Neural drive to the deltoid segments

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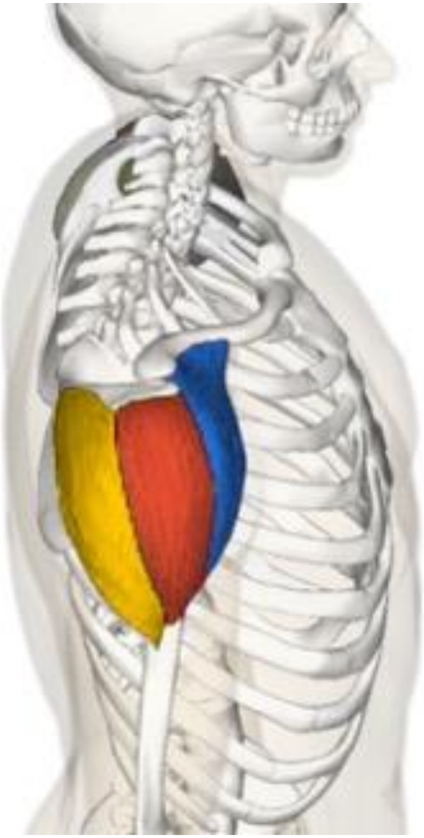

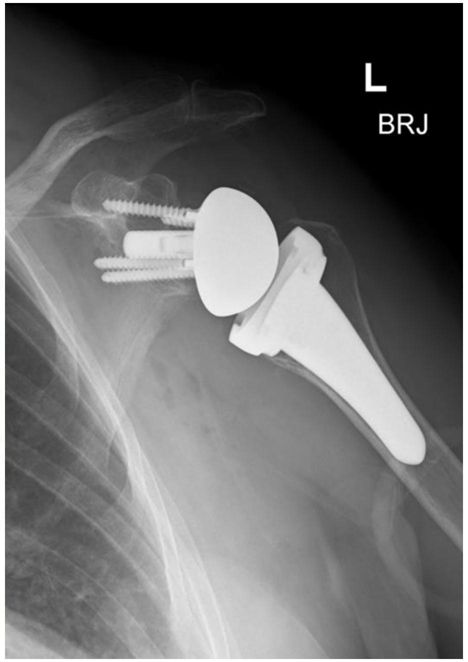

Background

Total reverse shoulder replacement

- Good deltoid function is critical[1]
- Functional outcomes are variable
- Possibly due to inefficient strategy or co-activation of deltoid parts[2-7]

[1] Grammont P et al Rhumatologie. 1987
[2] Walker et al J Shoulder Elbow Surg. 2014
[3] Pegreffi et al Musculoskeletal Surg. 2017
[4] Rienmüller et al J of Clin Medicine. 2020
[5] Li et al J Shoulder Elbow Surg. 2020
[6] Smith et al J of Orthopaedics. 2020
[7] Pelletier-Roy et al J Shoulder Elbow Surg. 2021

Disclosures

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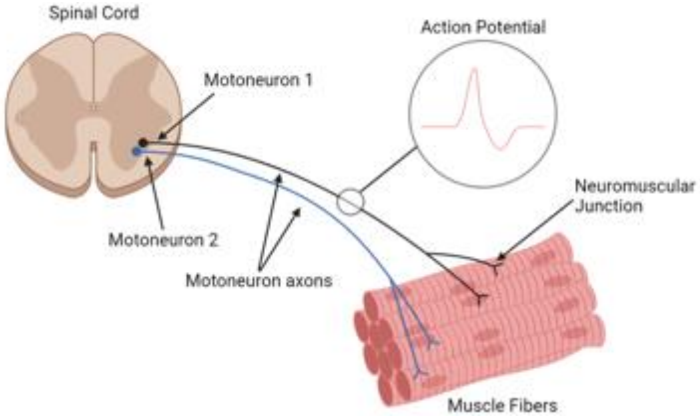
Background

<u>To understand the neuromechanics of deltoid function</u> we need to change the level at which we observe activity: from whole muscle to motoneuron

Motor neurons are the final common path

Sherrington (1906)



<u>Has been assessed in other joints</u>

Correlated nature of motor units

Knee[1] – high = common drive VL & VM

Ankle[2,3] – low = no common drive GM & GL

Shoulder of Rhesus Macaque

Deltoid drive highly task dependent[4]

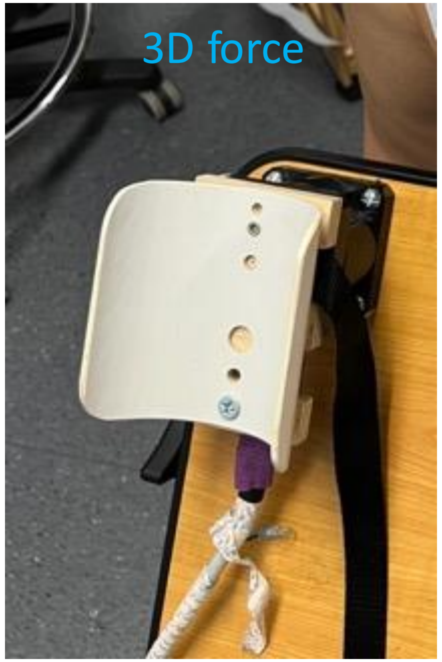
<u>Remains unknown in humans</u>

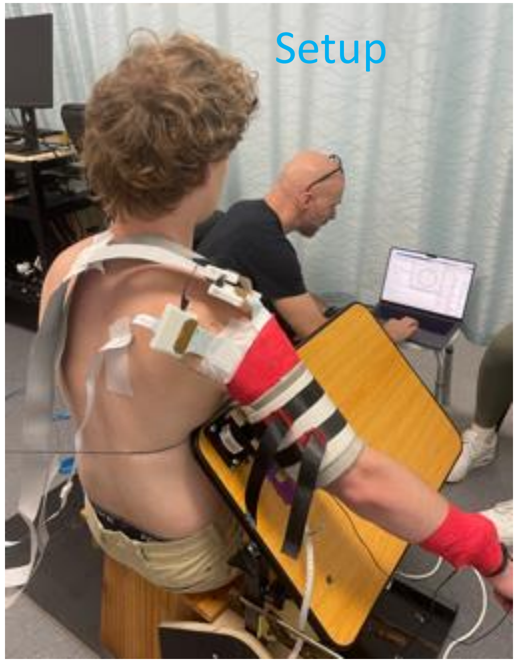
AIM:

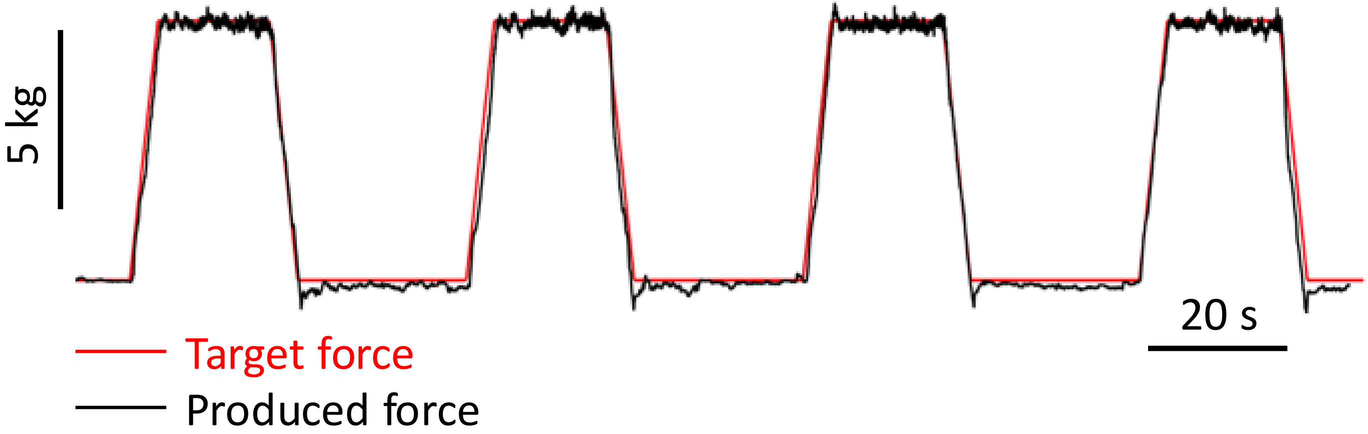
To determine the common drive within and between deltoid heads during isometric force match tasks performed in different directions in individuals with normal shoulder function

[1] Avrillon et al J Appl Physiol. 2021
[2] Hamard et al J Appl Physiol. 2023
[3] Hug et al J Appl Physiol. 2021
[4] Marshall et al Nat Neurosci. 2022

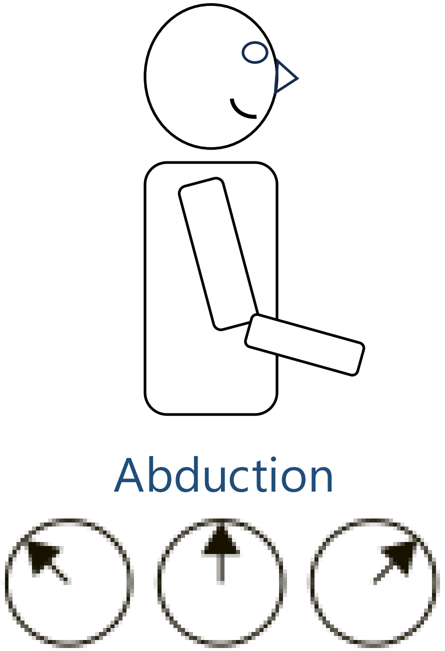
Methods: experimental setup







Force direction



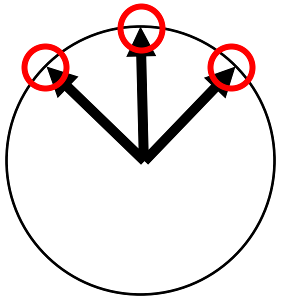
Participants

N = 14 (1 female, 13 male)

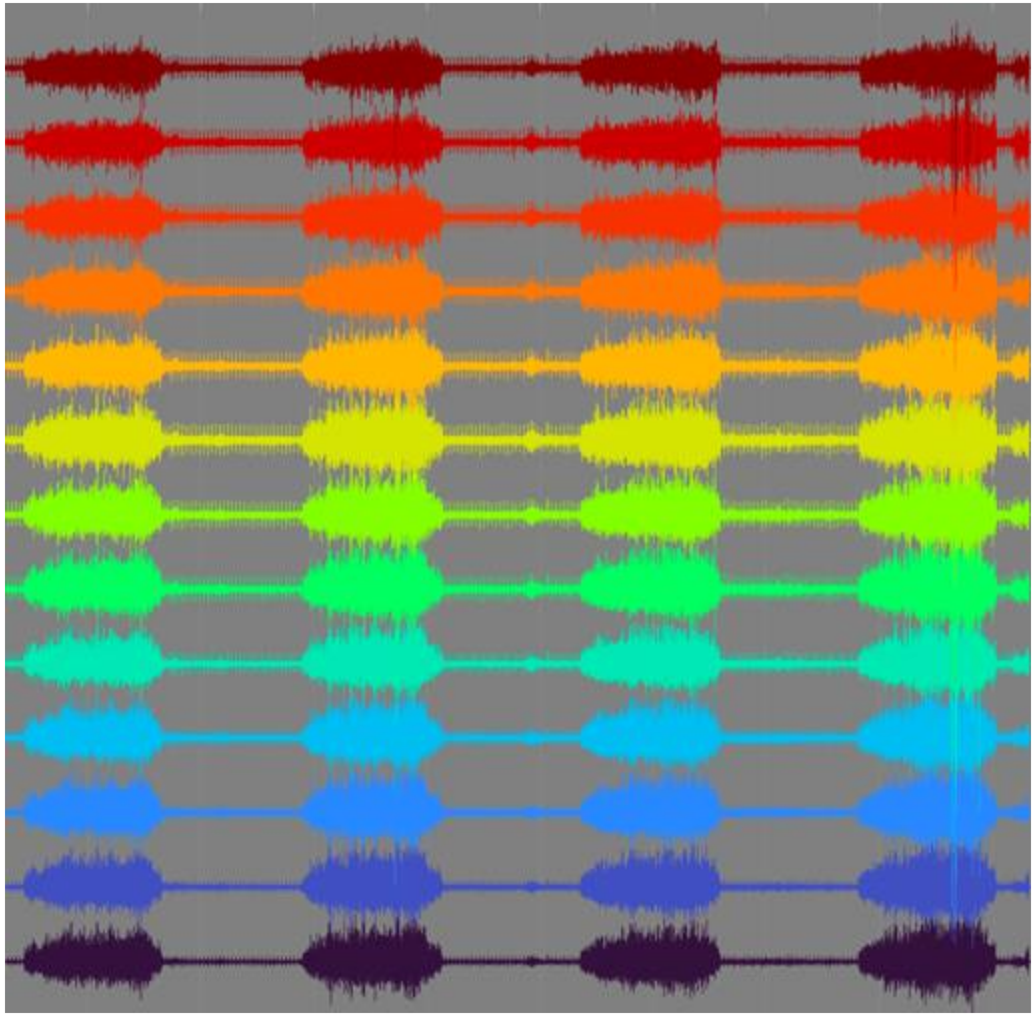
	Mean (SD)
Age:	28 (9) years
Height:	1.76 (0.10) m
Mass:	72 (14) kg

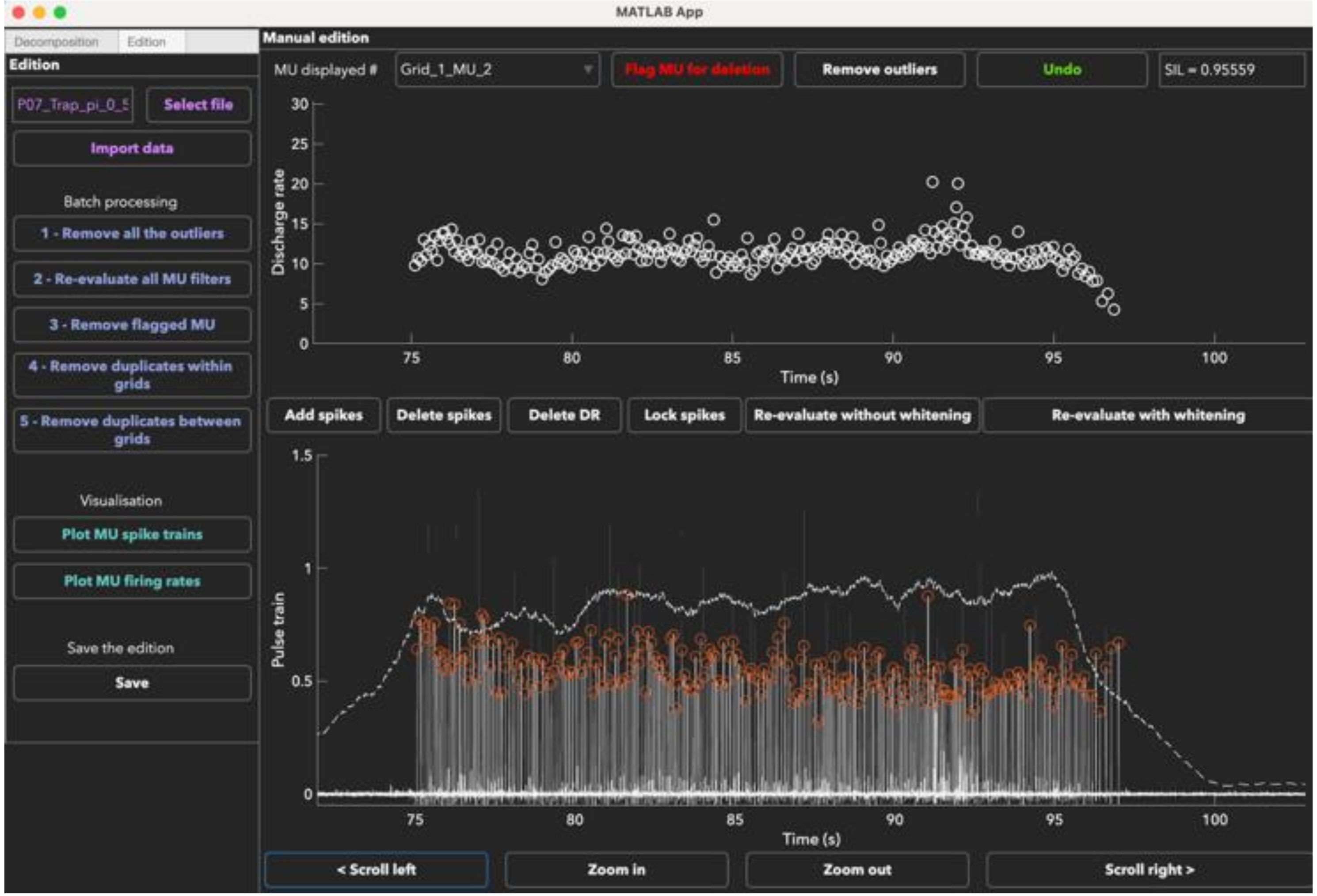
Challenging to get motor units from n = 3 (excluded from analysis)

Feedback on screen



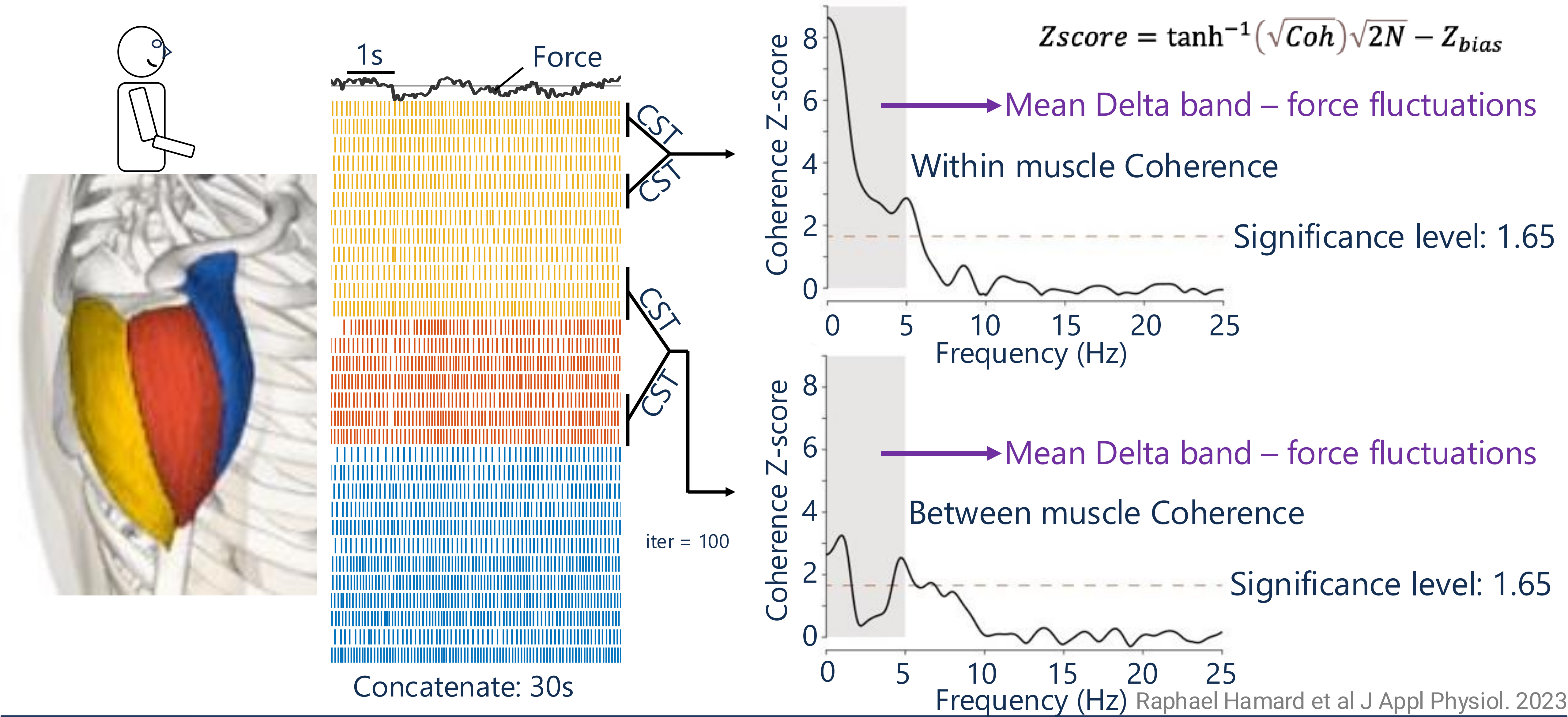
Methods: extraction of motor units (blind source decomposition)





https://github.com/simonavrillon/MUedit

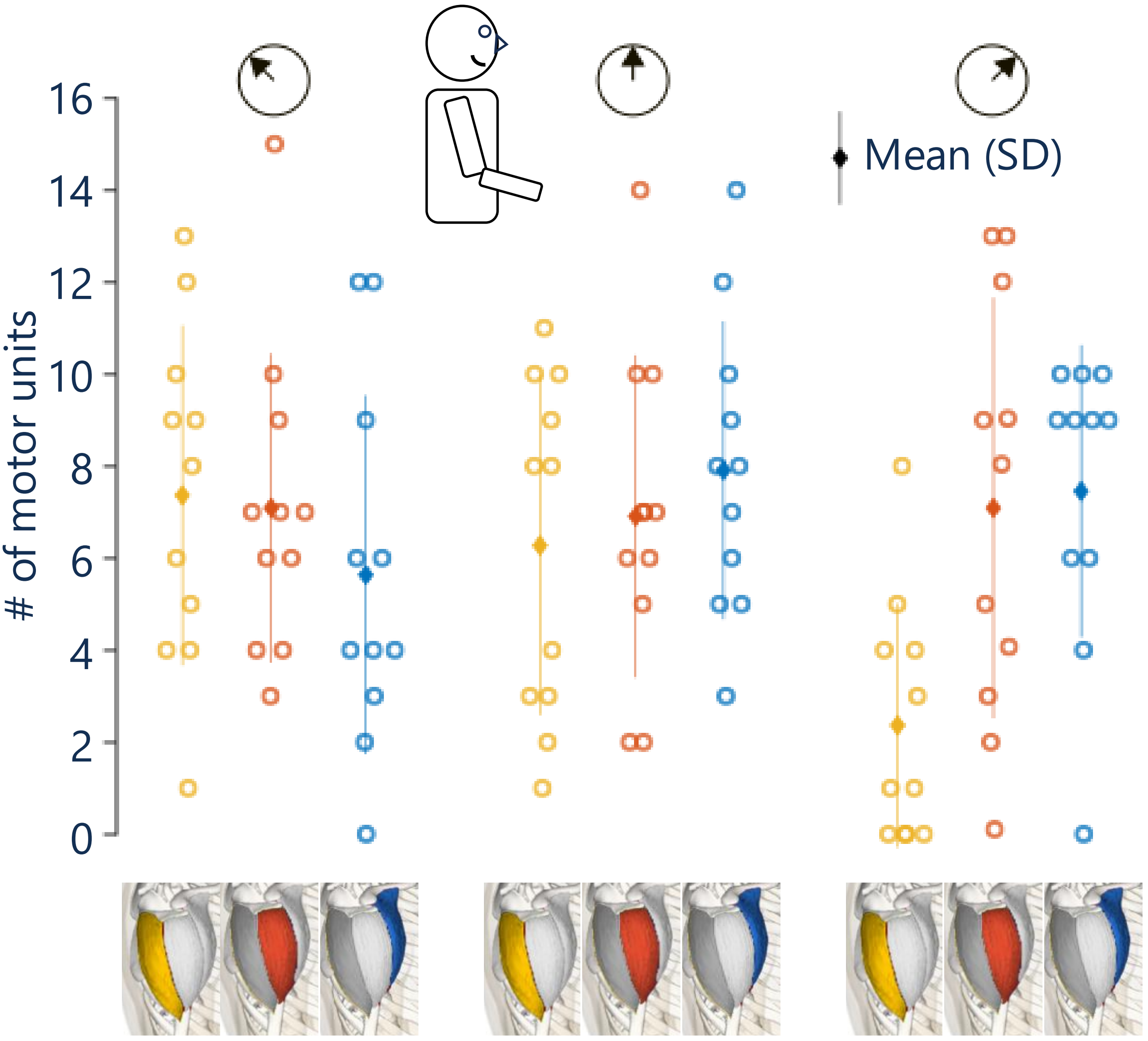
Methods: extraction of motor units (blind source decomposition)

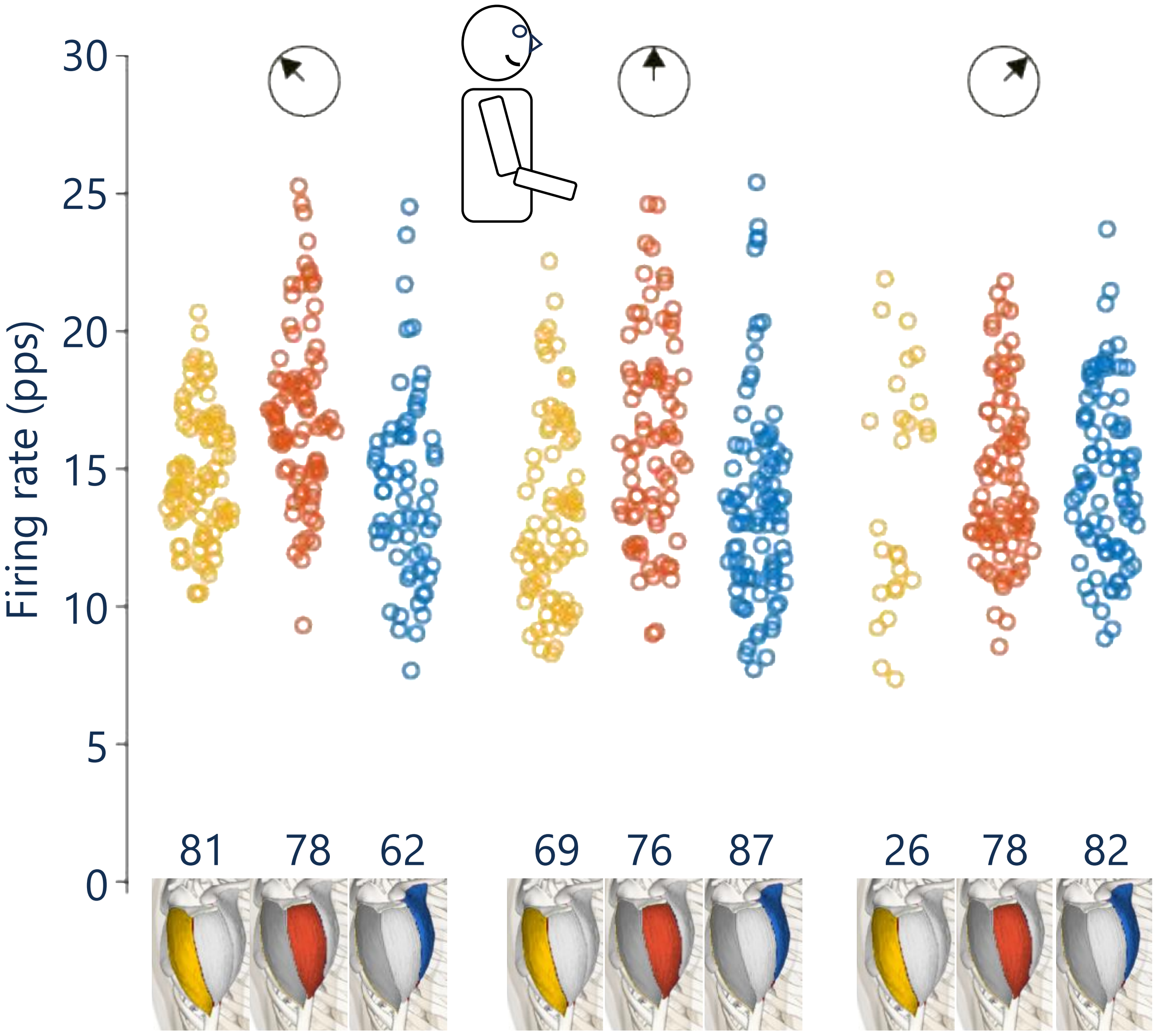


Raphael Hamard et al J Appl Physiol. 2023

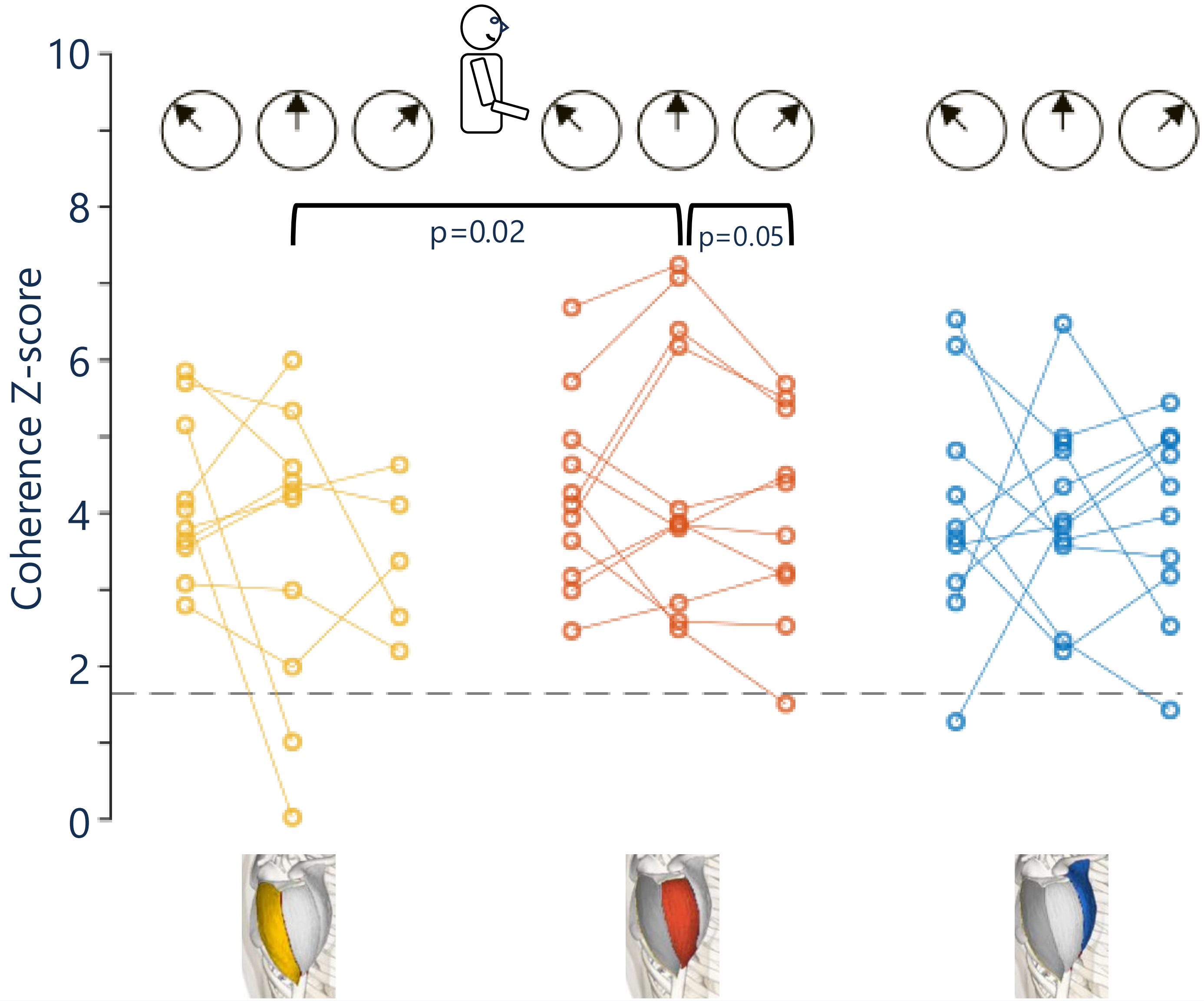
Results: # of motor units

Mean firing rate (pps)





Results: Within muscle coherence (correlation in freq domain)



Strong common drive within muscle heads

High between subject variability

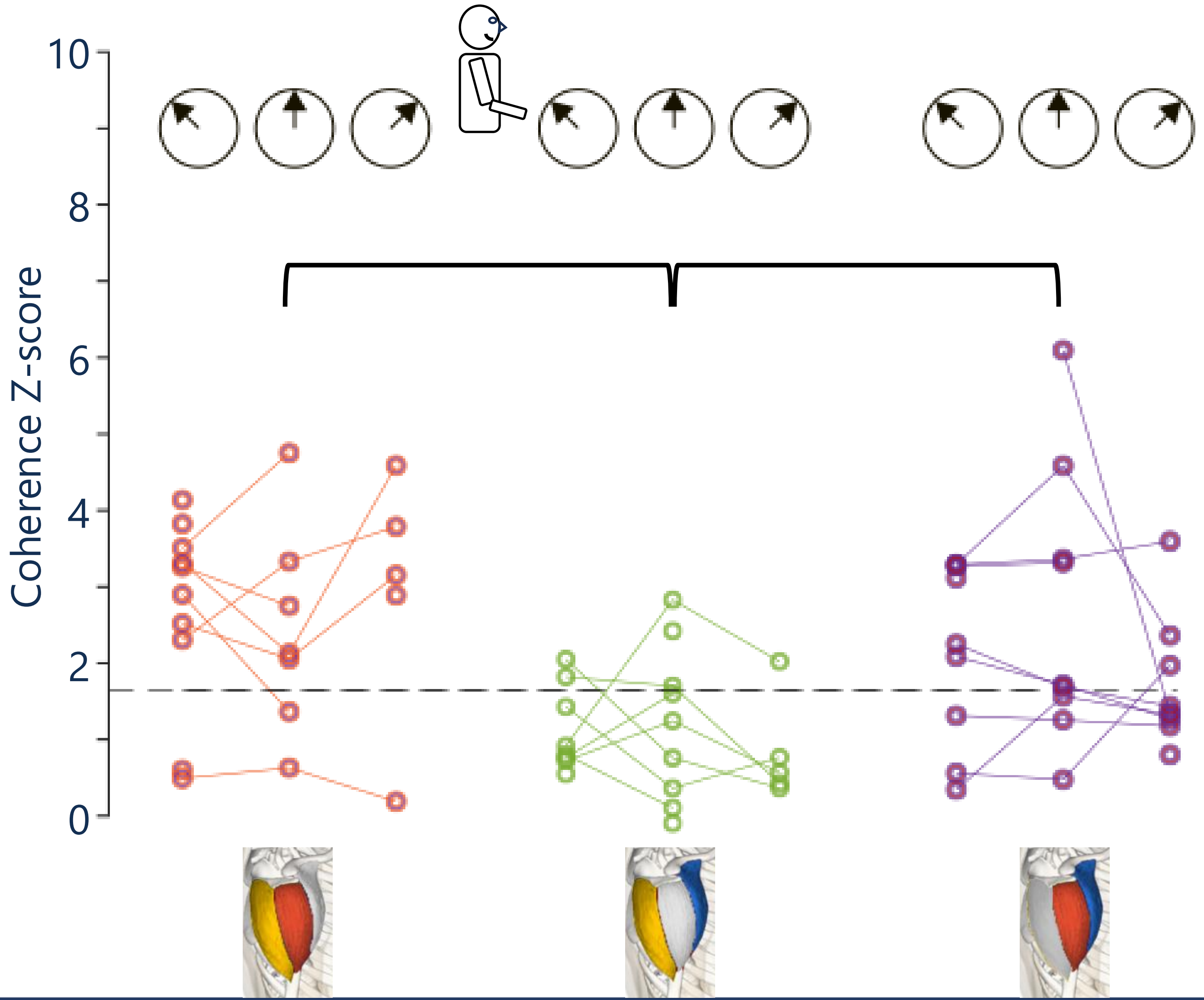
Linear mixed model: Muscle x Force direction interaction ($p=0.01$)

More common drive in the middle deltoid during abduction than anterior abduction

Task dependent flexible control; more common drive during primary task

Higher common drive in the middle deltoid than posterior deltoid in abduction

Results: between muscle coherence (correlation inf freq domain)



Main effect of muscle pair (p<0.001)

Low common drive to could be efficient

Some had sign common drive between the

No main effect of Force-direction (p=0.45), robust between muscle common drive?

Conclusions

[1] Marshall et al Nat Neurosci. 2022
[2] Avrillon et al J Appl Physiol. 2021

Common drive within middle deltoid altered depending on force direction (in line with Marshall[1]) and suggest some adaptation to task demands.

Common drive between the posterior-middle and middle-anterior could assist with force direction but did not change (on average) between force directions

We observed high between participant variation (we will re-test some participants). Individual differences were consistent between assessments for quadriceps neural strategies[2]

Strong common drive within deltoids heads and low common drive between posterior and anterior deltoids allow for flexible control (test other task constraints)

Next step: investigate deltoid neuromechanics pre- and post rTSA

Relationship with functional outcome

References & Project Team

[1] Marshall et al Nat Neurosci. 2022
[2] Avrillon et al J Appl Physiol. 2021
Raphael Hamard et al J Appl Physiol. 2023
[2] Hamard et al J Appl Physiol. 2023
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