

Confounding Factors when analyzing Motor Unit Firing Adaptations during Muscle Fatigue

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Motivation

The control of motor units (MUs) during fatigue is characterized by increasing MU firing rate and recruitment of new MUs [1]. Yet these adaptations remain disputed by some reports [2,3] that describe decreasing MU firing rate with fatigue. Conflicting reports typically group MU data across MUs and subjects, and investigate MU firing rate relative to MU recruitment threshold. These practices have been suggested to obscure MU firing pattern, but their influence on fatigue-induced MU firing adaptations has not been empirically investigated.

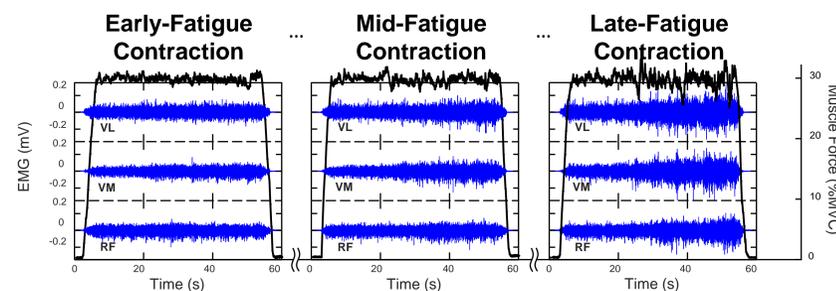
Objective

Investigate the influence of different methods of analyzing MU data on the observed fatigue-induced adaptations in MU firing rate. Specifically, we compared:

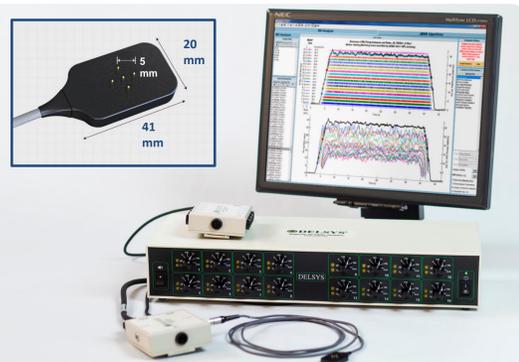
1. analysis of individual MU firing rates vs. averaged firing rate data across MUs;
2. analysis of firing rates relative to recruitment threshold vs. MUAP amplitude;
3. analysis of MU firing rate for individual subjects vs. grouped subjects.

Fatigue Protocol

Subjects: 3 males and 2 females (24-33 yrs.)
Protocol: isometric knee-extensions at 30% maximal voluntary contraction (MVC) force repeated to the endurance limit
Signals: knee-extension torque and sEMG signals from the Vastus Lateralis (VL), vastus medialis (VM), and rectus femoris (RF) muscles



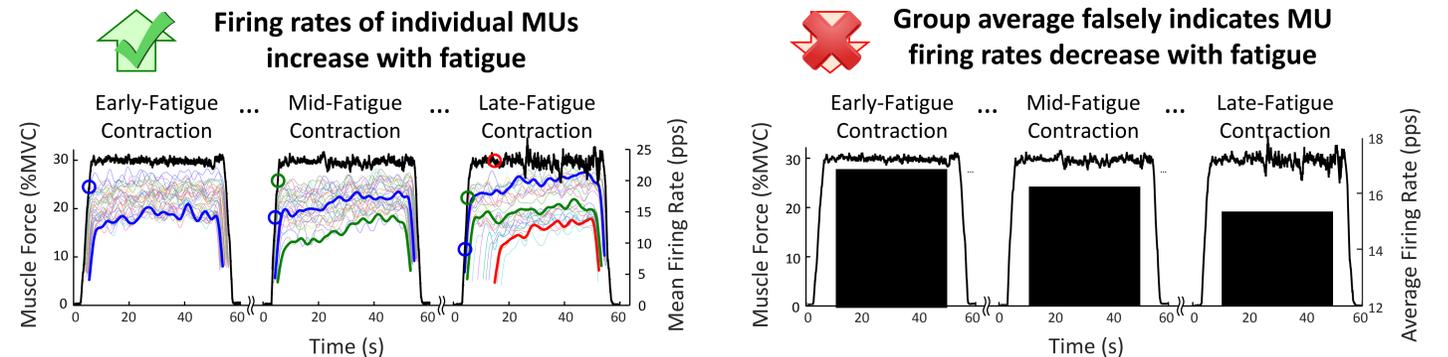
Analysis of MU Firing Data



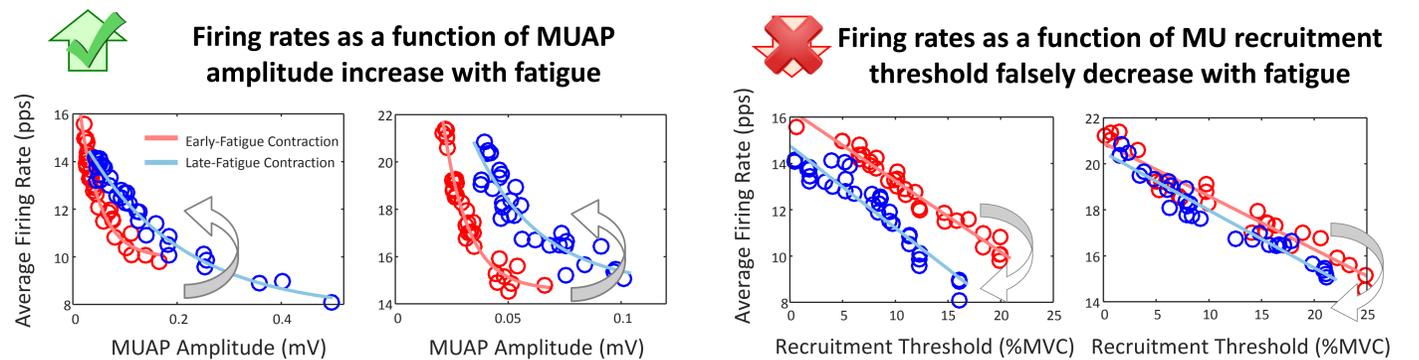
We used the dEMG System (Delsys Inc., Natick, MA) to non-invasively record and accurately decompose the sEMG signals from the VL muscle into the constituent MU action potentials (MUAPs) and their firing instances [4]. For each MU and contraction, we calculated:

1. the MU average firing rate;
2. the MUAP amplitude;
3. the MU recruitment threshold.

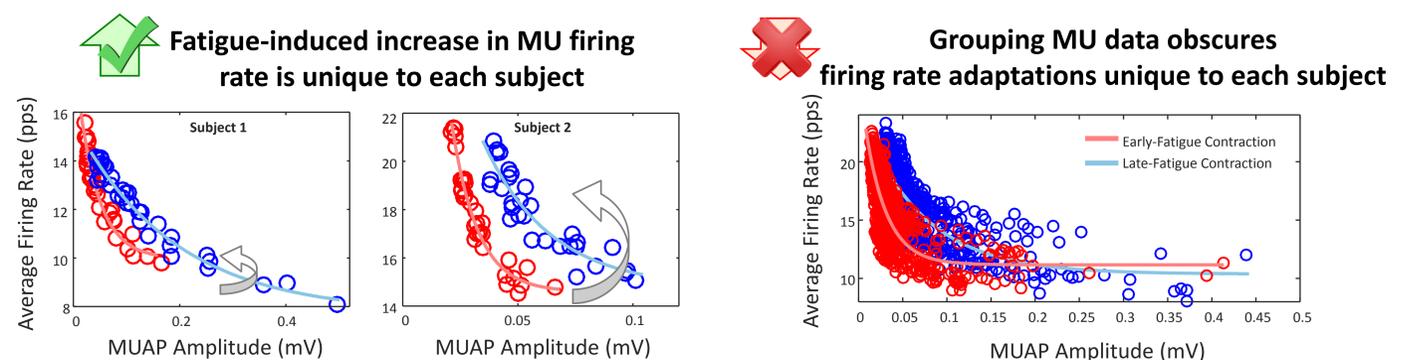
Errors result from grouping and averaging firing rates across MUs during fatigue



Errors result from regressions of MU recruitment threshold vs. firing rate during fatigue



Grouping MU data across subjects obscures the subject-specific firing adaptations to fatigue



Conclusions

Grouping MU data across MUs and subjects, and analyzing MU firing rate relative to MU recruitment threshold may obscure fatigue-induced MU firing adaptations and confound the understanding of MU behavior during fatigue.

References

- [1] Contessa et al. *J Neurophysiol*, 2016
- [2] McManus et al. *J Neurophysiol*, 2015
- [3] Vila-Chã et al. *Med Sci Sports Exerc*, 2012
- [4] Nawab et al. *Clin Neurophysiol*, 2010

Acknowledgements/Support

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