Comparison of EMG pattern separability in the affected and non-affected arm in individuals with amputation

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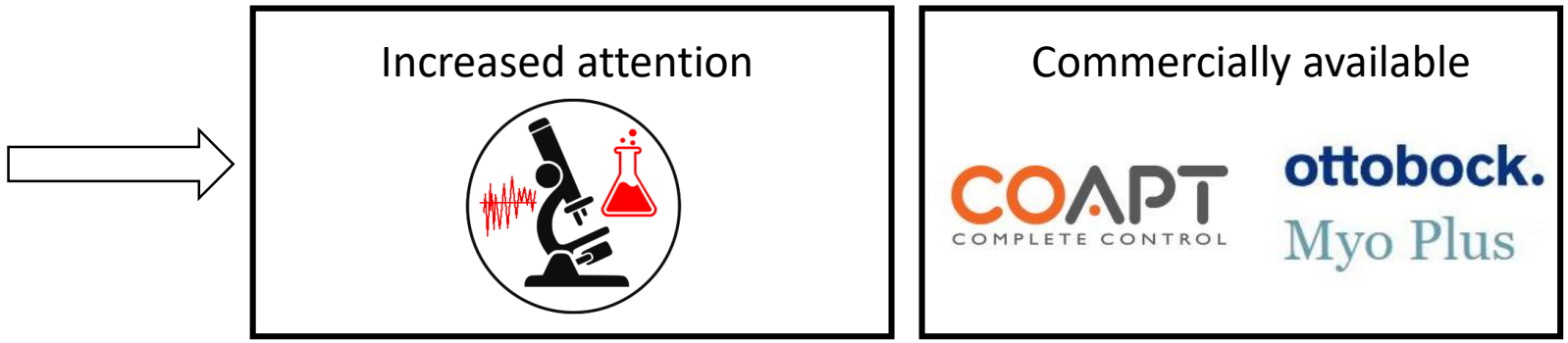
Background

- (Myo-)Prostheses: Machine Learning Control

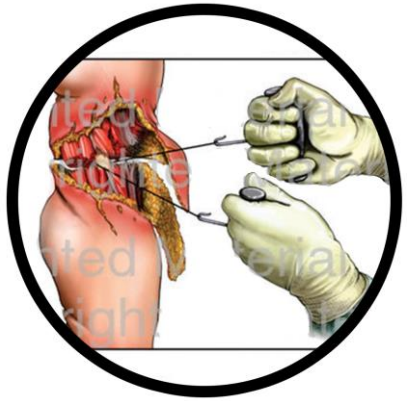


- Studies (E.g. user training, system performance): Often Able bodied
  - ➢Conclusions about: Learning/Training/Performance

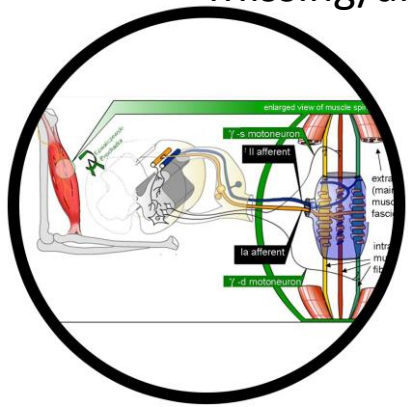
- Amputated limb:
  -Anatomically/physiologically different

Background

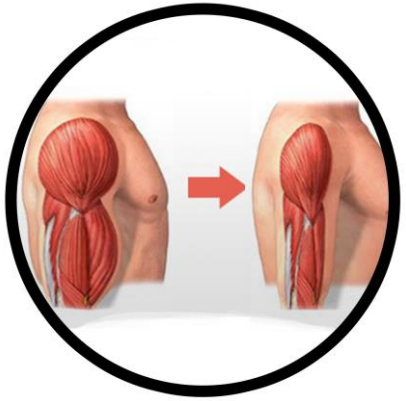
Anatomical changes due to surgery



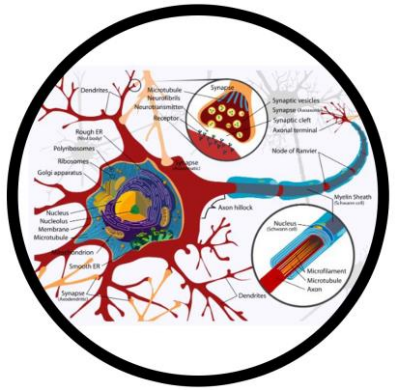
Missing/altered feedback



Muscle atrophy



Cortical reorganization

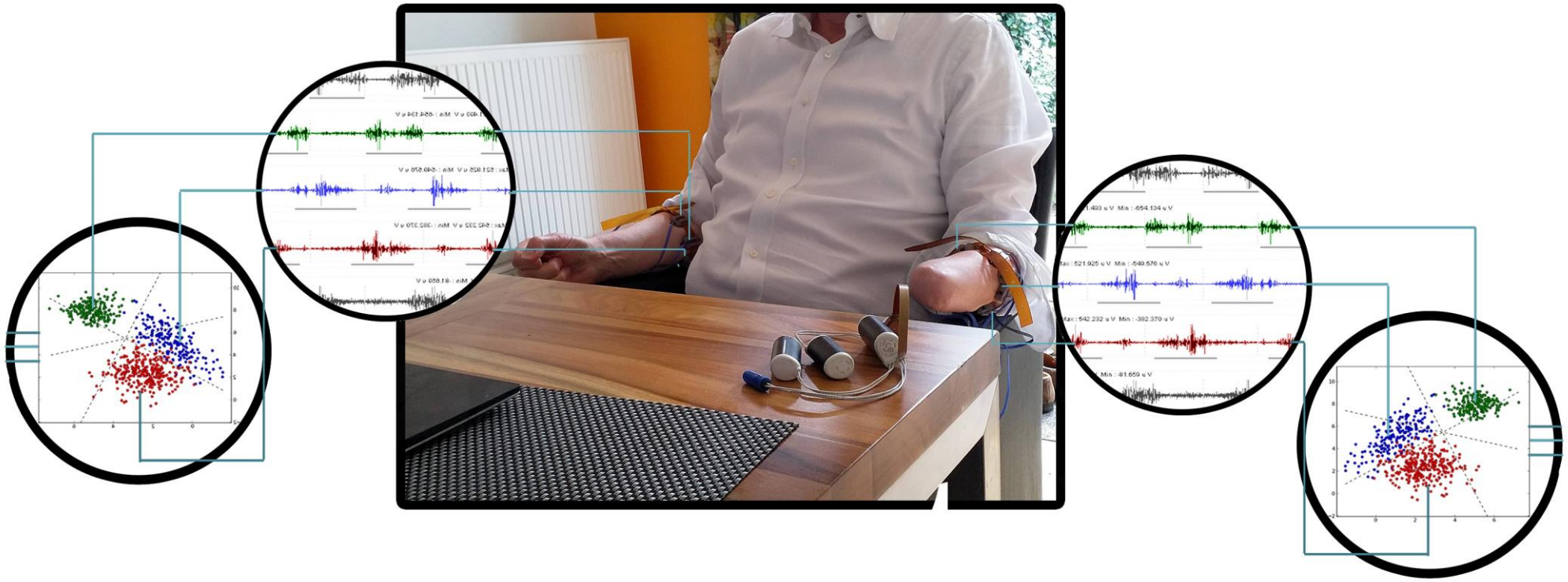


- Amputated limb:
  -Anatomically/physiologically different
  ⟹ Effect on EMG/Muscle Control?

Image Sources:
saebo.com/causes-prevention-muscle-atrophy-stroke
wikipedia.org/wiki/Muscle_spindle
soundhealthportal.com/neuroplasticity/
mgmtrialservices.medicalillustration.com

As a first step…

- Compare separability of EMG patterns in sound and affected limbs of individuals with amputations



Separability of EMG patterns?

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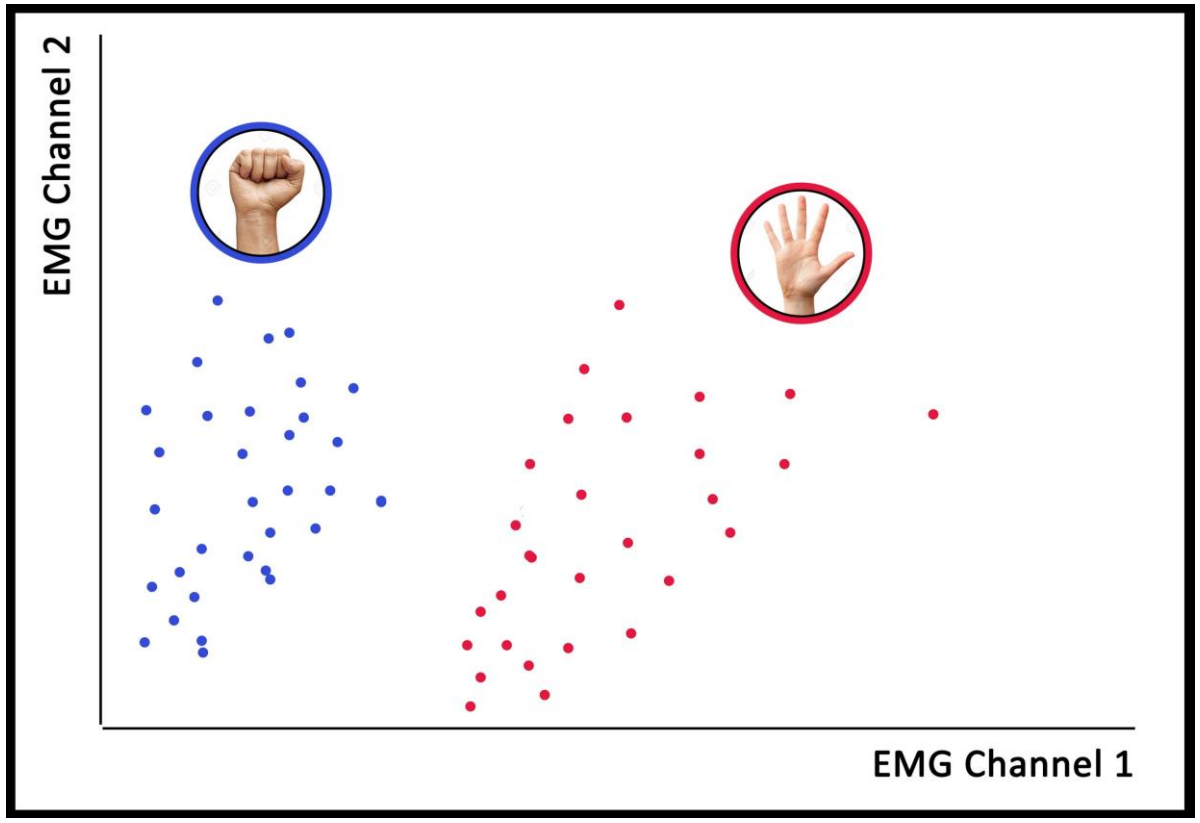

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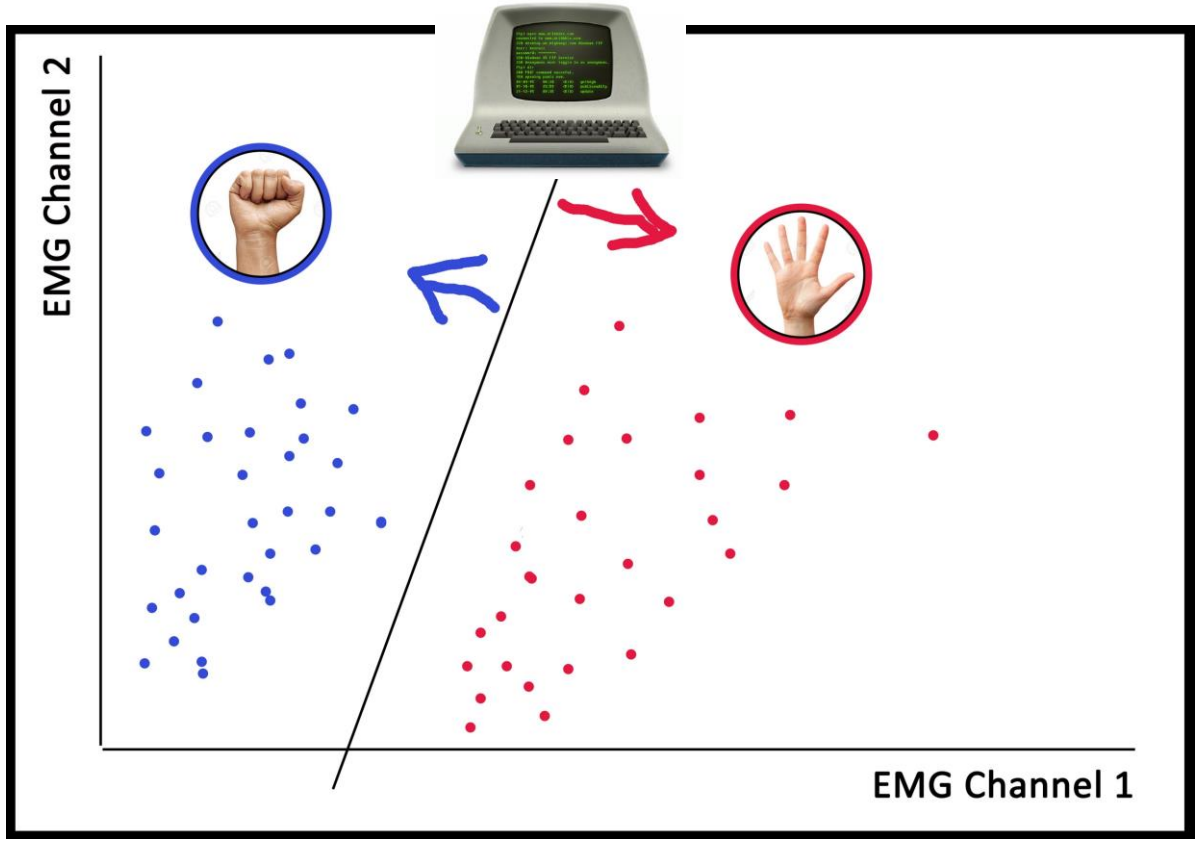

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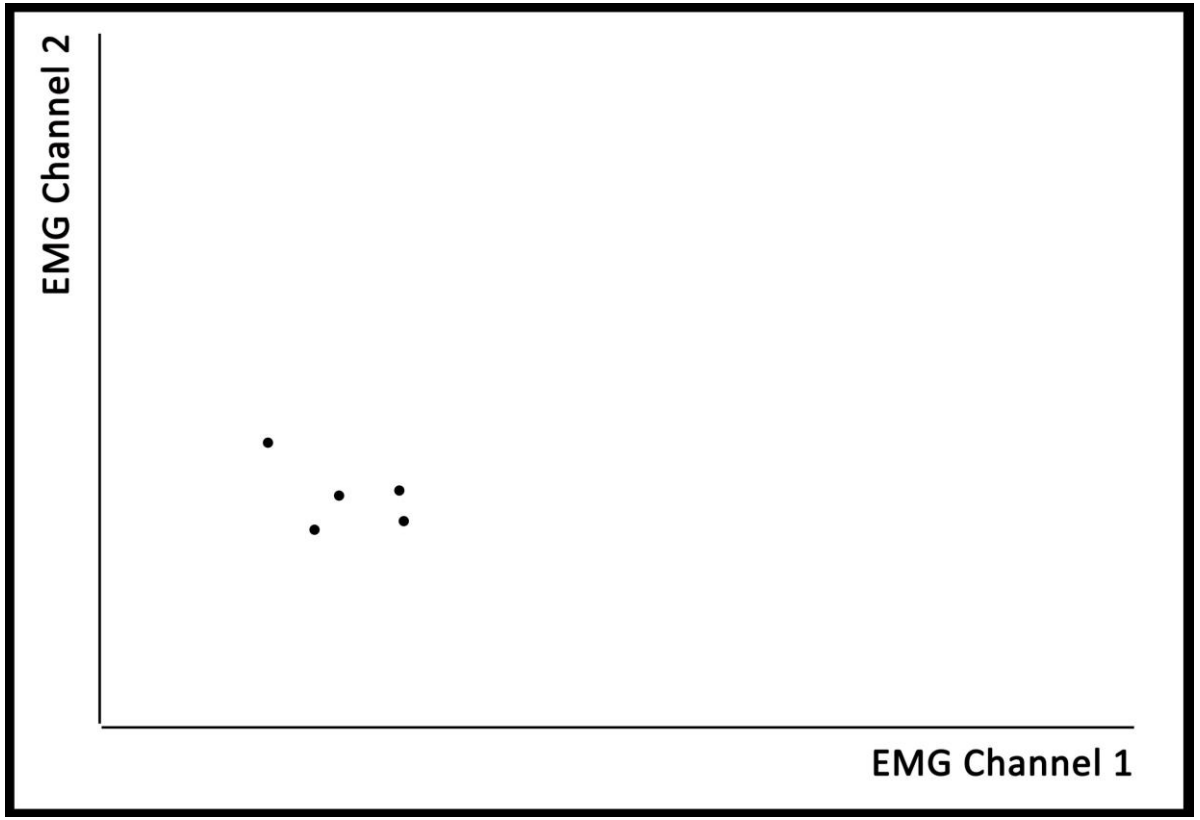

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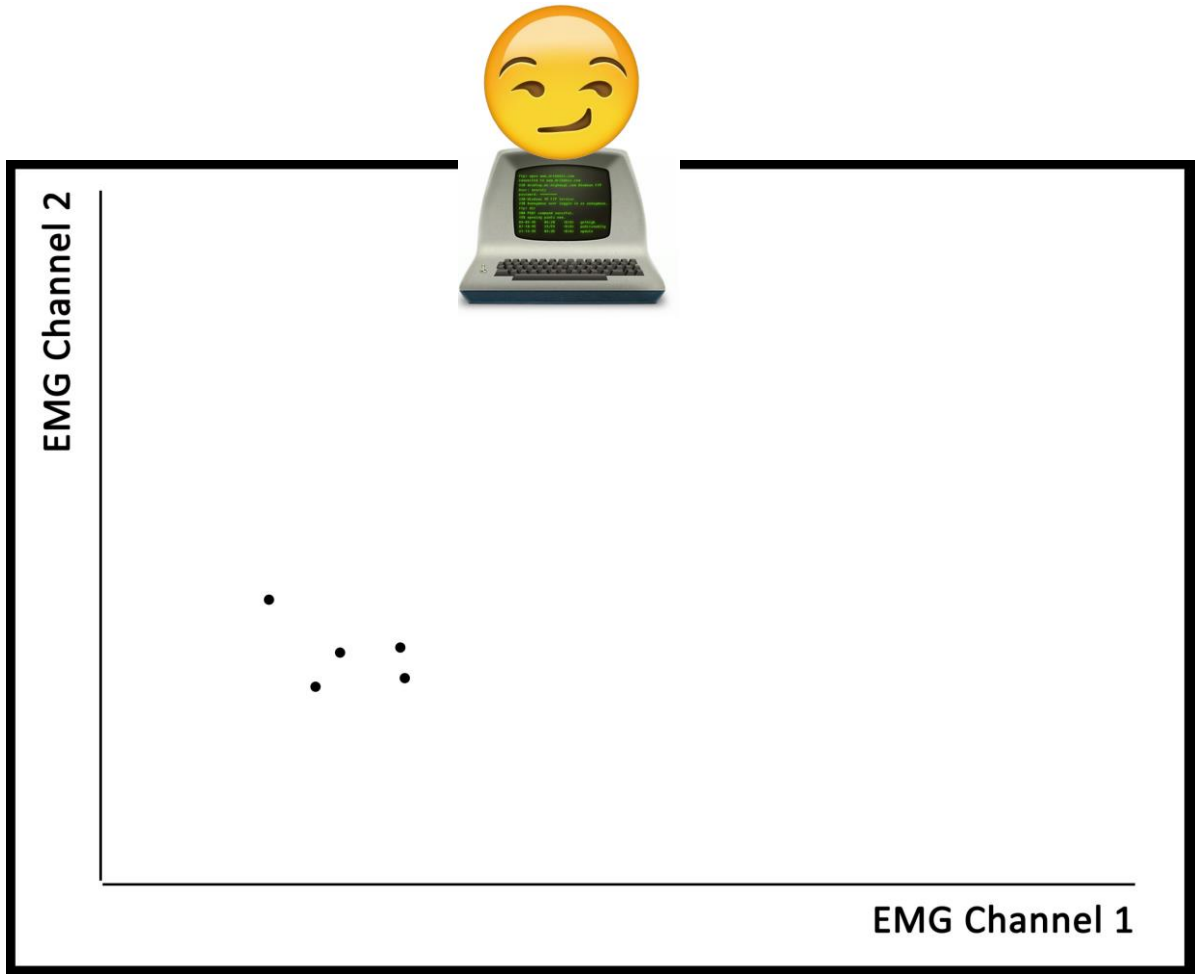

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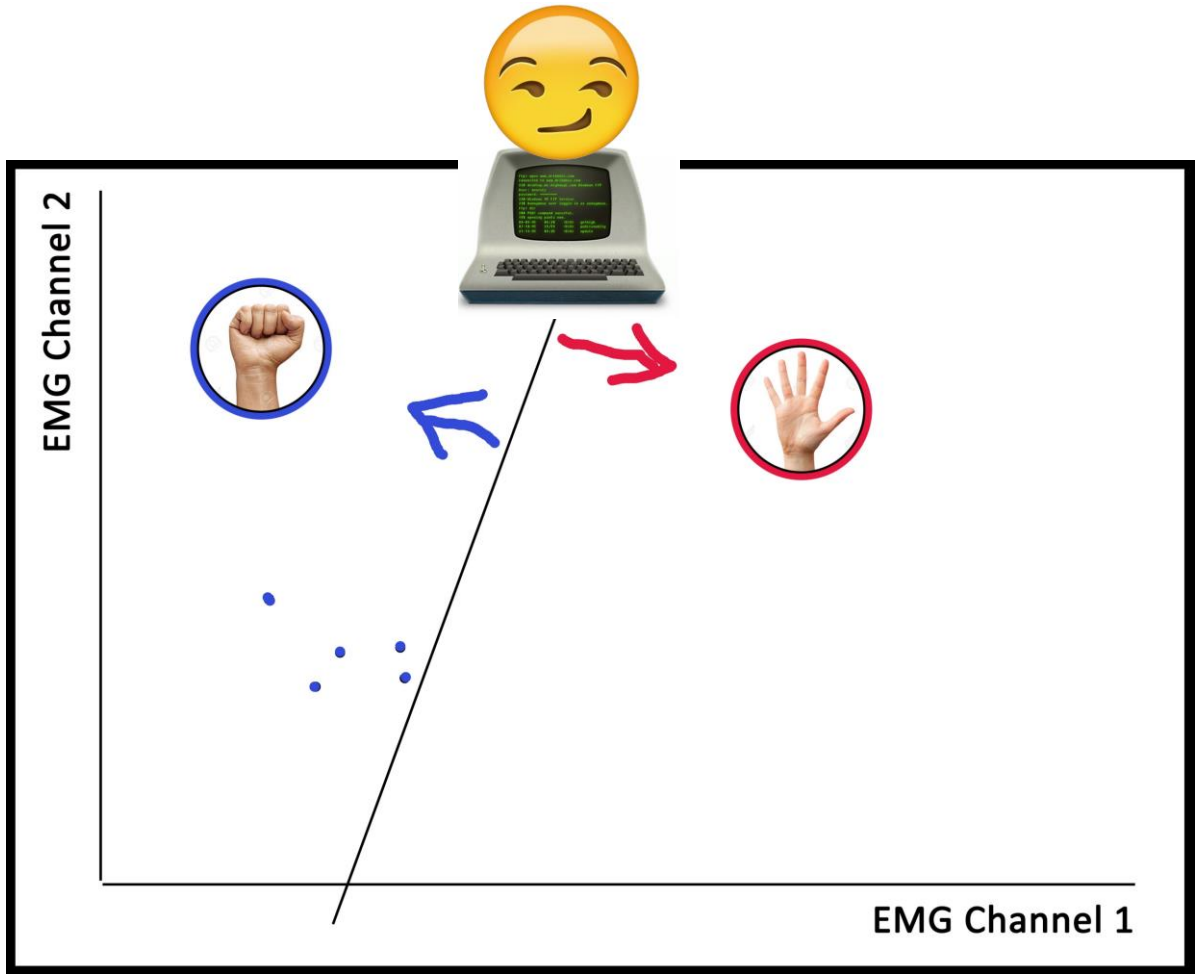

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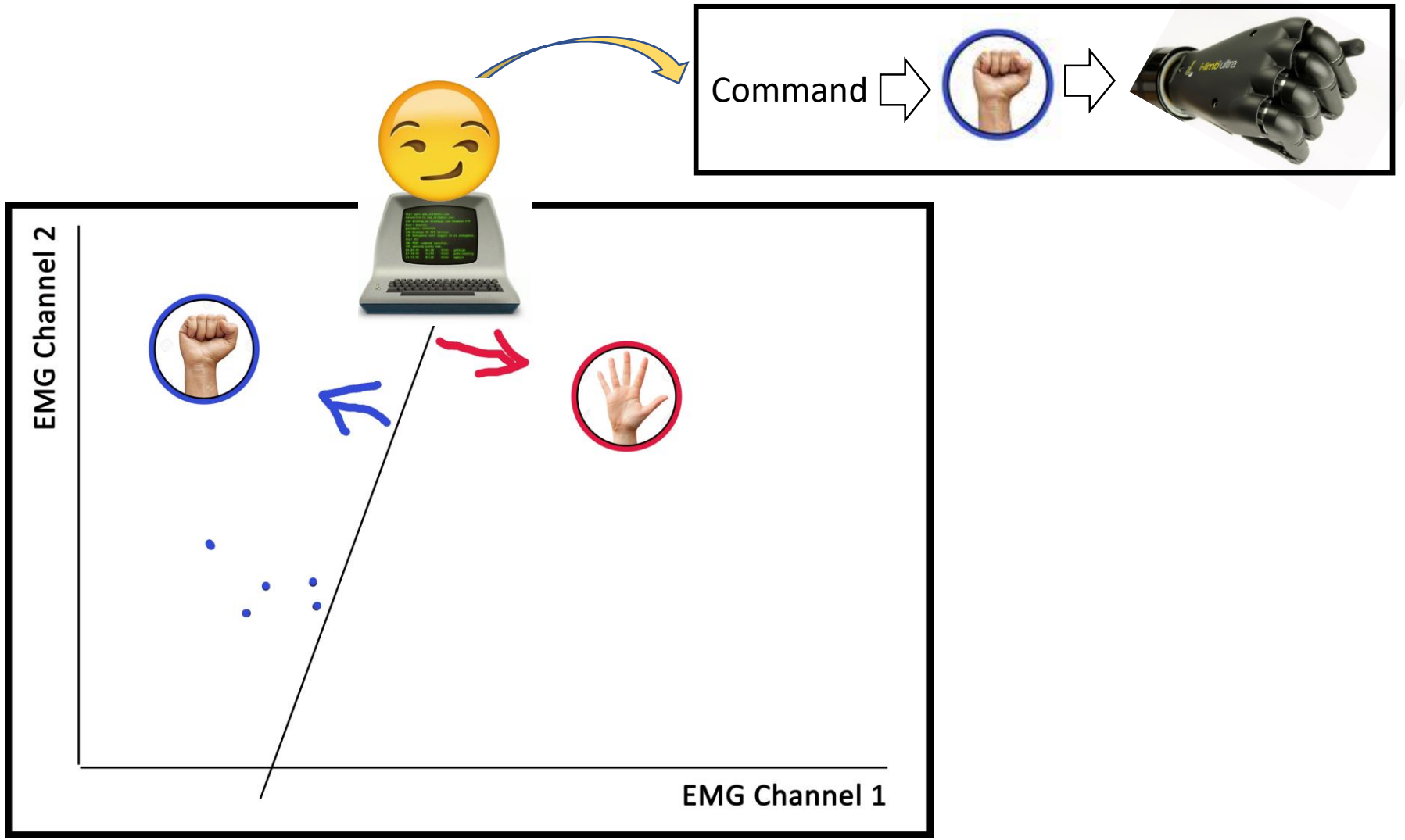
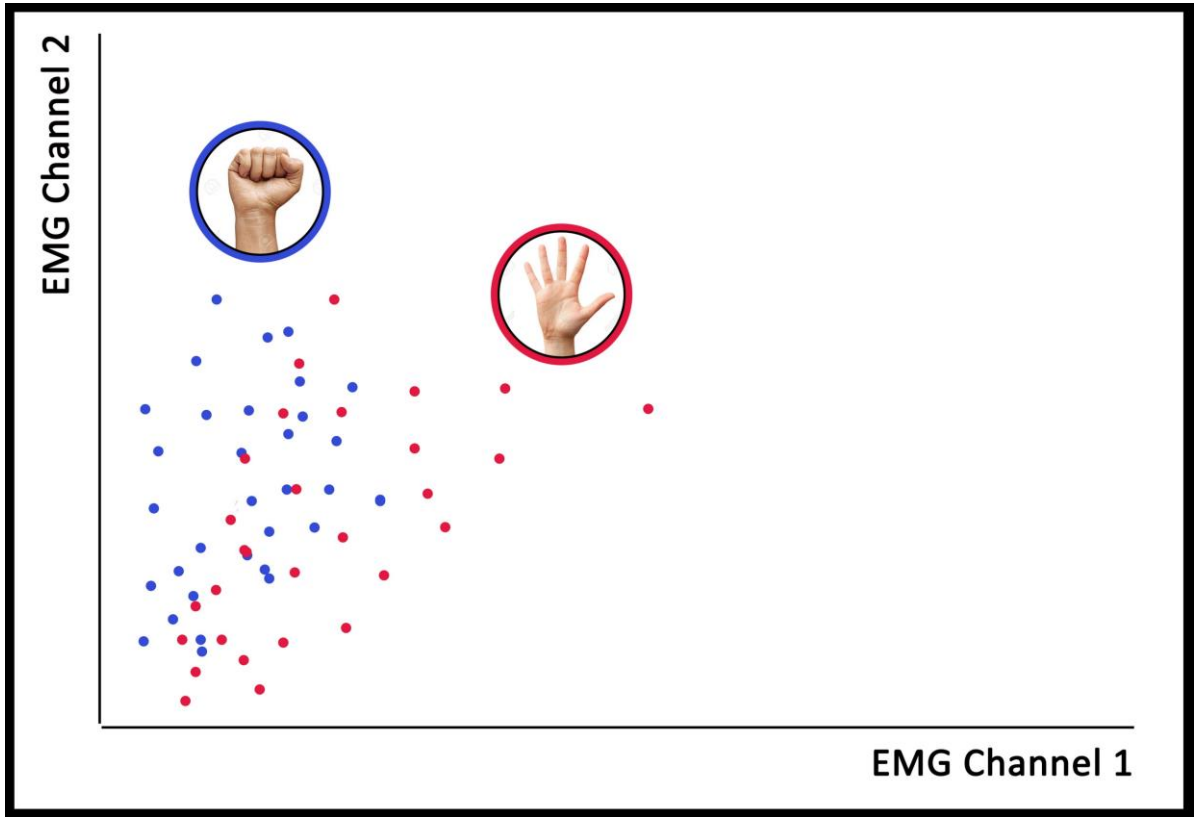


Separability of EMG patterns?

"Bad" (= low) separability



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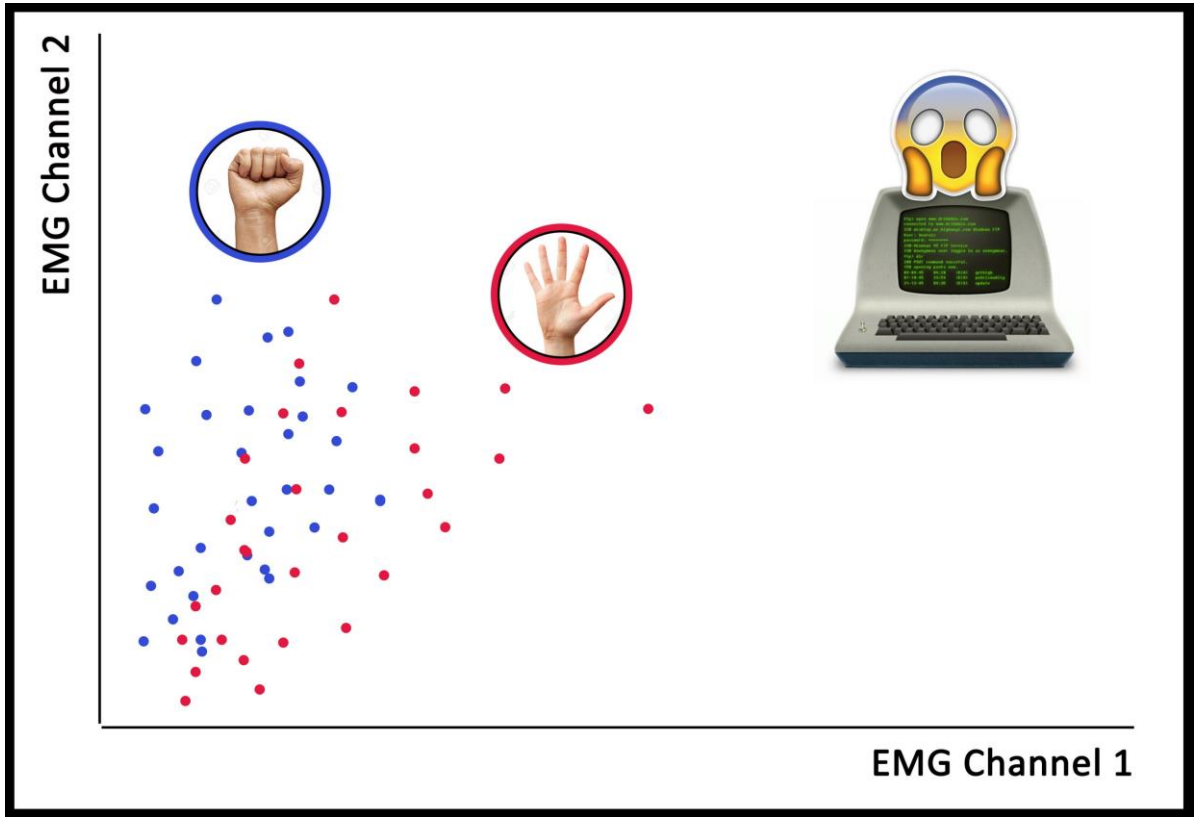
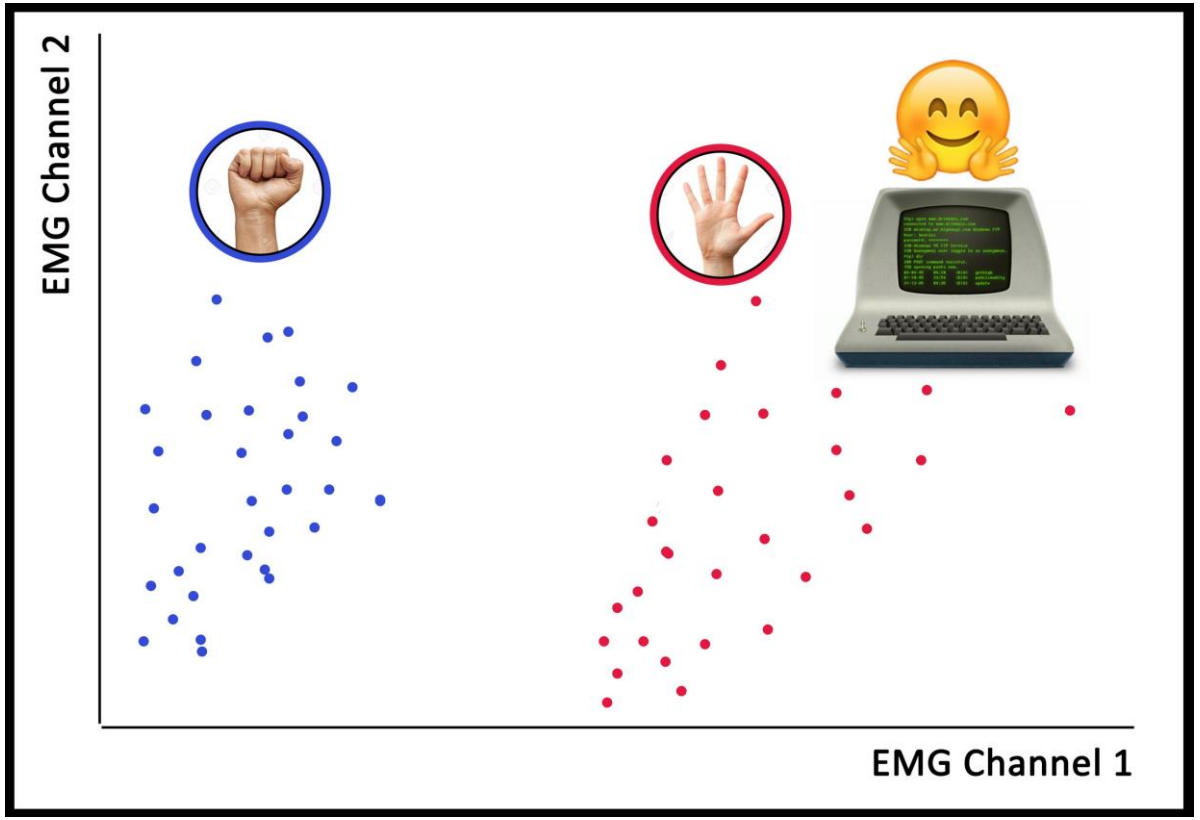


Separability of EMG patterns?

"Good" (= high) separability



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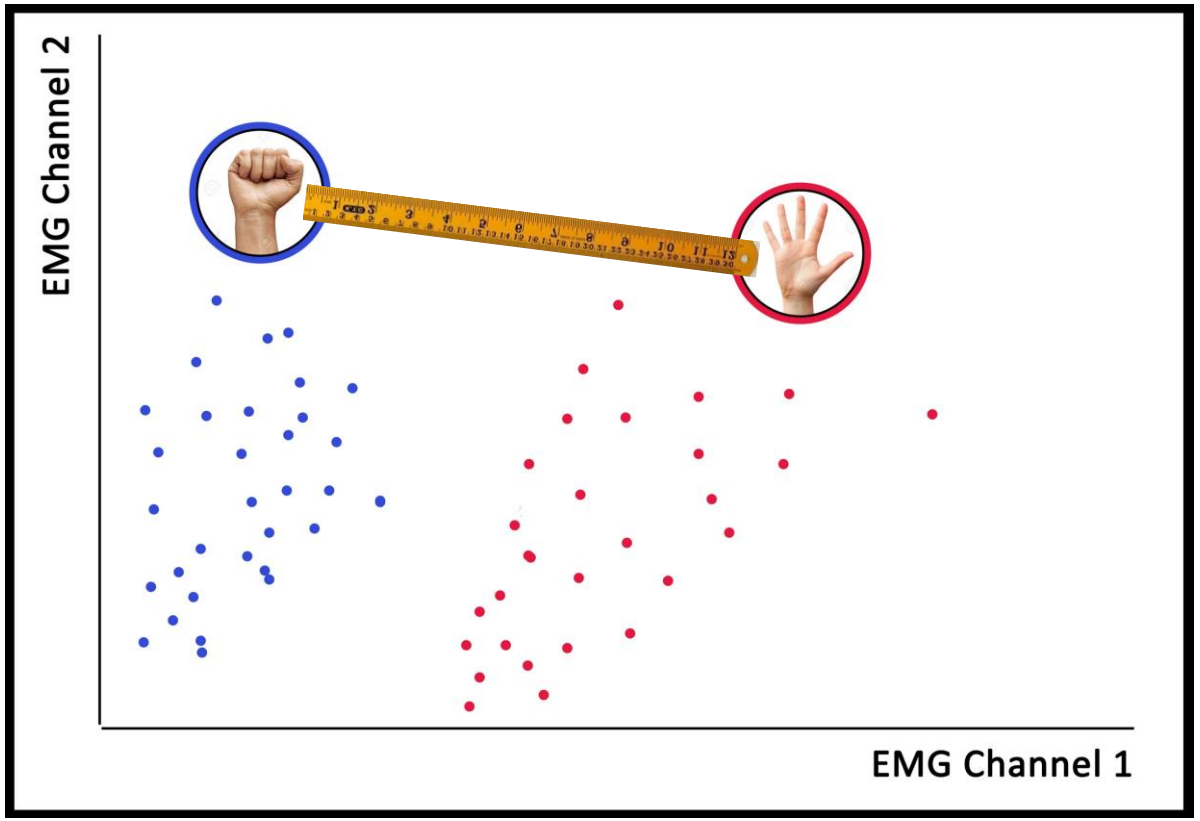
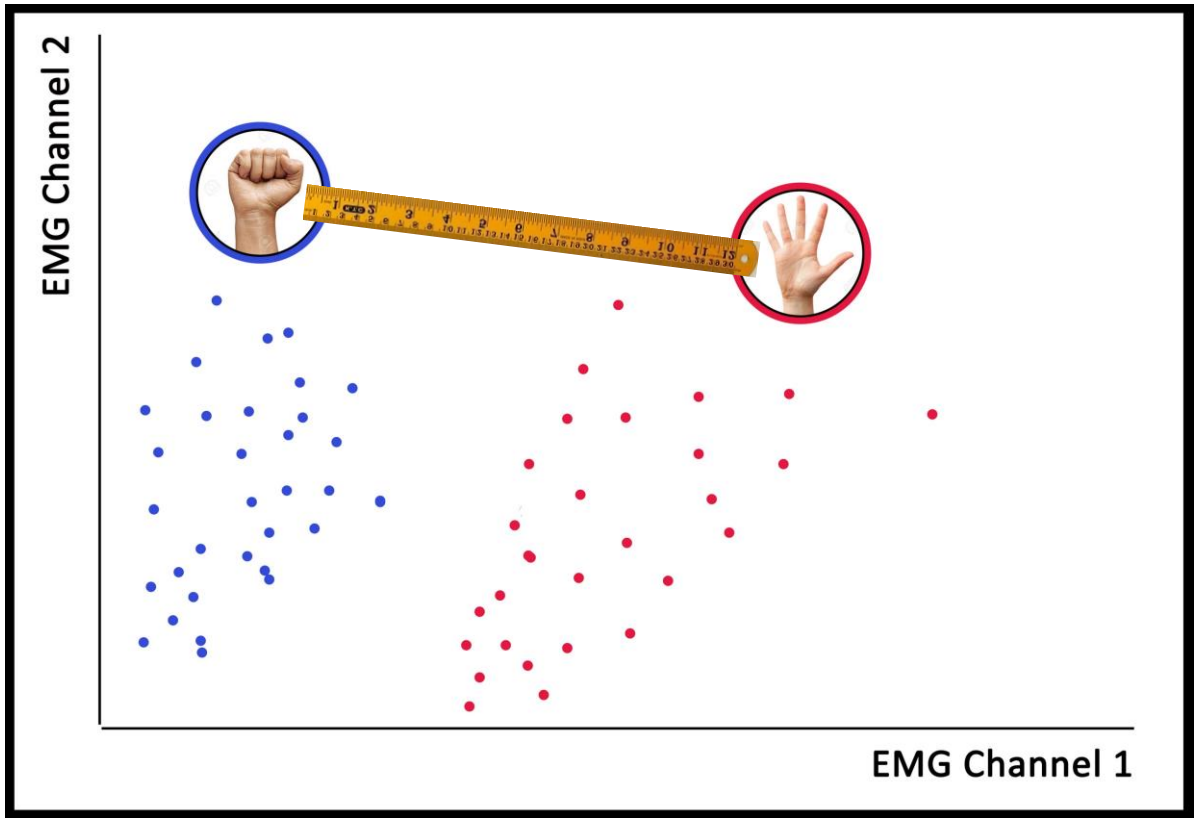


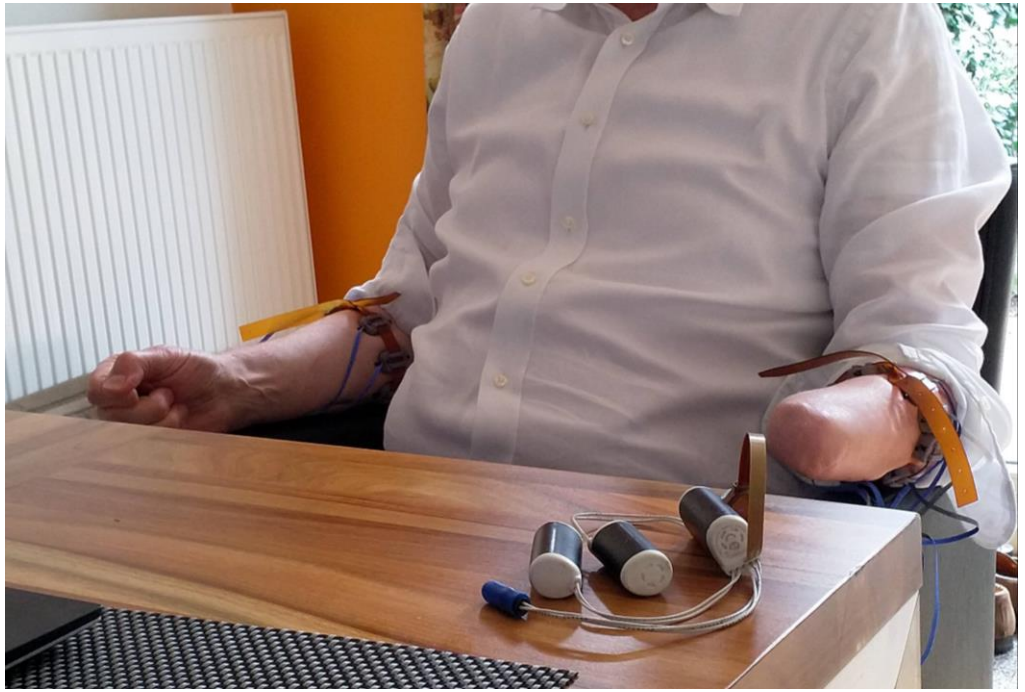
What does influence separability?

- Compare separability of EMG patterns in sound and affected limbs of individuals with amputations



What does influence separability?

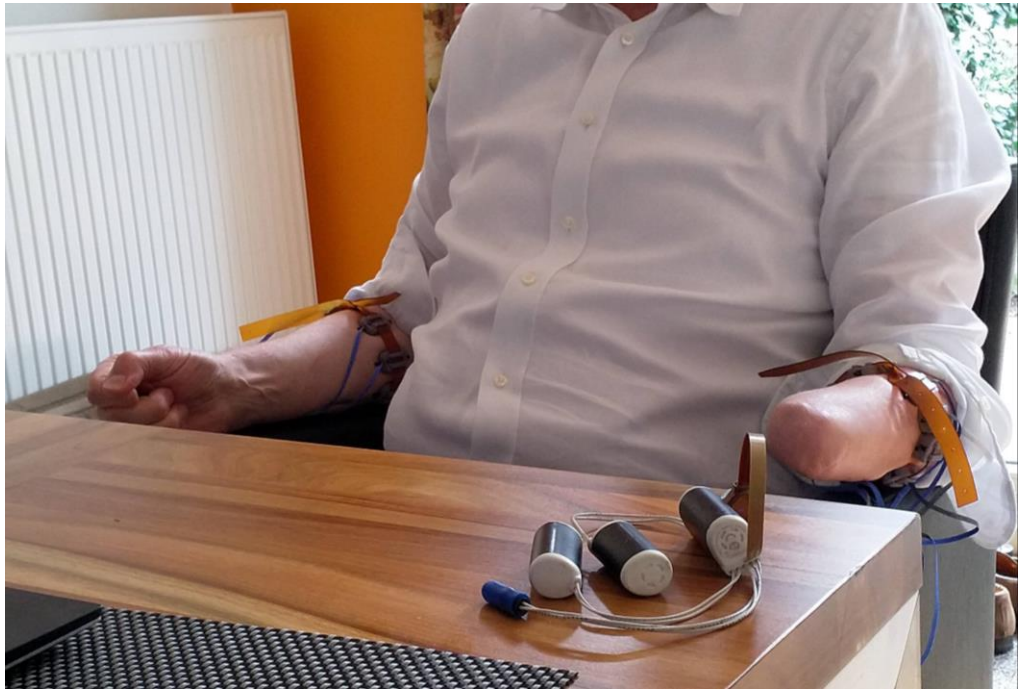
Methods



Methods

14 Individuals with Amputation

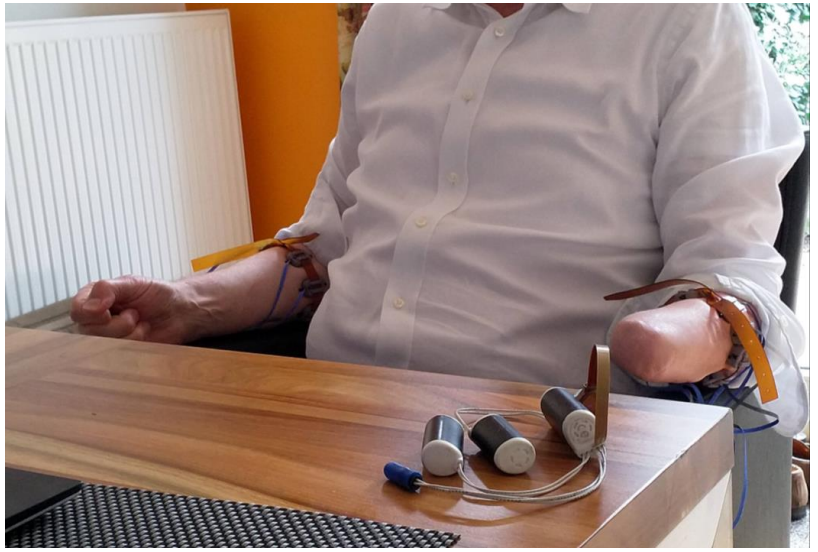
- Unilateral, transradial amputation
- Age: 53 (+- 15)
- Time since limb loss: 25 years(+- 19)
- 2 Females
- 10 Myoelectric, 1 cosmetic, 3 no prosth.
- All daily users (10 hours/day (+- 2.7))

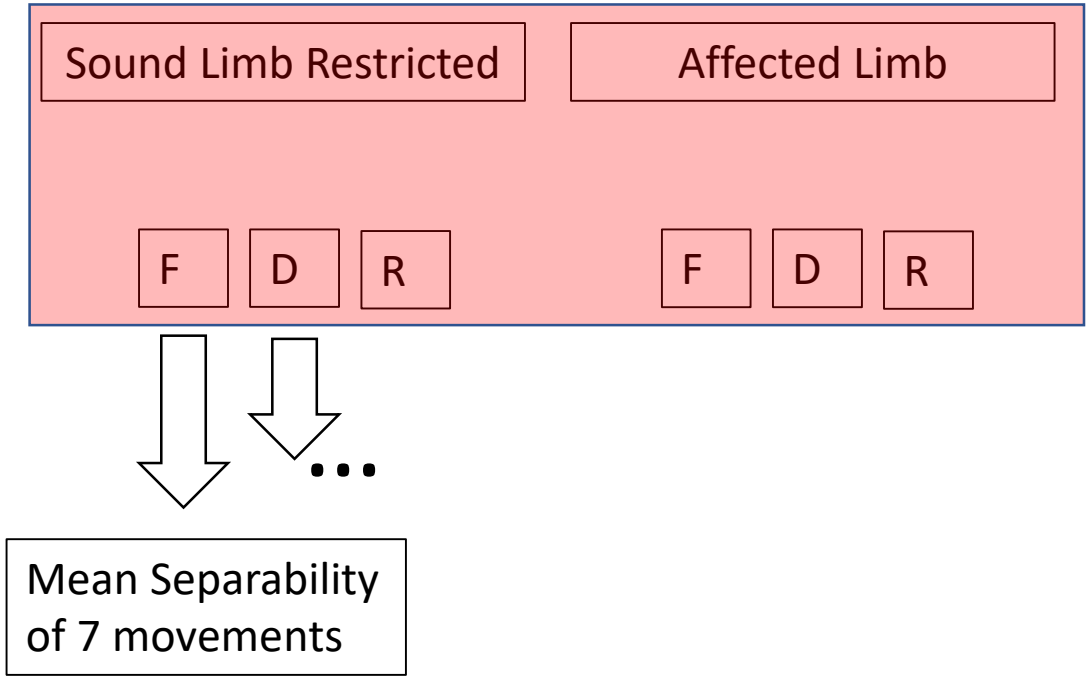


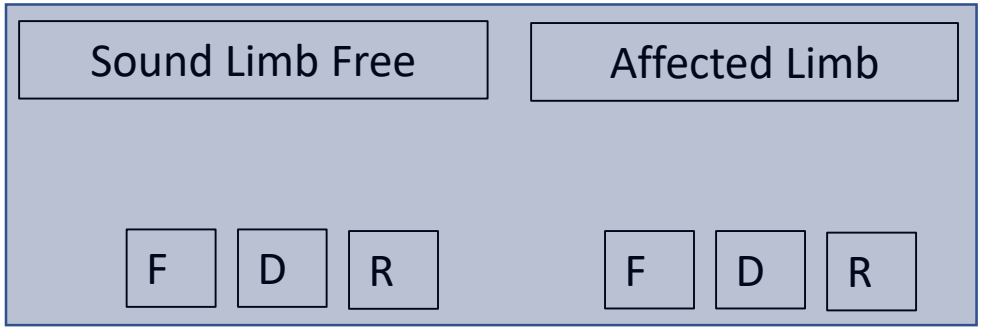
Methods

Protocol

-Performing 7 bimanual movements
 in three arm orientations
 sound hand unrestricted/ restricted
- 8 EMG electrodes on each arm





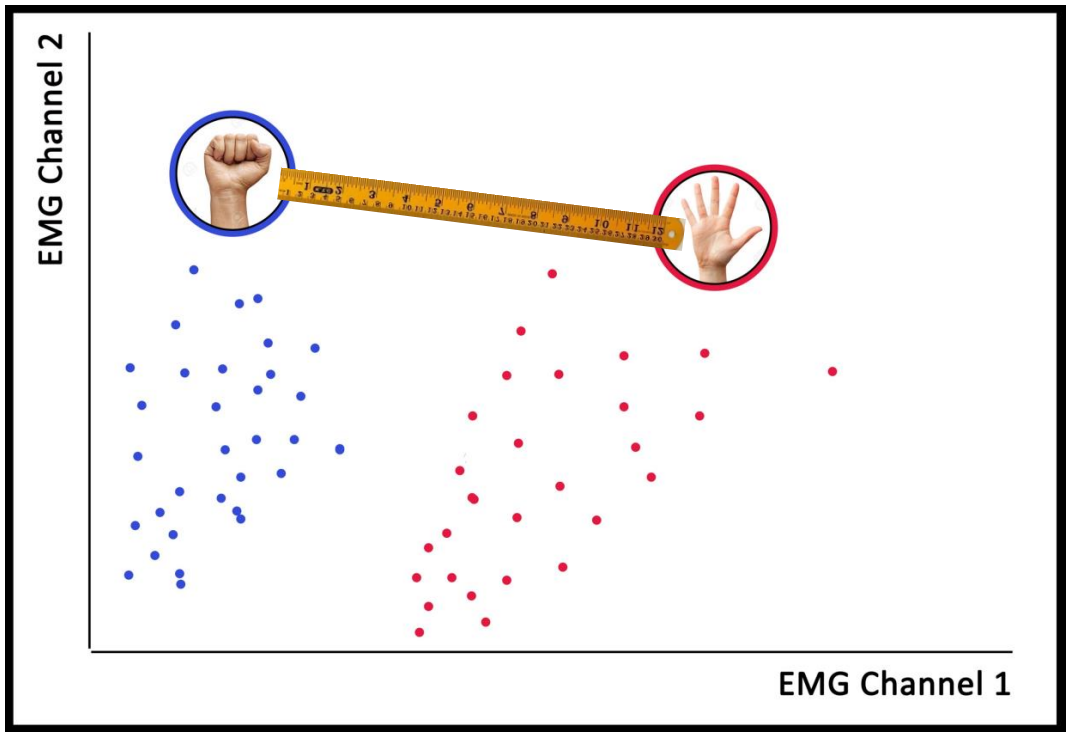


Methods

Analysis:

- Separability: (Bunderson, 2012 | Roduit 2006)
- Sliding Time Windows (200ms), 4 Time-Domain Features (Hudgin's)
- Mahalanobis (nearest neighbor) Interclass-distance:
- D_1 = ½ *Mahalanobis Distance movement A -> movement B*
- D_2 = ½ *Mahalanobis Distance movement B -> movement A*
- $Separability = \frac{D_1 * D_2}{D_1 + D_2}$

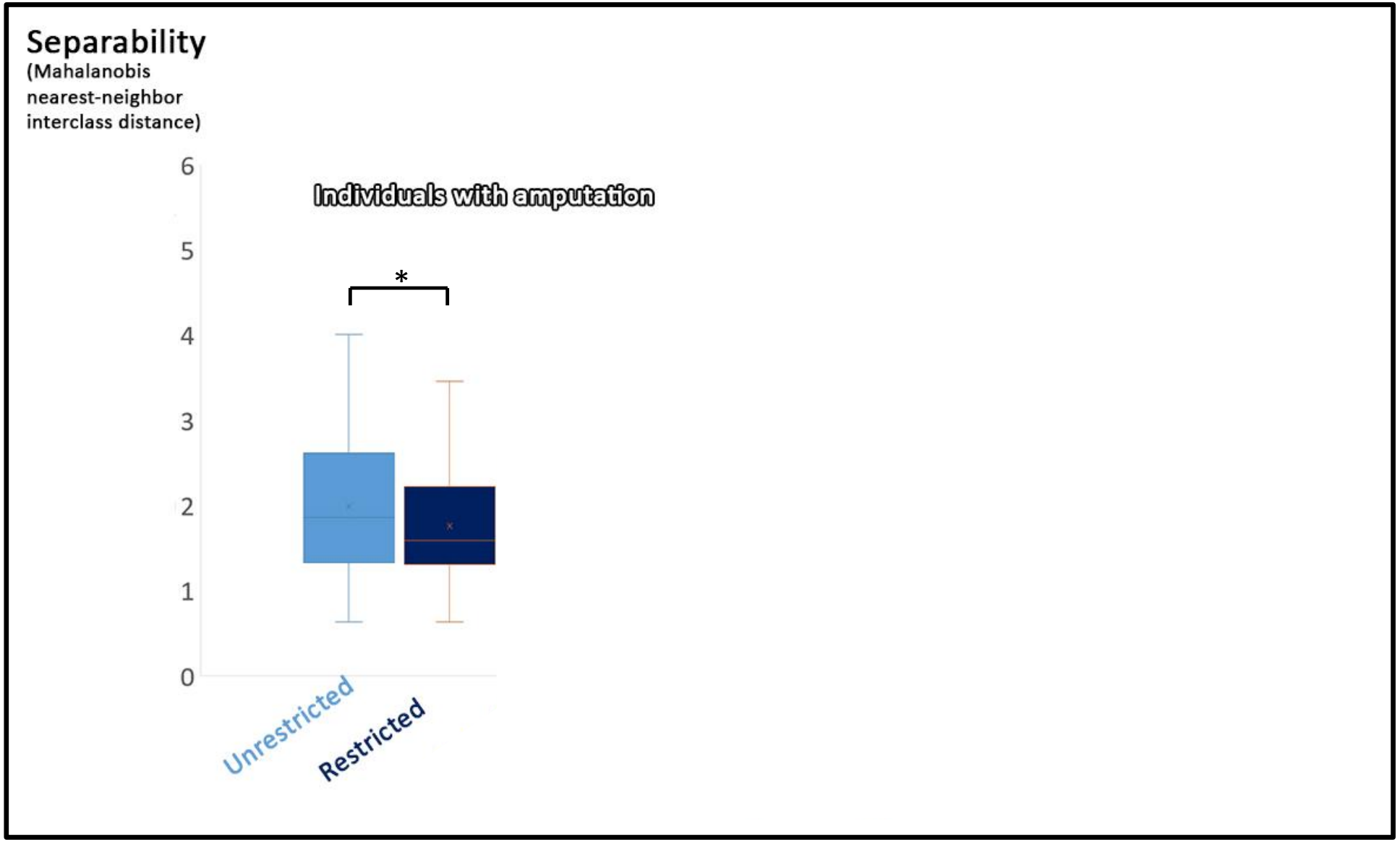
- Statistical Analysis:
- GLM Repeated Measures, significance level: 0.05
- (Within subject factors: Sound hand restriction, Arm, Orientation)



Results

Two main effects:

Sound Hand Restriction (p=0.015)



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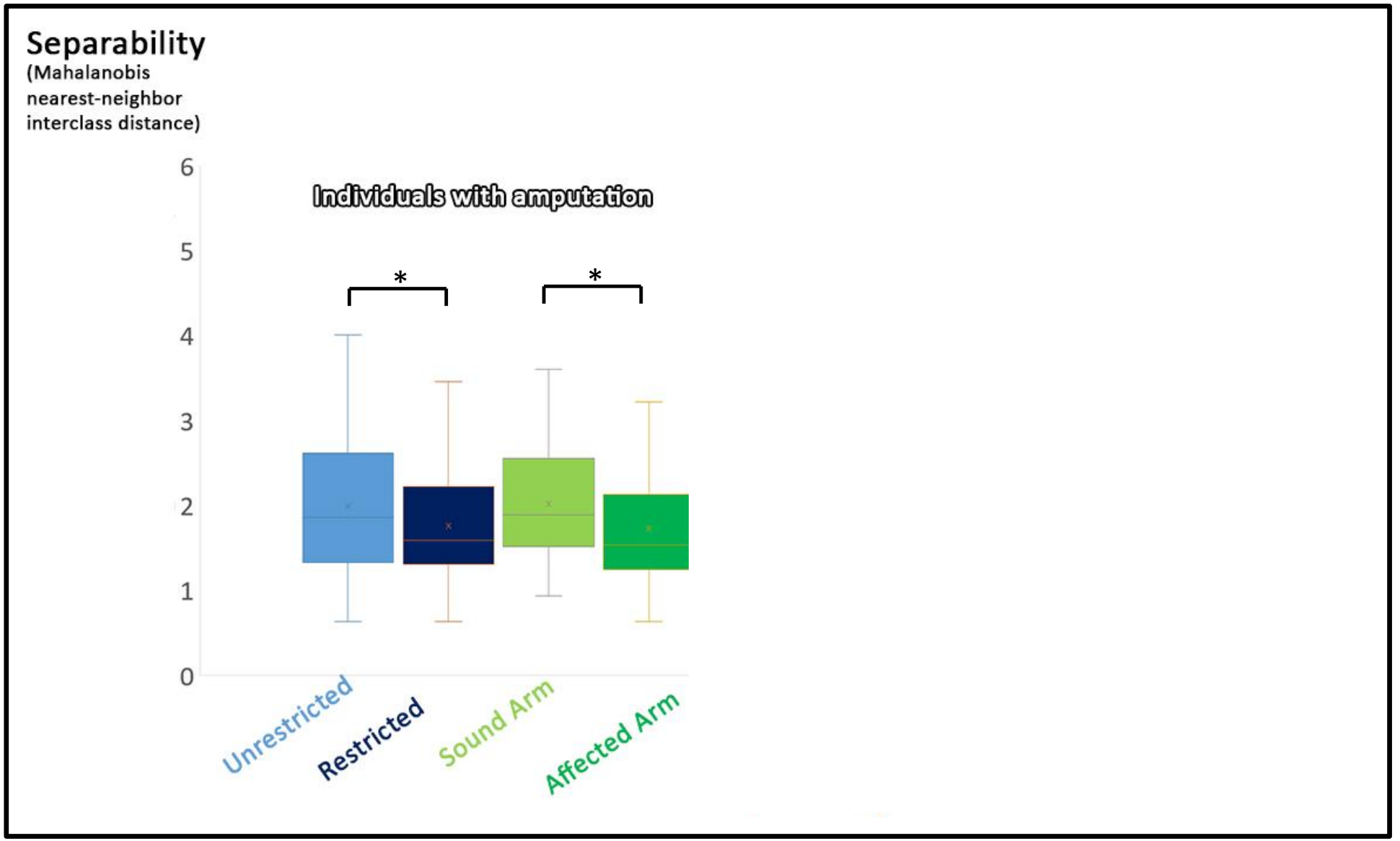
Arm (p=0.011)



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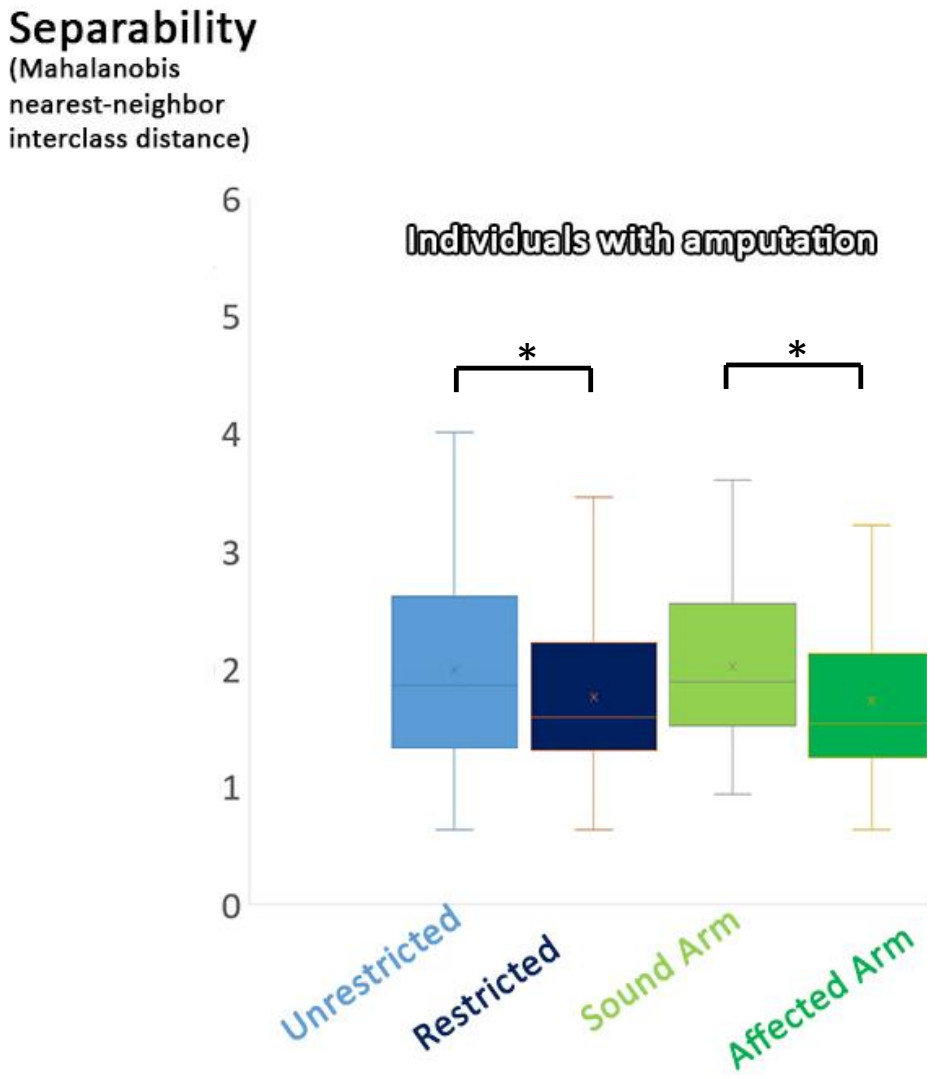

- Separability is negatively affected by limb absence…
  - How to interpret these numbers?
  - Is it a meaningful difference?

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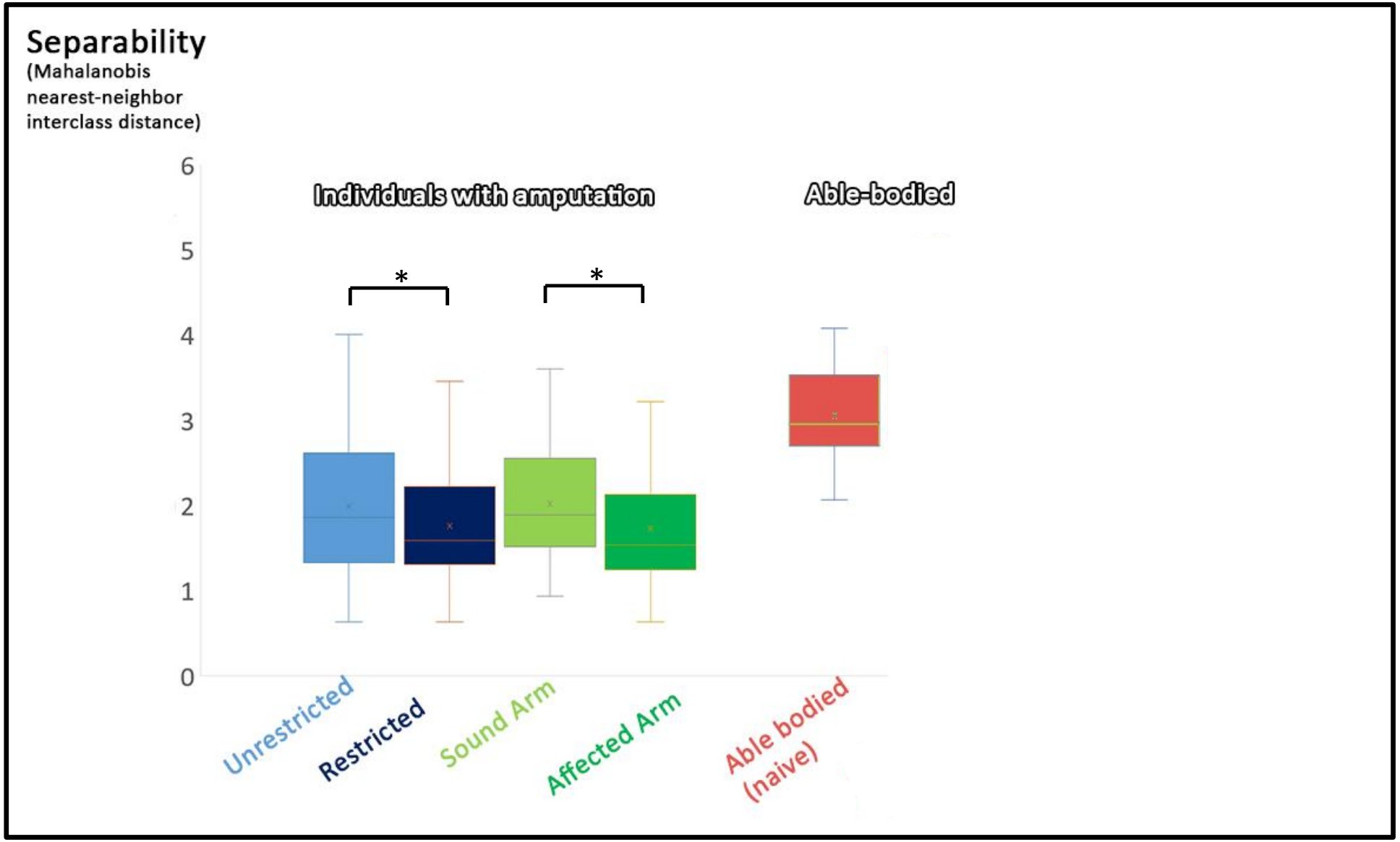

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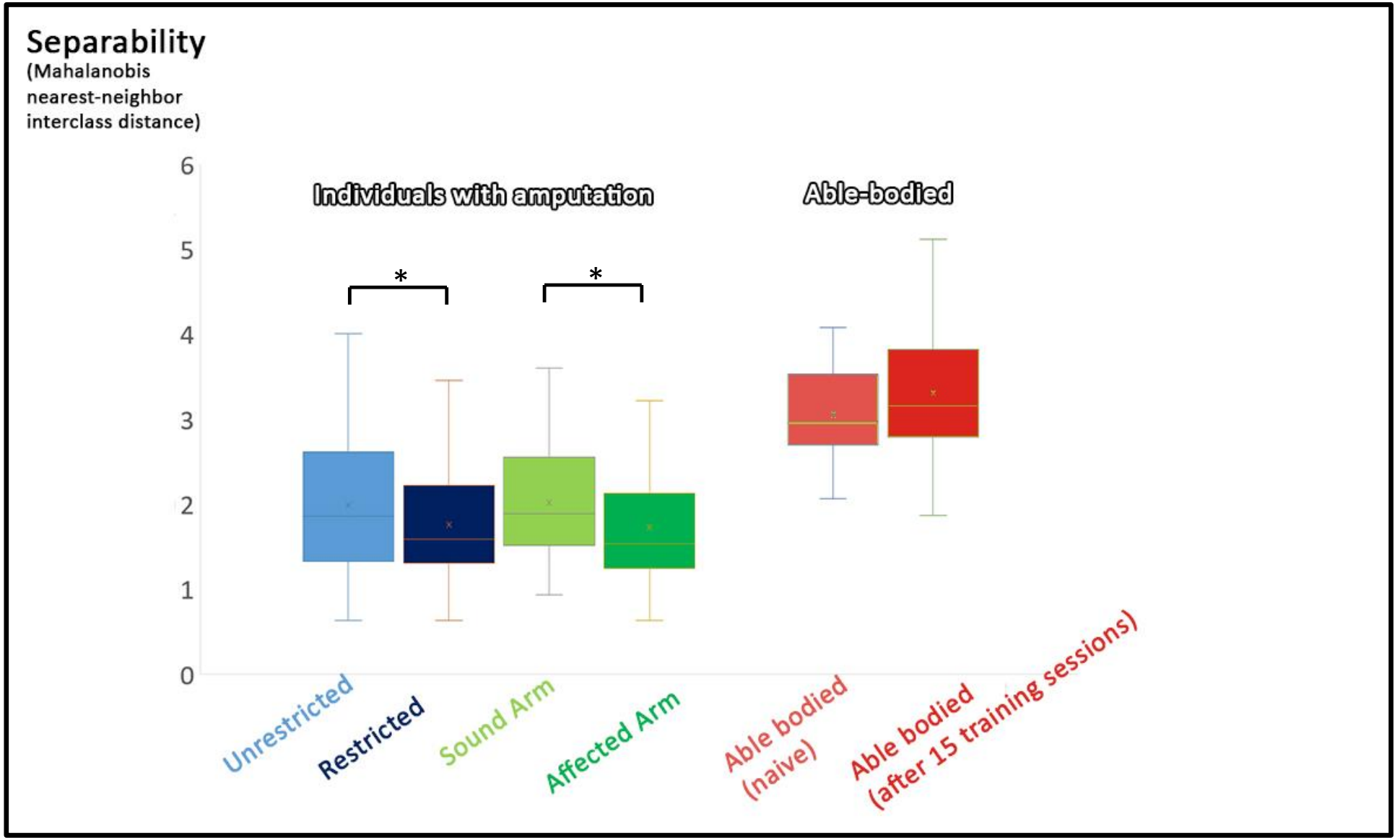
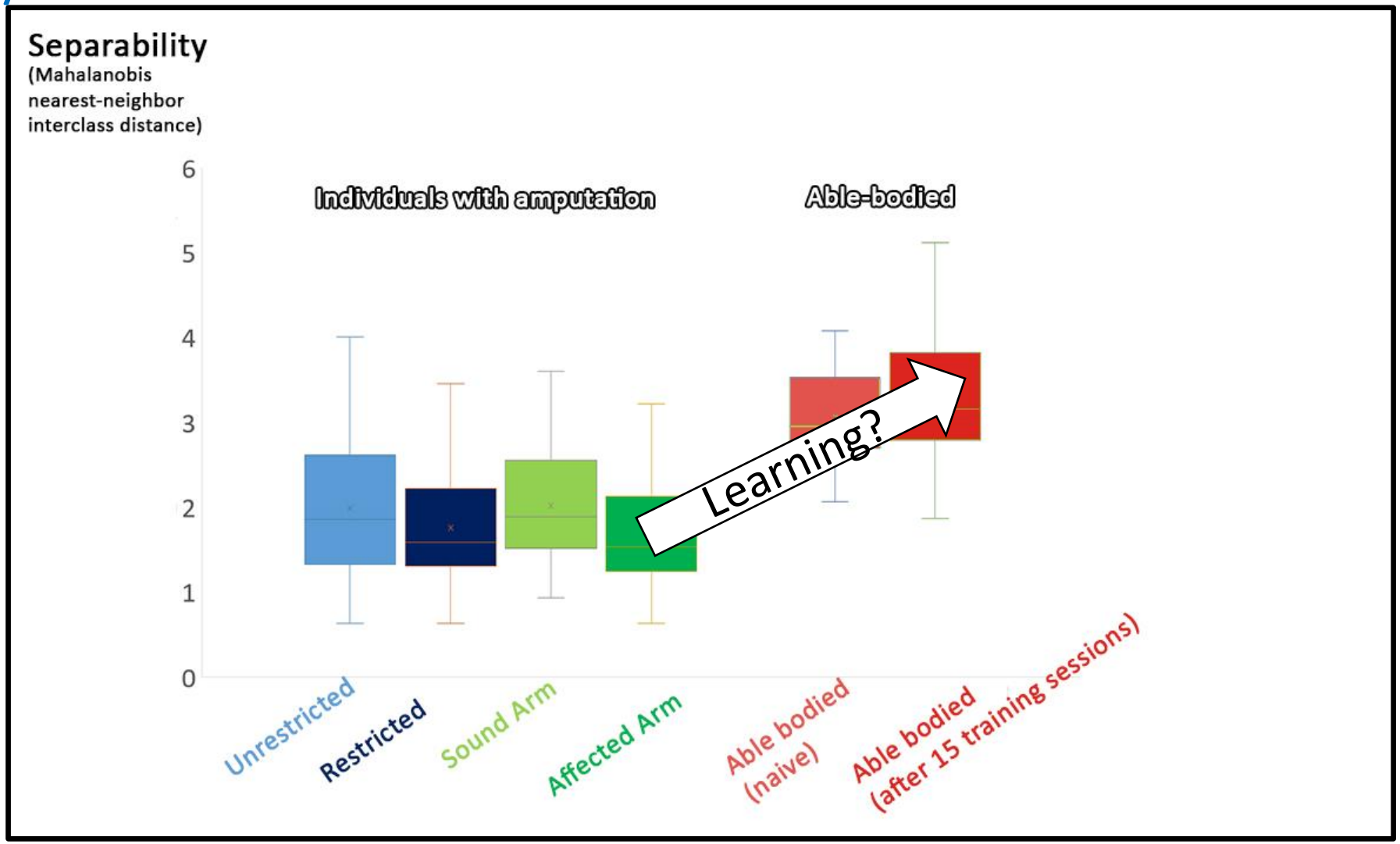


Discussion/Conclusion

- EMG pattern separability is negatively affected by limb absence
  - -> Amputated limb appears to be different
  - -> Might affect experiments with able bodied / sound limbs

- Question for the future:
  Does this finding have an effect on other parameters?

Discussion/Conclusion



Thank you for your attention!

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- Alessio Murgia
- Raoul Bongers