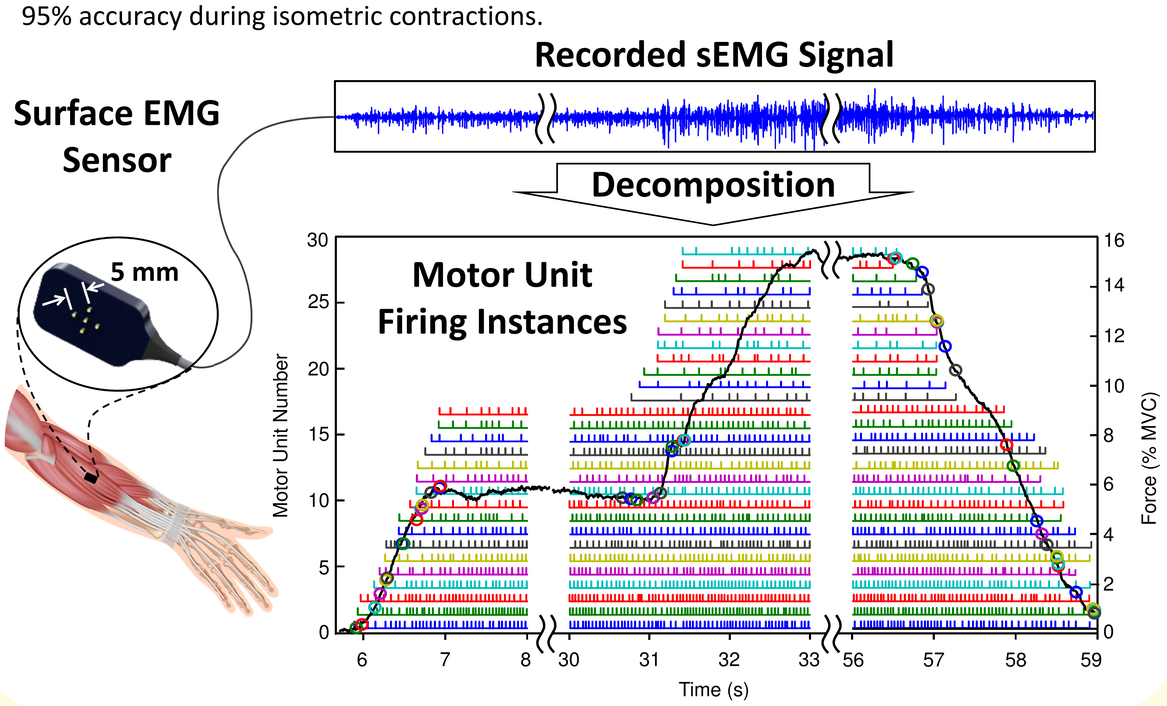

## Experimental Design



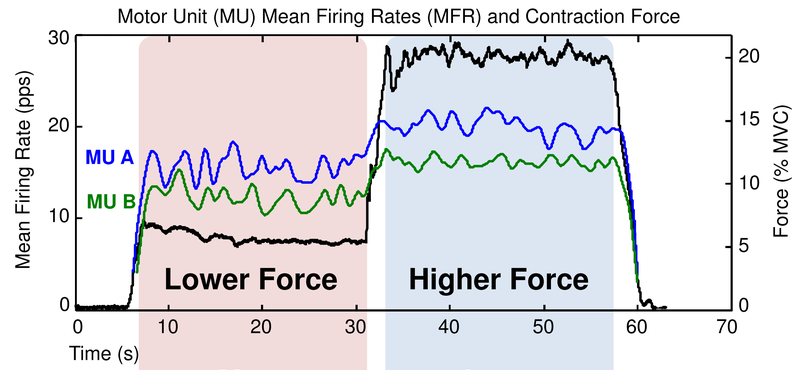

- Voluntary isometric contractions with multiple force plateaus were performed by 6 healthy human subjects.
- Synchronization was quantified between pairs of motor units (MU) using a statistically based method, SigMax (De Luca and Kline, in review).
- Synchronization measured during the relatively lower force level was compared to that measured between the same motor units at the relatively higher force level.

## Surface EMG Decomposition Technology

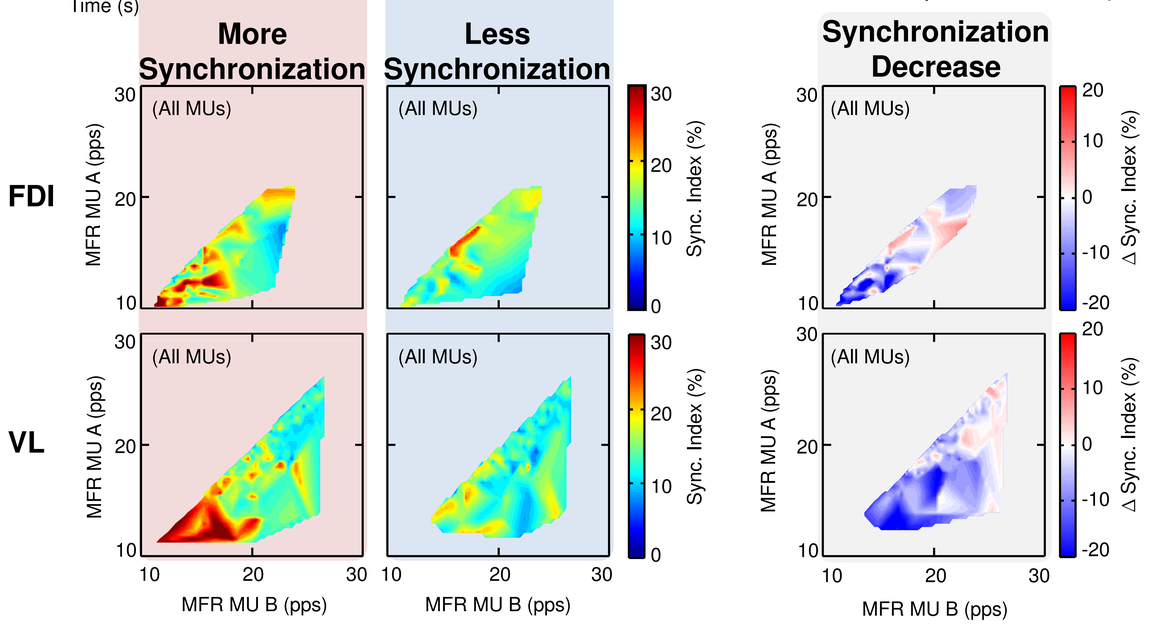
Surface electromyographic (EMG) signals were recorded during voluntary contractions using a five-pin decomposition EMG (dEMG) sensor, previously described in De Luca et al (2006). Recorded signals were decomposed using the dEMG algorithms described by De Luca et al. (2006), substantially improved in Nawab et al (2010) and independently verified by Hu et al (2013). The algorithms are capable of extracting motor unit firing instances with greater than 95% accuracy during isometric contractions.




## Empirical Results

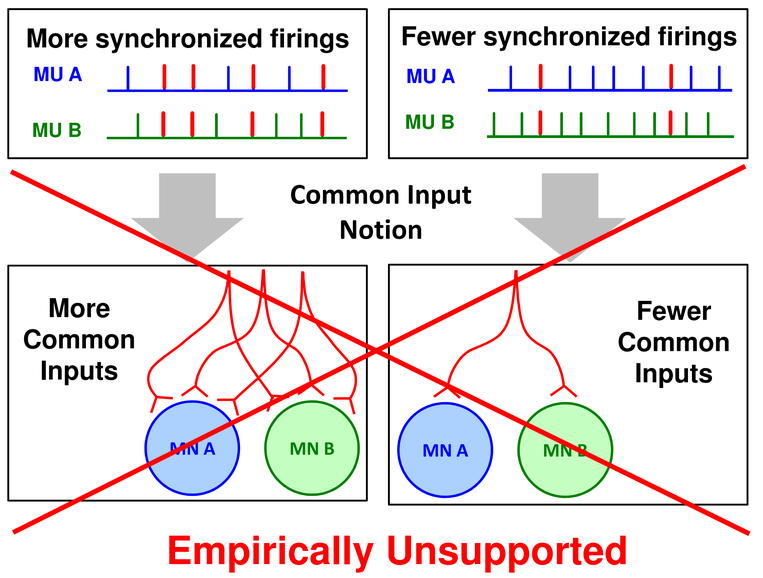



- As the force of contraction increases, the amount of synchronization between paired motor units generally decreases.
- Synchronization decrease is statistically significant for FDI and VL data ($p<0.00001$, Mann-Whitney-Wilcoxon Test)




## Conclusions

- **According to the Common Input Notion** – decreases in synchronization indicate that the number and/or strength of common inputs to motoneurons also decreased.
- **However,** no evidence has ever suggested that physical common inputs are selectively inhibited and/or remodeled during voluntary contraction.
- **Therefore**, our results indicate that alleged common inputs are not responsible for motor unit synchronization.




***Synchronization likely occurs as an epiphenomenon of more general control properties of motor units, as was suggested by De Luca et al (1993) and De Luca and Kline (2010).***

## References

De Luca et al, *J Neurophysiol* (1993)
De Luca et al, *J Neurophysiol* (2006)
Nawab et al, *J Clin Neurophysiol* (2010)
De Luca and Kline, *J Neurophysiol* (in review)
Hu et al, *J Neurophysiol* (2013)

## Acknowledgements

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