Faculty of Sport Science

RUB

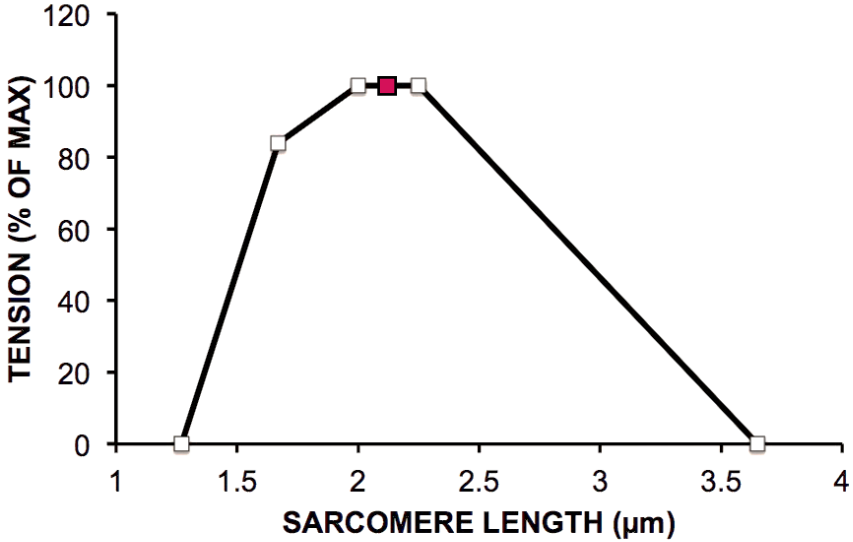
Politecnico di Torino

# Neural drive *differs* following submaximal stretch versus shortening contractions of the human tibialis anterior

**Brent J. Raiteri**, Karla Bosse, Marta Boccardo, Alberto Botter & Daniel Hahn

# Muscle force predictions

- Active isometric force-length relation



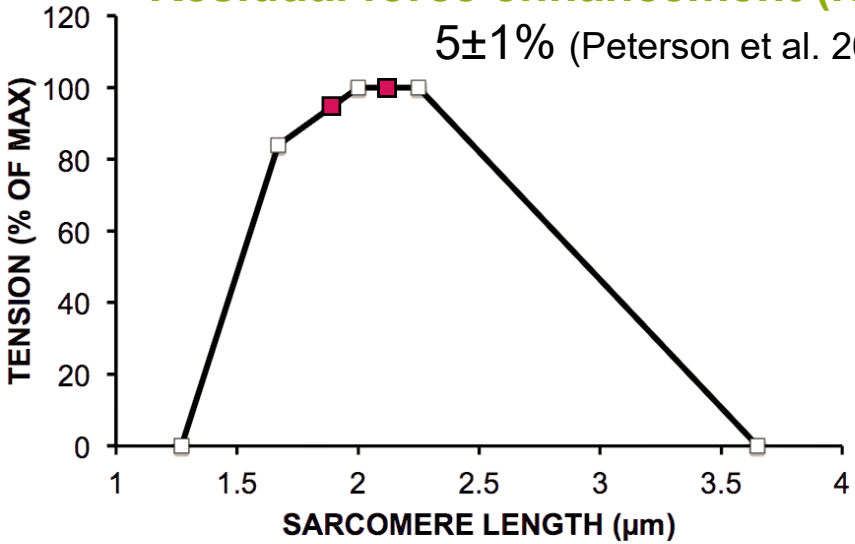

Gordon et al. 1966

# Muscle force predictions

- Active steady-state force-length relation
- Active force following muscle stretch (**STR**)

**Residual force enhancement (rFE)**

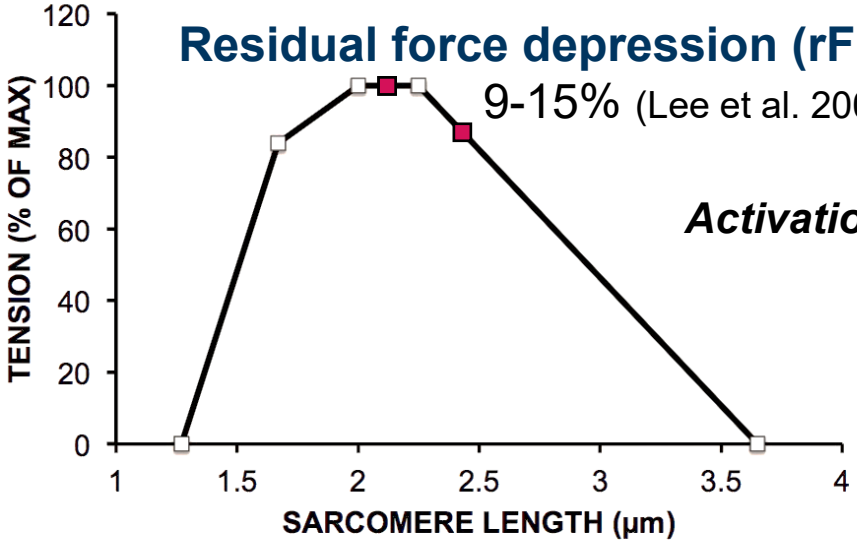
5±1% (Peterson et al. 2004)




Gordon et al. 1966

# Muscle force predictions

- ↓ steady-state force following active muscle shortening (**SHO**)




***Activation-matched*** experiments

Gordon et al. 1966

# History dependence of force production

- ***Torque-matched*** experiments: How is **neural drive** affected?

…**not** well known as most studies used **bipolar** surface EMG

≤ **neural drive** following **STR** via **intramuscular** EMG

≤ motor unit (MU) **discharge rate** [0 to ~4 Hz]

(Altenburg et al. 2008; Jakobi et al. 2020)

**3** to **4 MUs** per person

**> neural drive** following **SHO**

**>** MU **discharge rate** [~1 Hz]

(Altenburg et al. 2008)

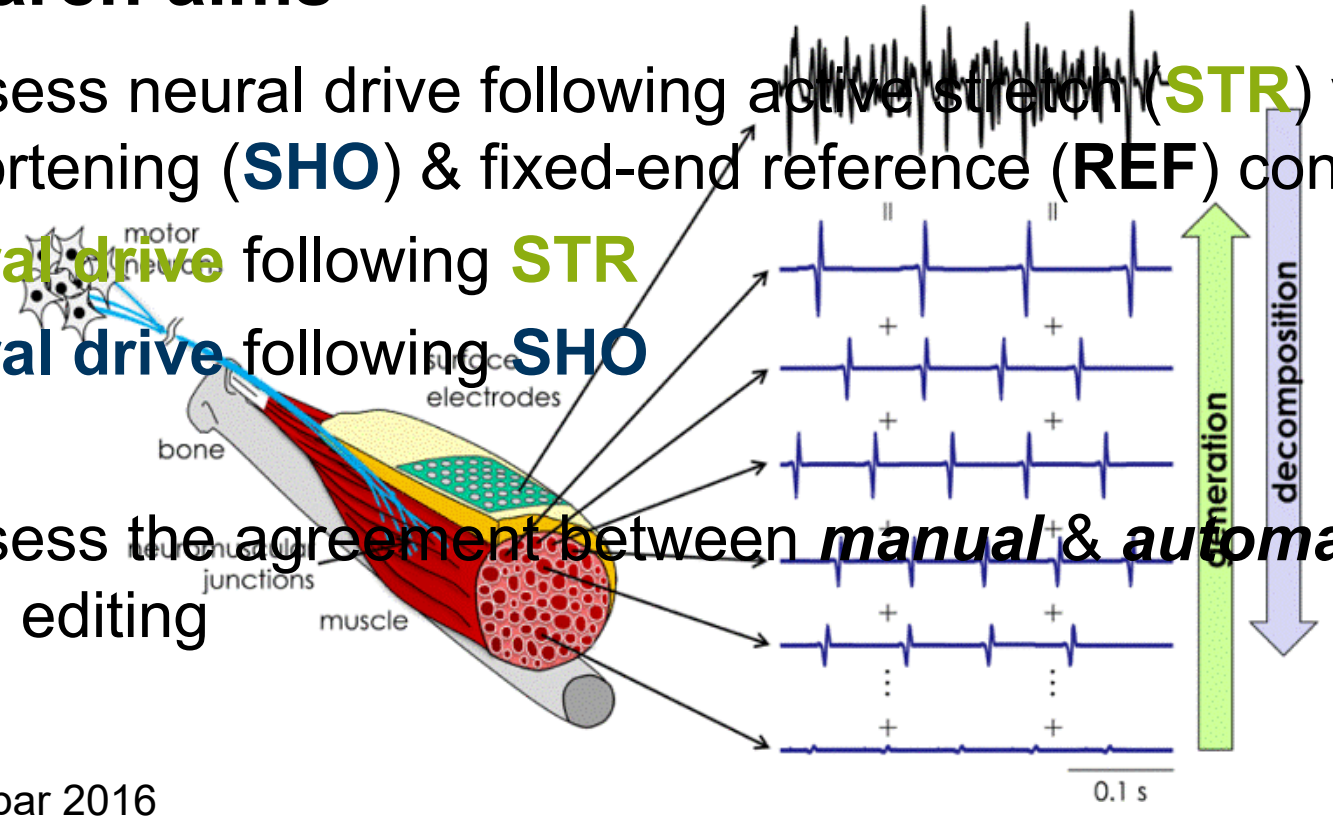
# Research aims

1. Assess neural drive following active stretch (**STR**) vs. shortening (**SHO**) & fixed-end reference (**REF**) conditions

< **neural drive** following **STR**

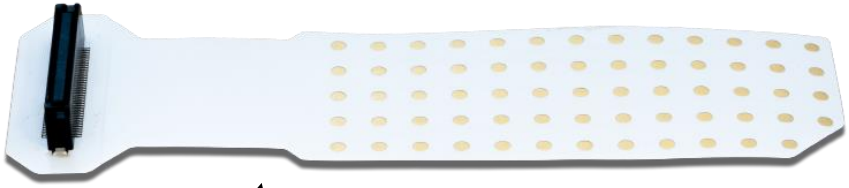
> **neural drive** following **SHO**

2. Assess the agreement between ***manual*** & ***automatic*** MU editing

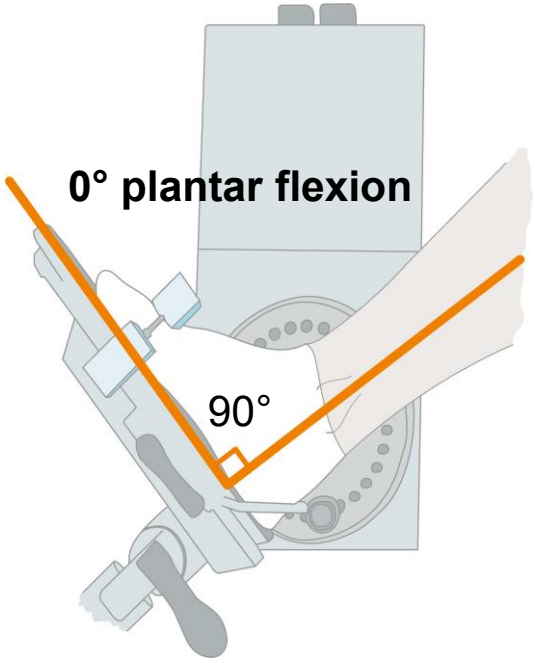


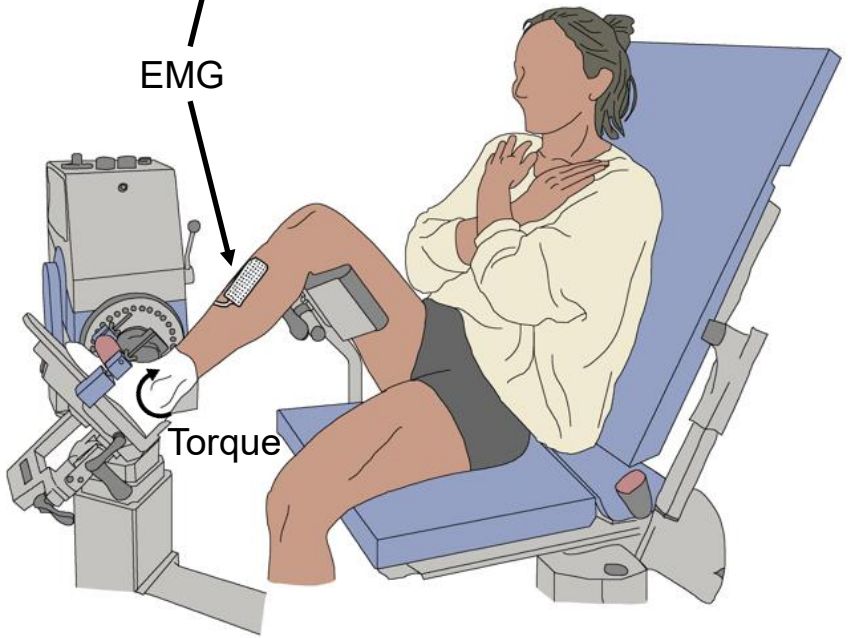

Farina & Holobar 2016

# Methods

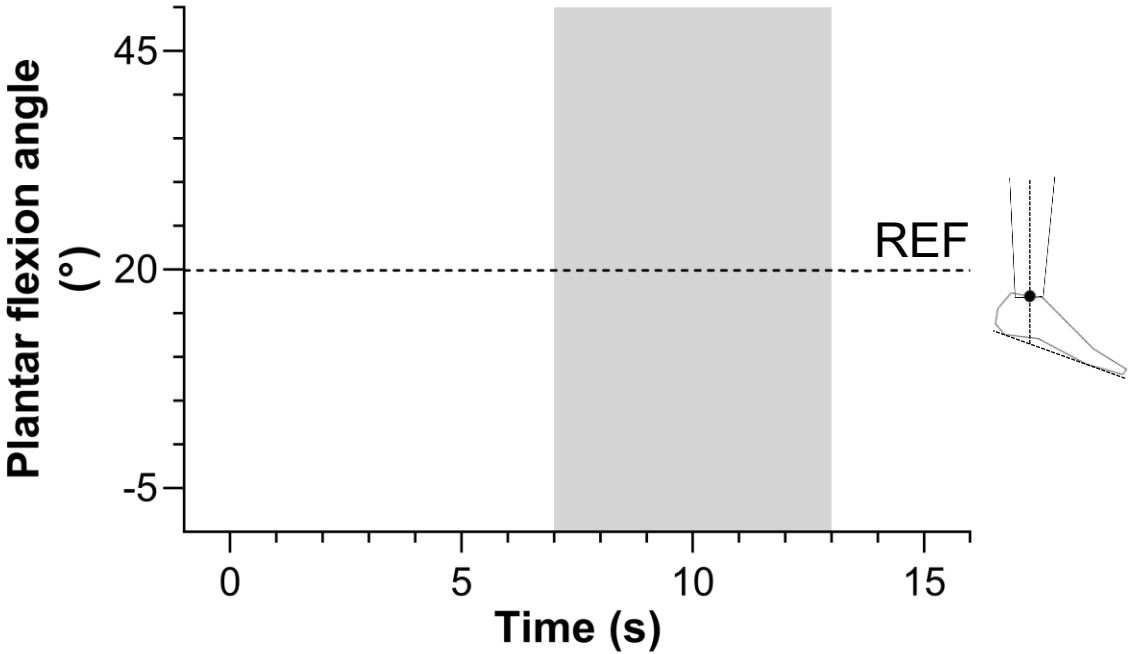


- *N* = 17 (22-31 yr, 6 women)

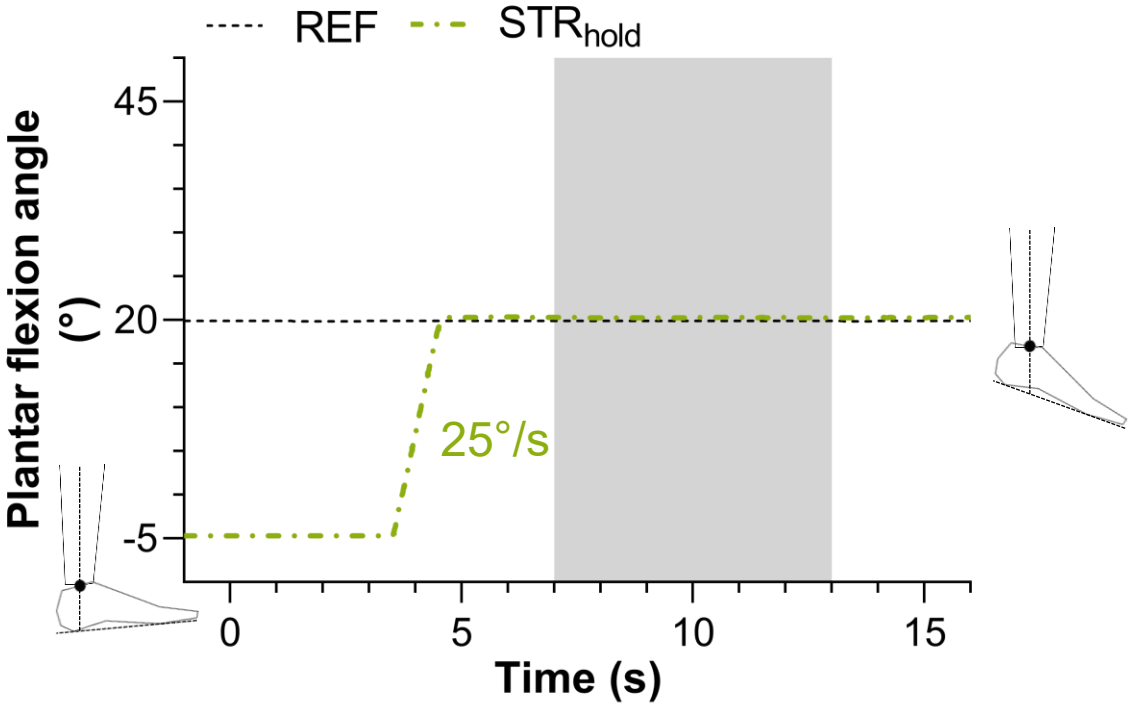


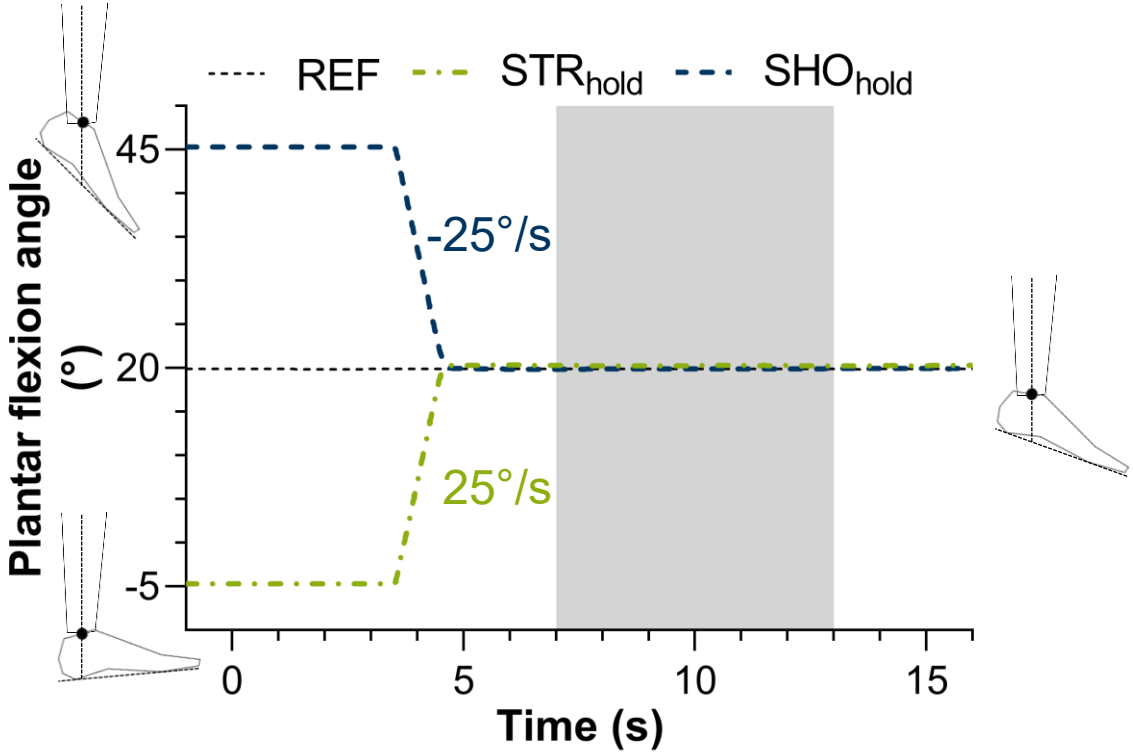
# Methods

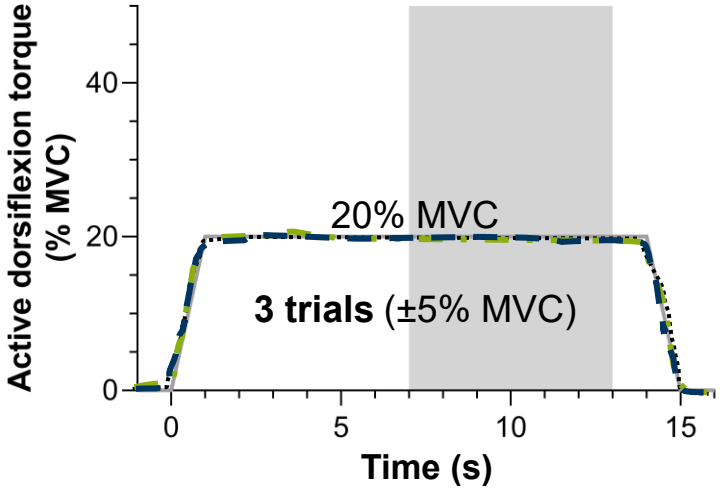


# Methods

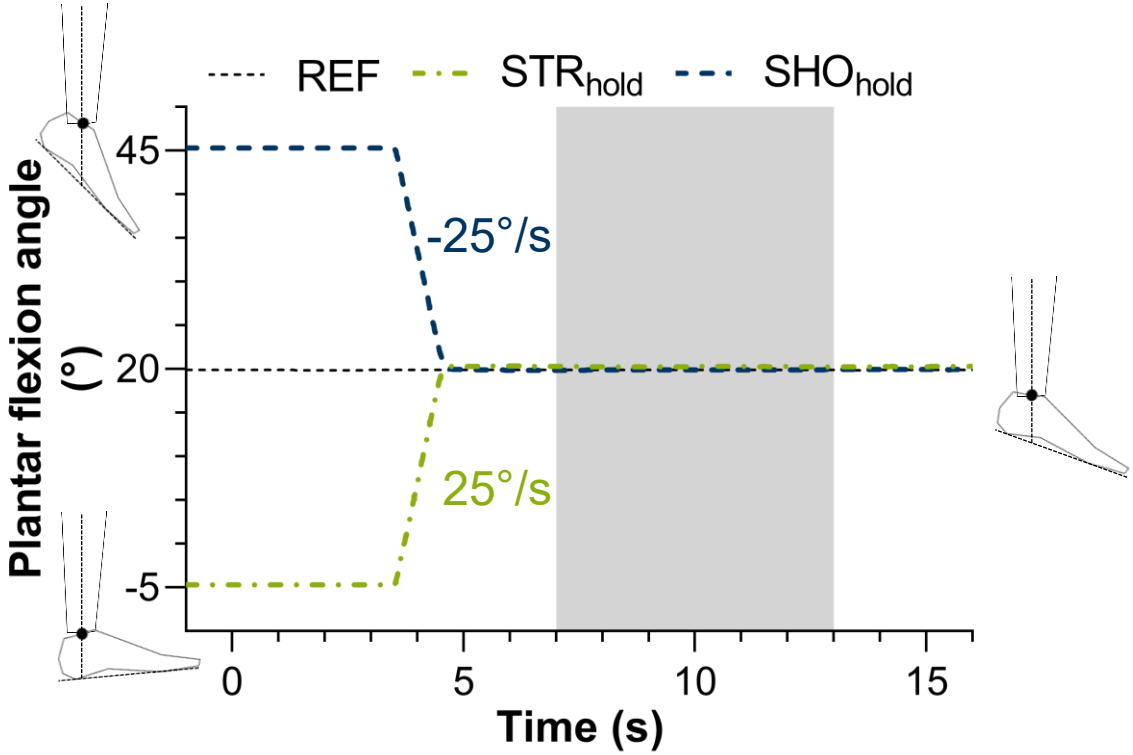


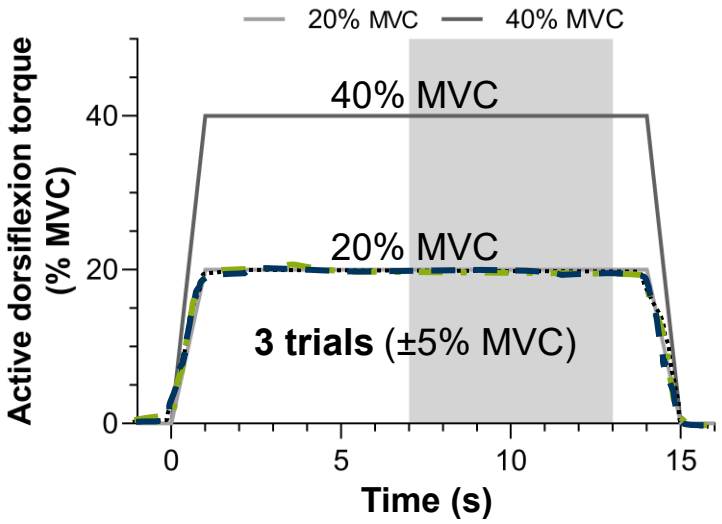
# Methods


REF
STR$_{hold}$
SHO$_{hold}$
45
20
-5
-25°/s
25°/s
Plantar flexion angle (°)
0
5
10
15
Time (s)

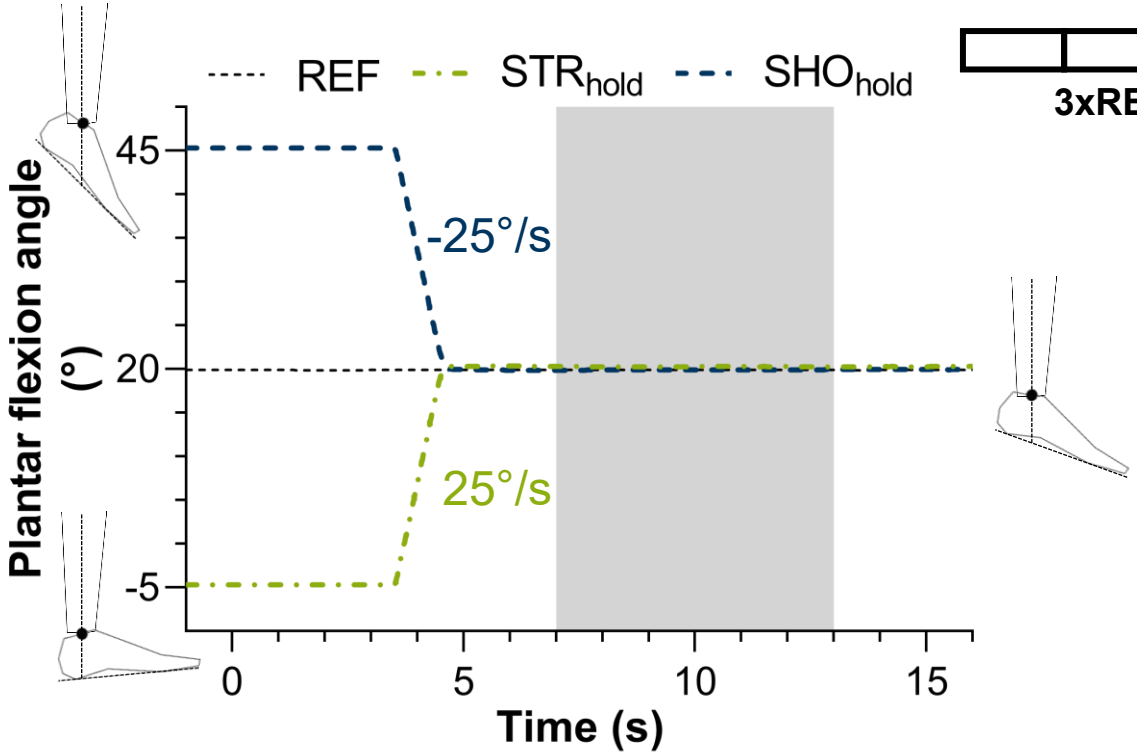

Active dorsiflexion torque (% MVC)
40
20
0
20% MVC
3 trials (±5% MVC)
0
5
10
15
Time (s)

# Methods

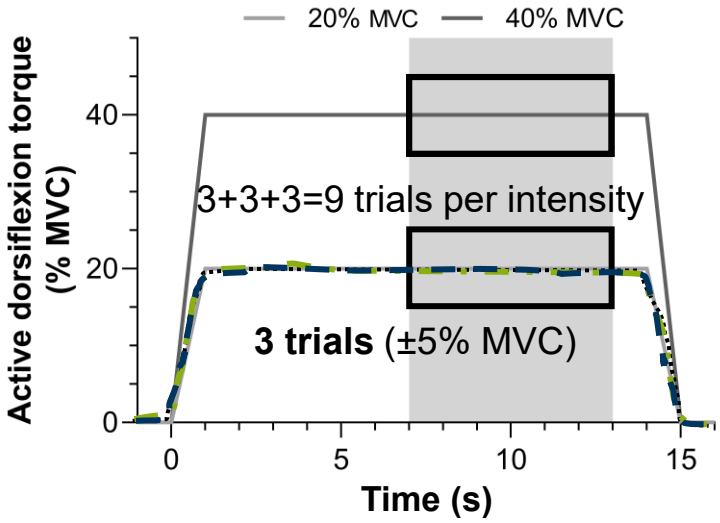

REF
STR$_{hold}$
SHO$_{hold}$
Plantar flexion angle (°)
45
20
-5
-25°/s
25°/s
0
5
10
15
Time (s)


20% MVC
40% MVC
Active dorsiflexion torque (% MVC)
40
20
0
40% MVC
20% MVC
3 trials (±5% MVC)
0
5
10
15
Time (s)

# Methods


REF
STR$_{hold}$
SHO$_{hold}$
Plantar flexion angle (°)
45
20
-5
-25°/s
25°/s
0
5
10
15
Time (s)


3xREF
3xSTR
3xSHO


20% MVC
40% MVC
Active dorsiflexion torque (% MVC)
40
20
0
3+3+3=9 trials per intensity
3 trials (±5% MVC)
0
5
10
15
Time (s)

# Decomposition

simonavrillon/
**MUedit** **v1.2**

App to decompose electromyographic signals and manually edit the motor unit pulse trains

3 Contributors · 0 Issues · 31 Stars · 12 Forks

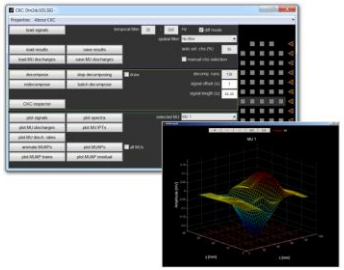
Reference: **EMG**
Contrast function: **skew**
Initialisation: **random**
Extension factor: **16**

CoV filter: **no**
Iterations: **50**
SIL threshold: **0.8**

# Goal

**Maximise MU yield**
time efficiently

Demuse



# Editing

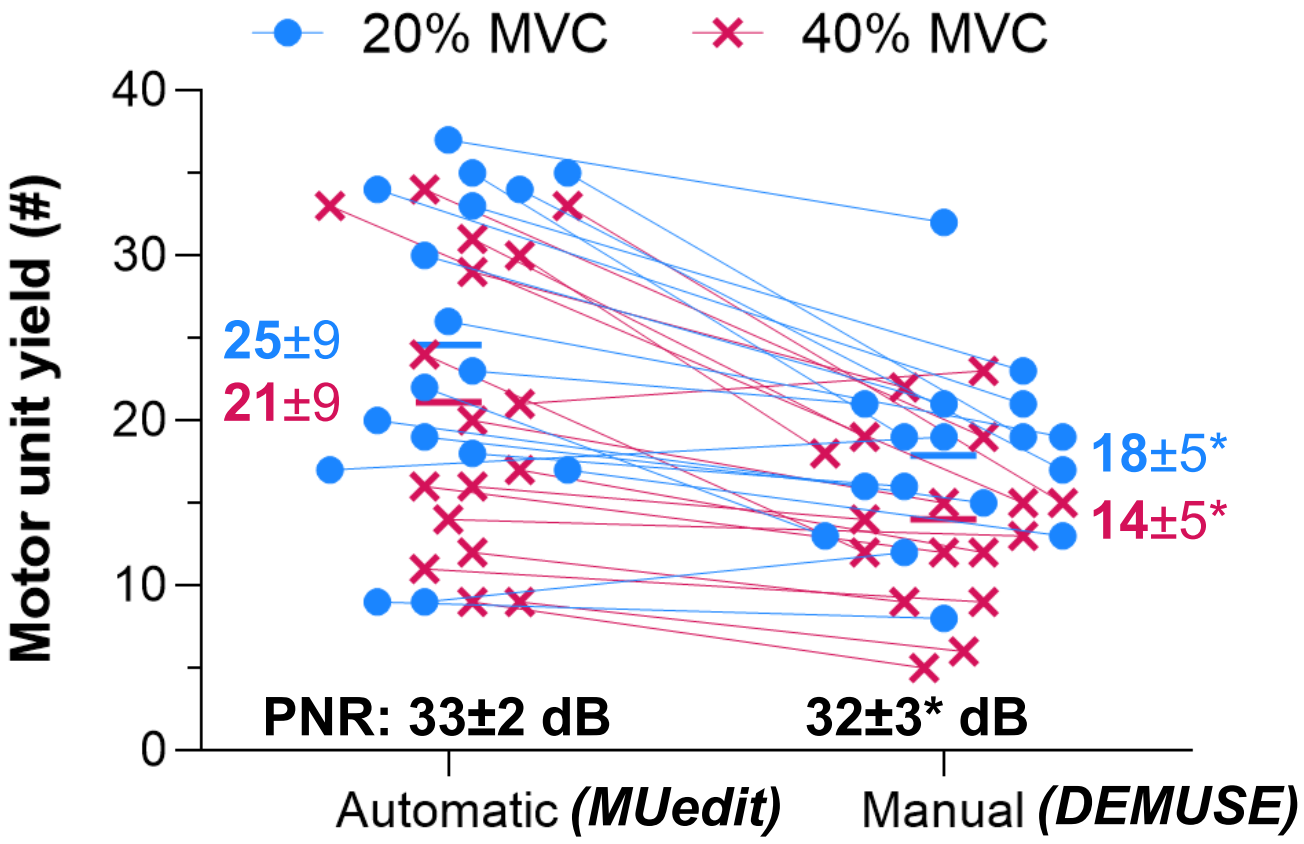
**Automatic** removal:

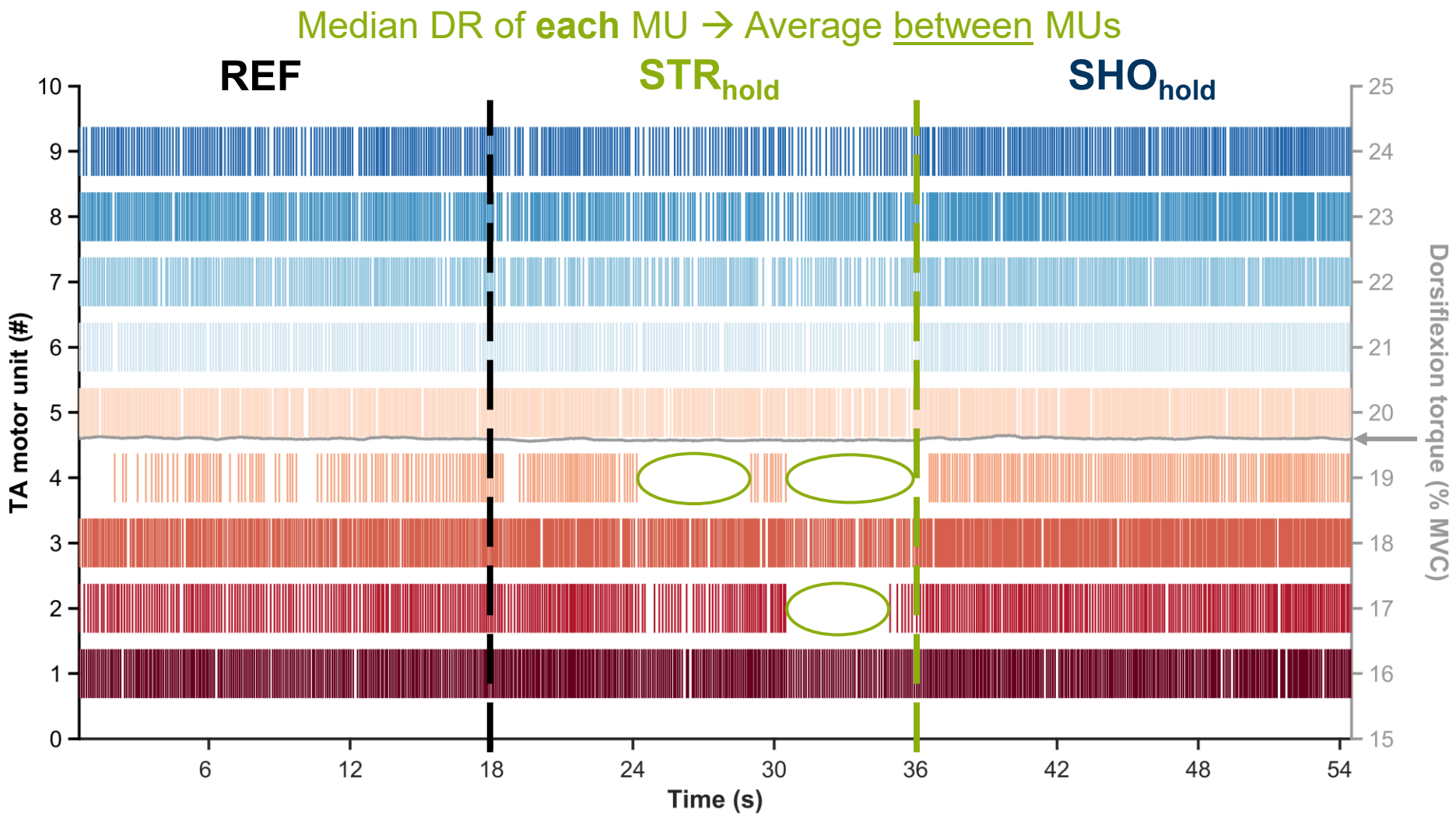
1. Duplicates (**>30%** firings)
2. PnR (**<28 dB**)
3. CoV in DR (**≥40%**)

**Manual**:

- Based on previous recommendations (Del Vecchio et al. 2020)

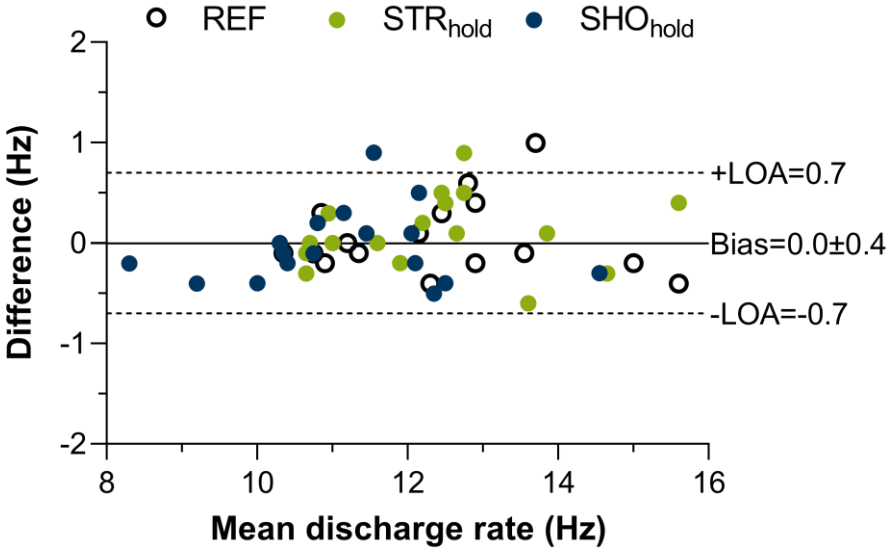
# Results



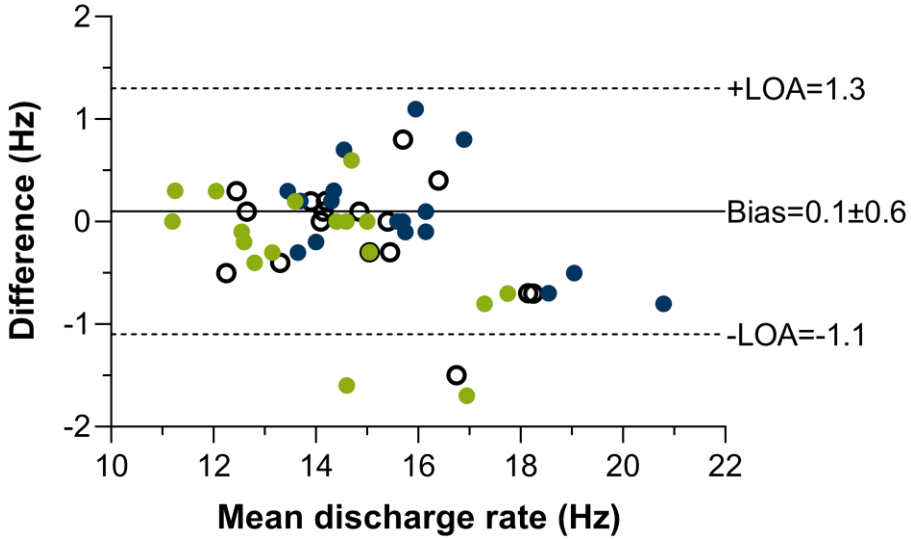

Median DR of **each** MU → Average between MUs
REF
STR$_{hold}$
SHO$_{hold}$
TA motor unit (#)
Dorsiflexion torque (% MVC)
Time (s)
0
1
2
3
4
5
6
7
8
9
10
15
16
17
18
19
20
21
22
23
24
25
6
12
18
24
30
36
42
48
54

# Results – automatic vs. manual methods

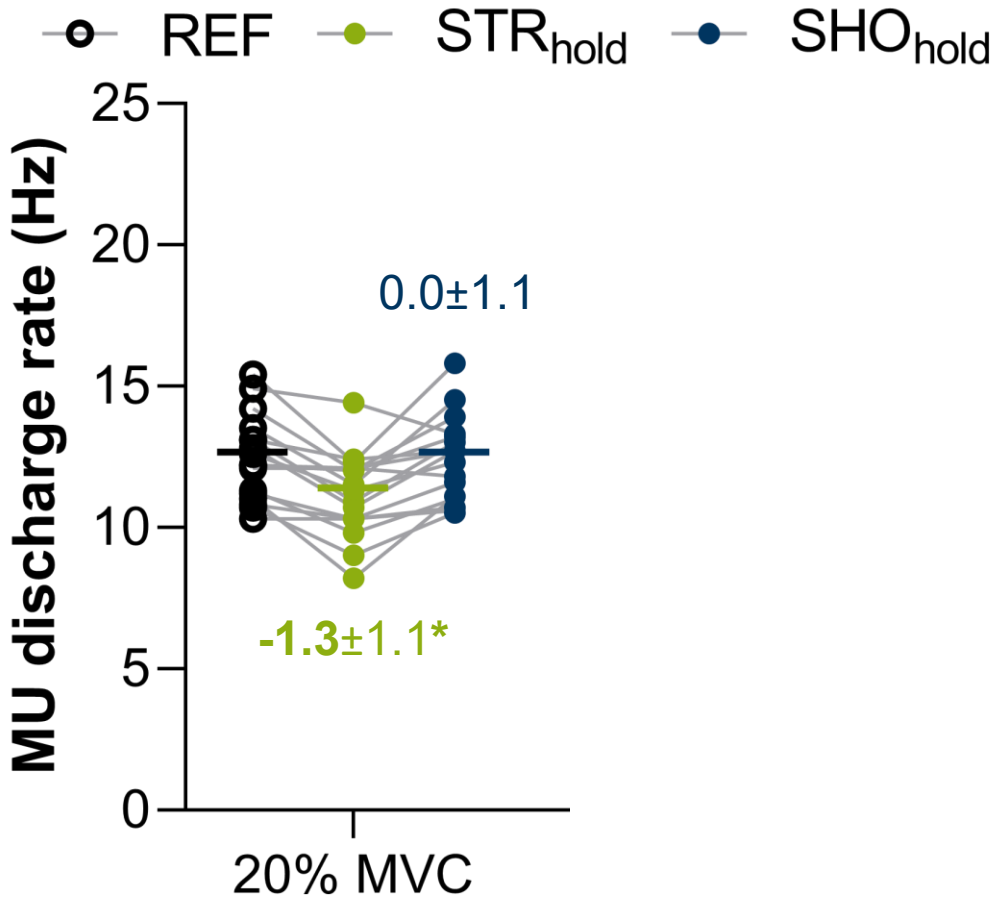
## 20% MVC



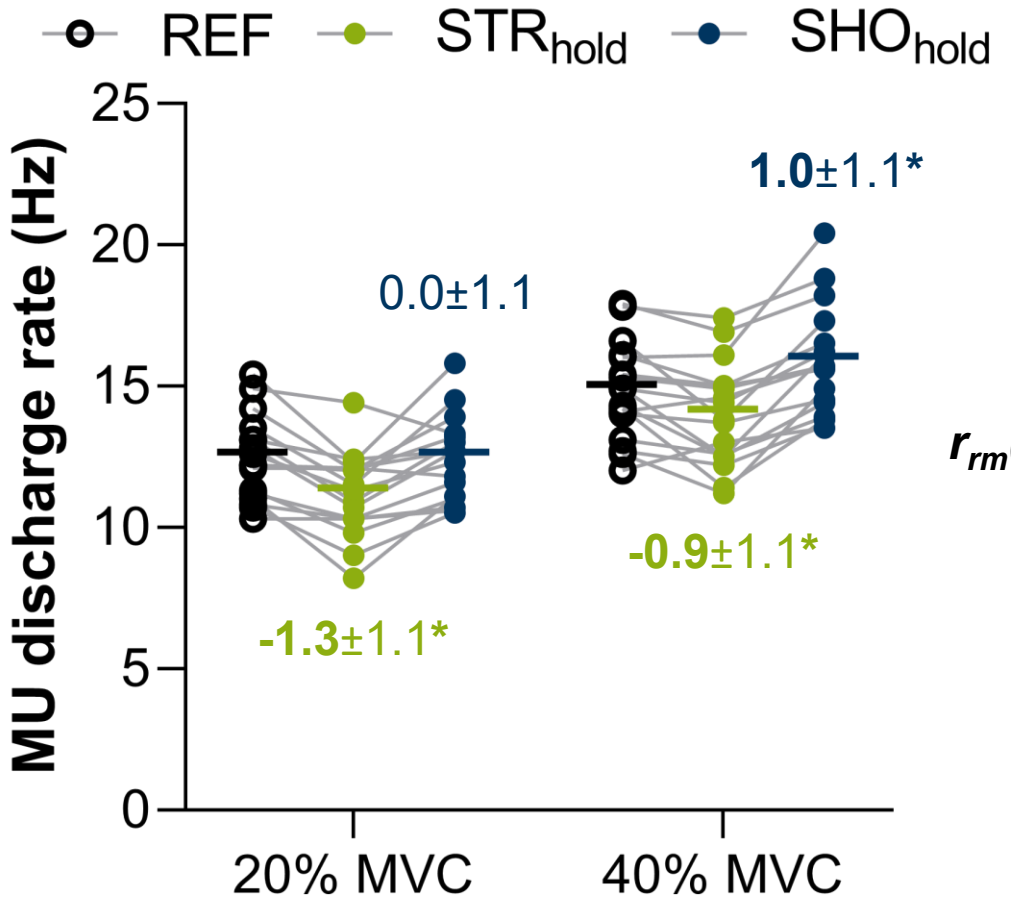

## 40% MVC



# Results

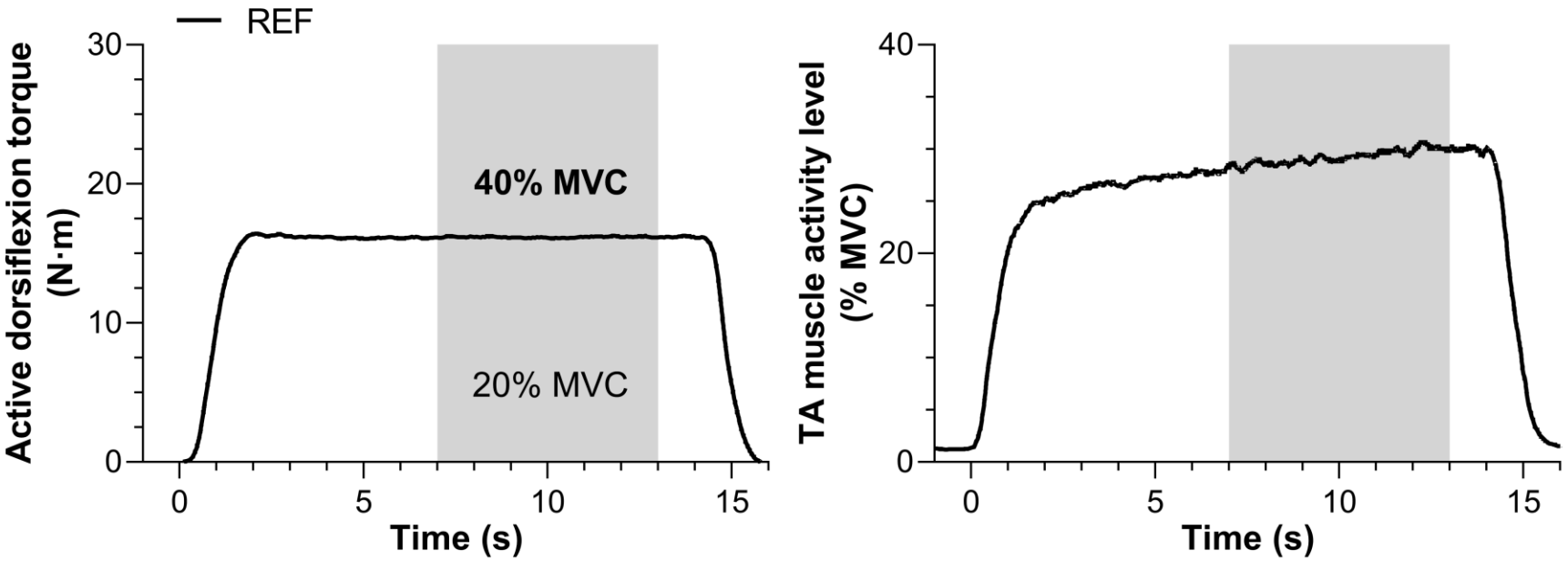


# Results

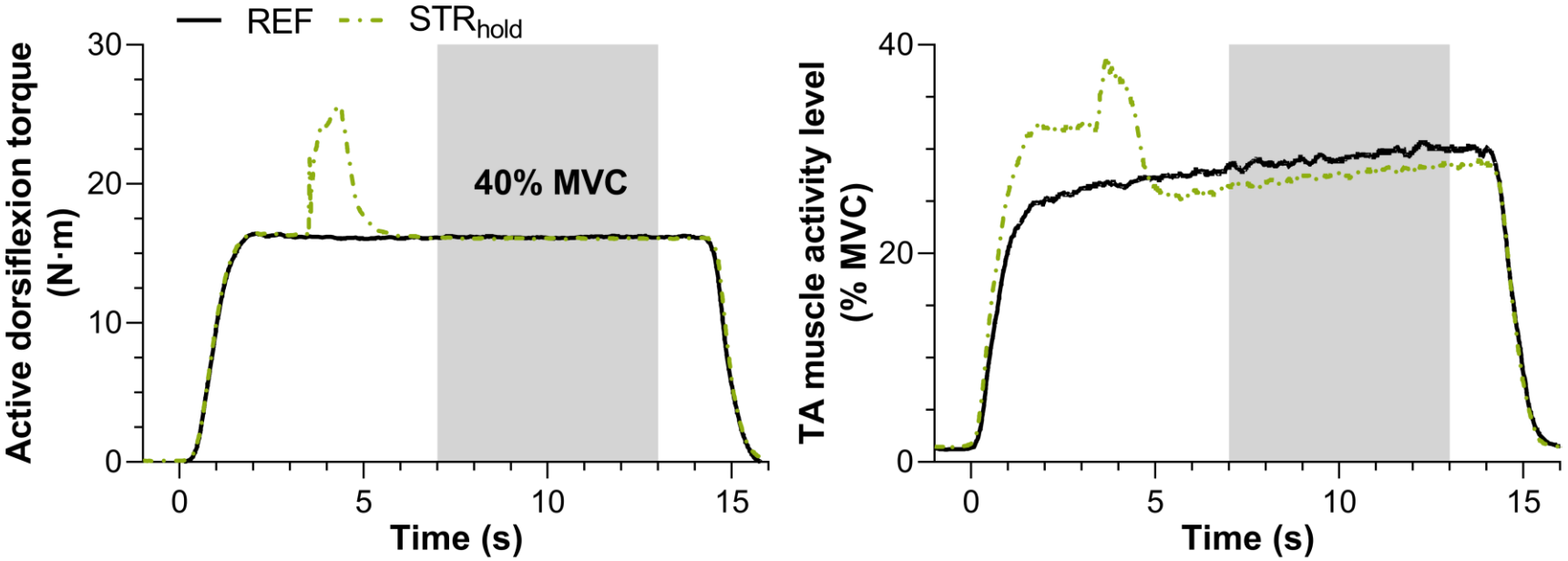



$r_{rm}(50)$ = .92 [.86-.95]

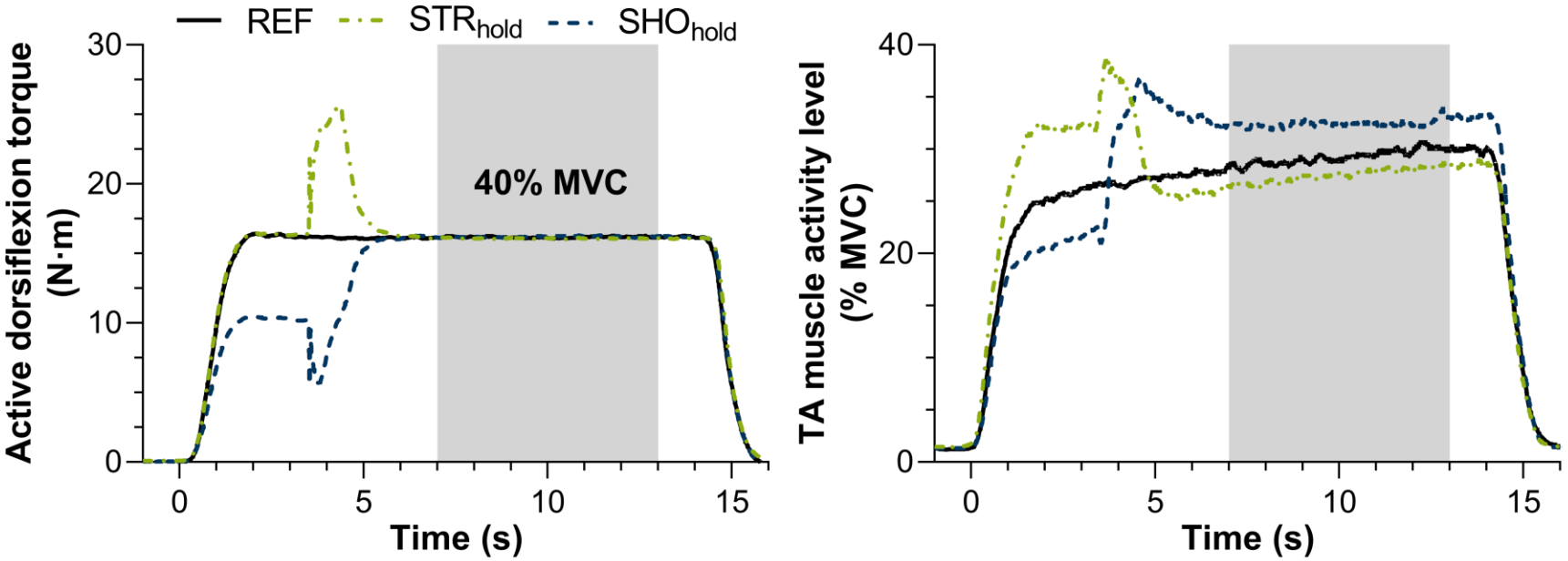
# Results



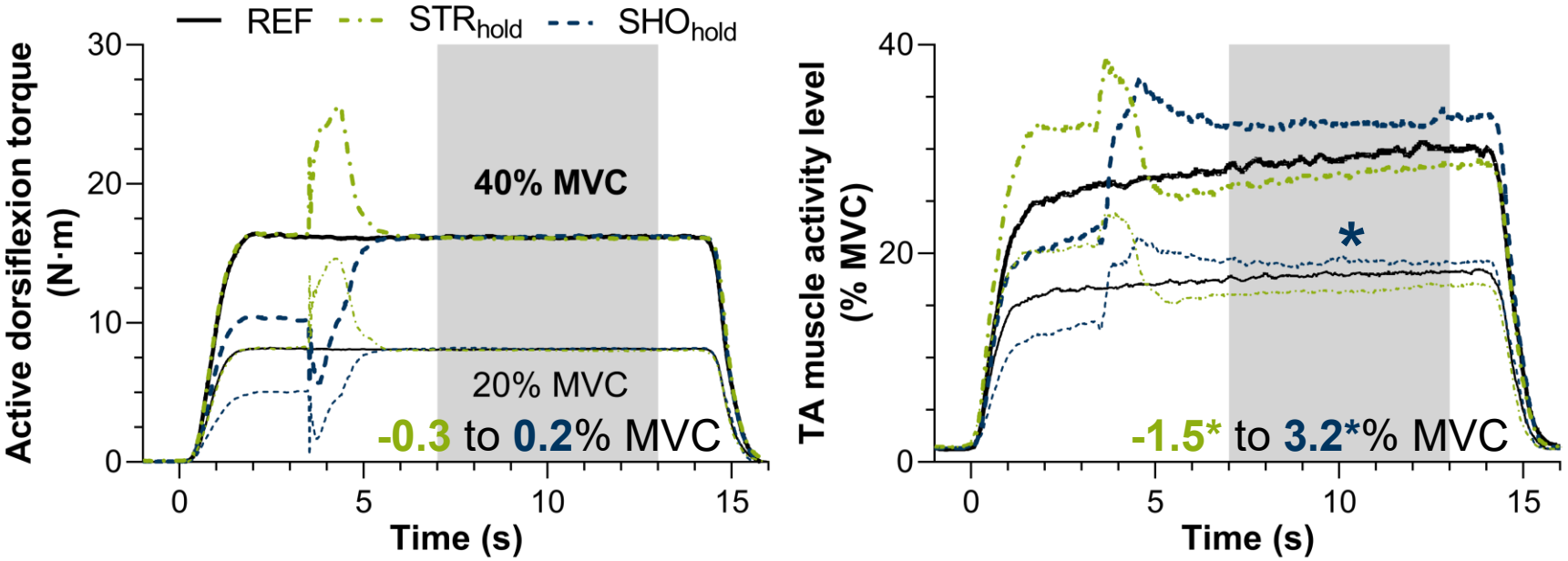
# Results


REF
STR$_{hold}$
40% MVC
Active dorsiflexion torque (N·m)
TA muscle activity level (% MVC)
Time (s)
Time (s)
0
10
20
30
40
0
5
10
15

# Results



# Results


REF
STR$_{hold}$
SHO$_{hold}$
Active dorsiflexion torque (N·m)
30
20
10
0
40% MVC
20% MVC
-0.3 to 0.2% MVC
0
5
10
15
Time (s)
TA muscle activity level (% MVC)
40
20
0
*
-1.5* to 3.2*% MVC
0
5
10
15
Time (s)

# Conclusions

✓**< neural drive** at a given torque following **stretch** (**-1 Hz**)

✓**≥ neural drive** at a given torque following **shortening** (**0-1 Hz**)

✓Acceptable agreement between ***manual*** & ***automatic*** MU editing

? Changes **during** **STR** / **SHO**?

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NeuromecHAHNics

# Thanks for your attention!

Tack för din uppmärksamhet!

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