

Performances comparison of the sensorimotor control of a hand prosthesis with EEG signal used by able-bodied and amputees subjects

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ottobock.



**Université
de Paris**

Context

~13 million
people with
upper-limb
amputations¹

~5-15%
have access
to prosthetic
services²

10 to 50%
stopped to use
their
prostheses³

Limitations
from the
Myoelectric
control

Context

Could a brain-machine interface control overcome these limitations ?

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Invasive
BMI

Collinger et al. 2013
Wodlinger et al. 2015
Ajiboye et al. 2017

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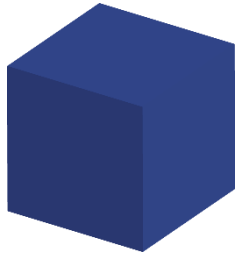
Context

- Recording of the brain activity :
 - EEG system for this application ?
 - Minimal number of electrodes needed ?
- Feature Extraction & decoding of the brain activity :
 - Algorithms for the best performance ?
- Sensory Feedback
 - Contribution of the sensory feedback on the performance of the system ?

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Material & Methods | Movements

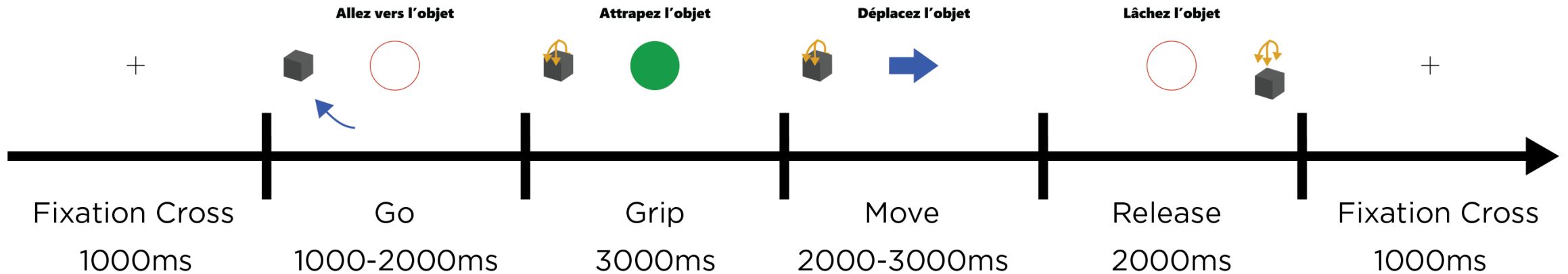


Material & Methods | Movements



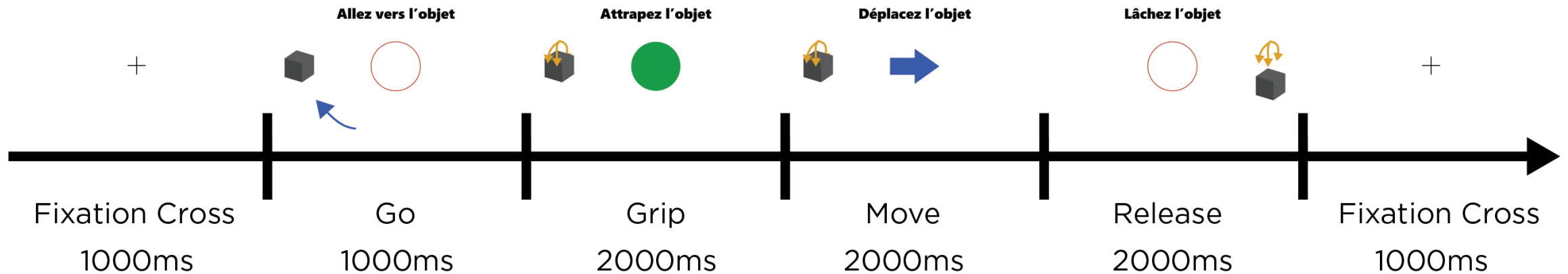
Material & Methods | Movements

Motor Execution

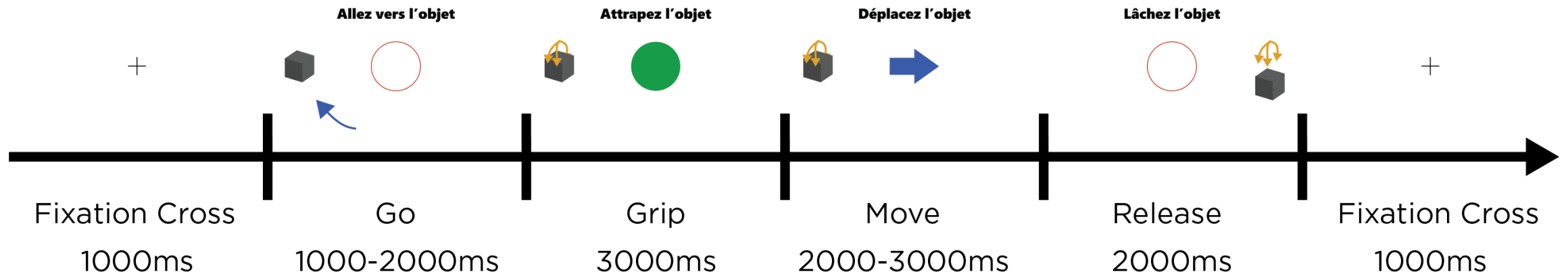


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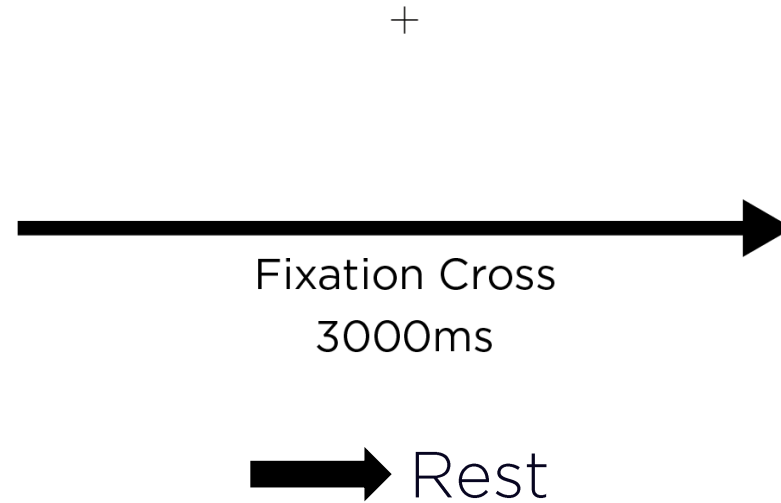
Motor Imagery



Material & Methods | Movements



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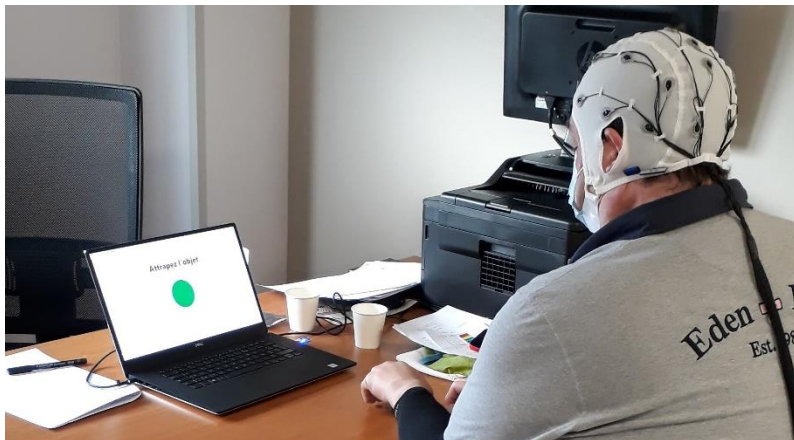


Material & Methods | Participants & Setups

Trans-radial amputees

n = 4

16 electrodes EEG system
(OpenBCI)



Able-bodied

n = 13

64 electrodes EEG system
(ActiChamp, Brain Products)

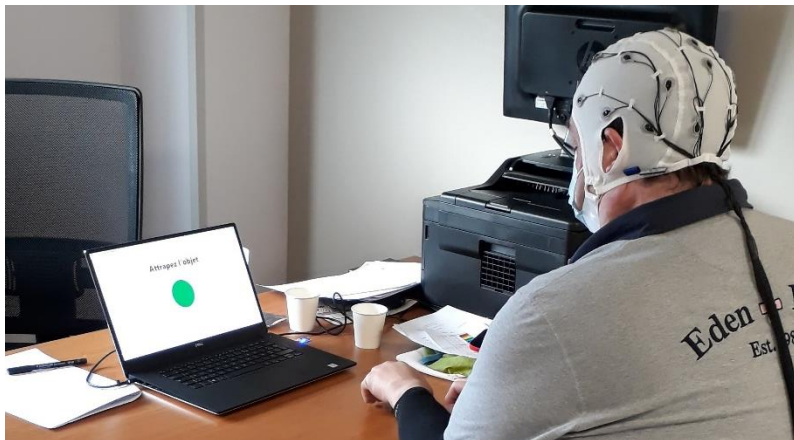


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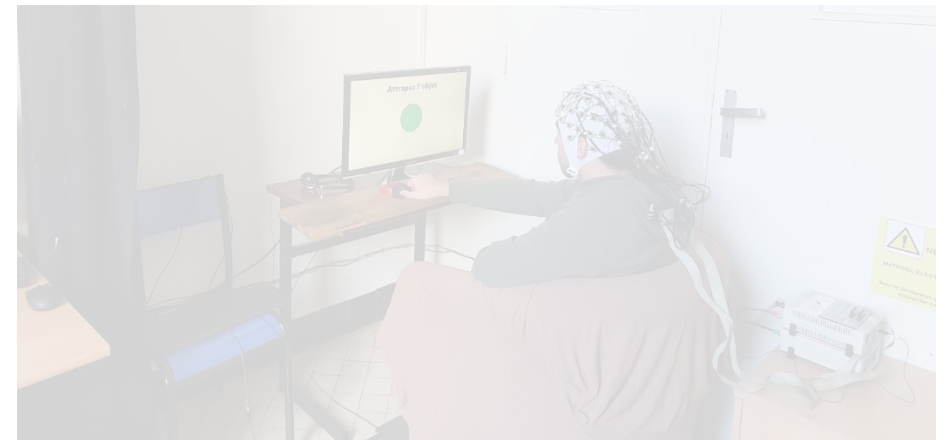
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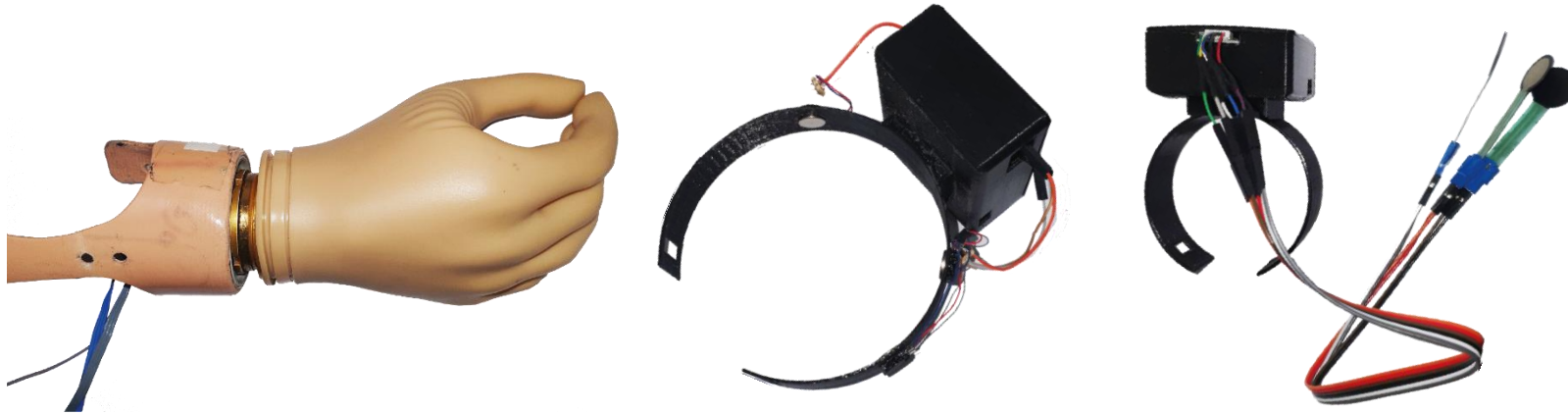
Material & Methods | Participants & Setups

3 recording sessions

S1 : Tests to evaluate performance with prosthesis
ME with original prosthesis + MI (n = 4)

S2 : ME with modified prosthesis + MI (n = 3)

S3 : ME with modified prosthesis & sensory feedback
+ MI (n = 1)

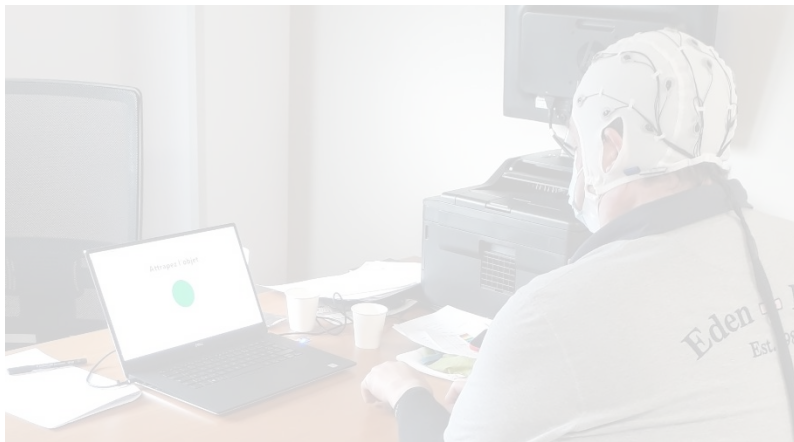


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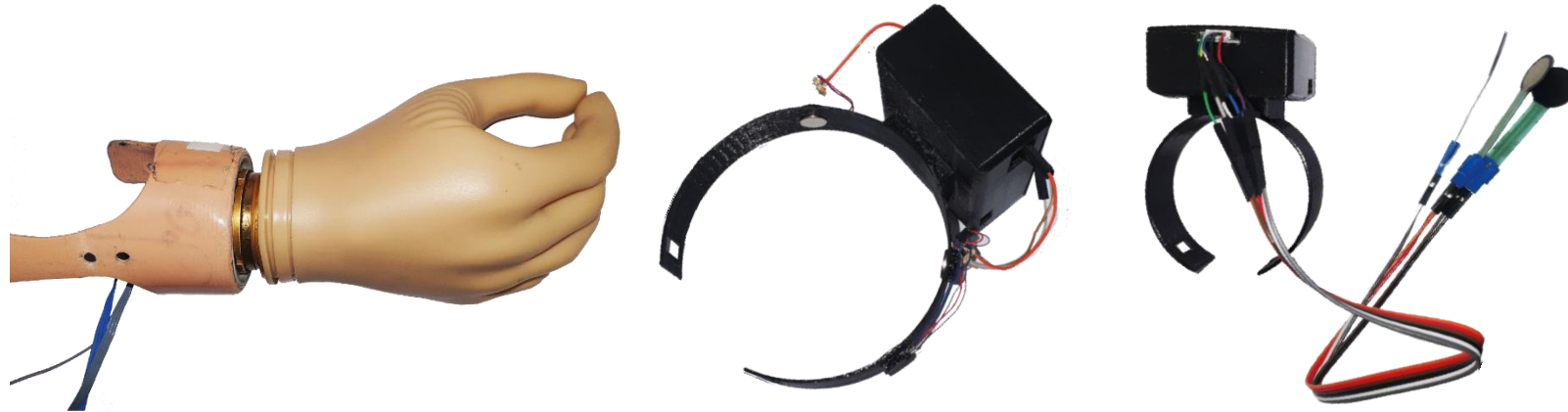
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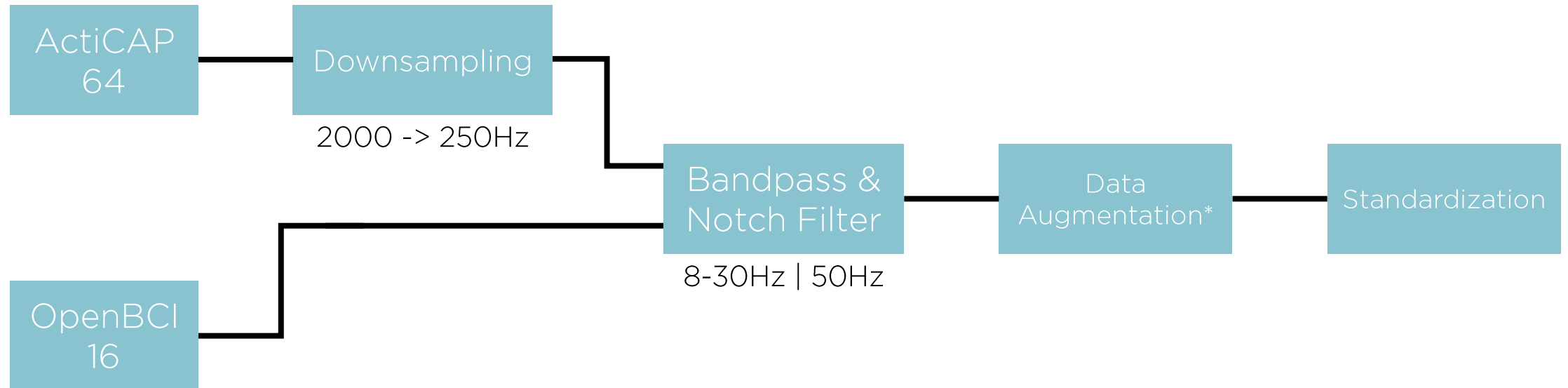
S1 : ME + MI (n = 13)

S2 : ME with modified prosthesis + MI (n = 6)

S3 : ME with modified prosthesis & sensory feedback + MI (n = 4)



Material & Methods | EEG Processing



* Based on the analogy method from Lotte 2015 : hal-01159171

Material & Methods | Feature Extraction

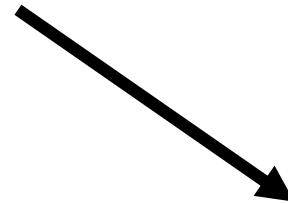
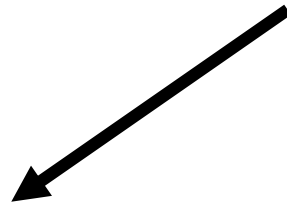


Material & Methods | Classification

One vs. One approach



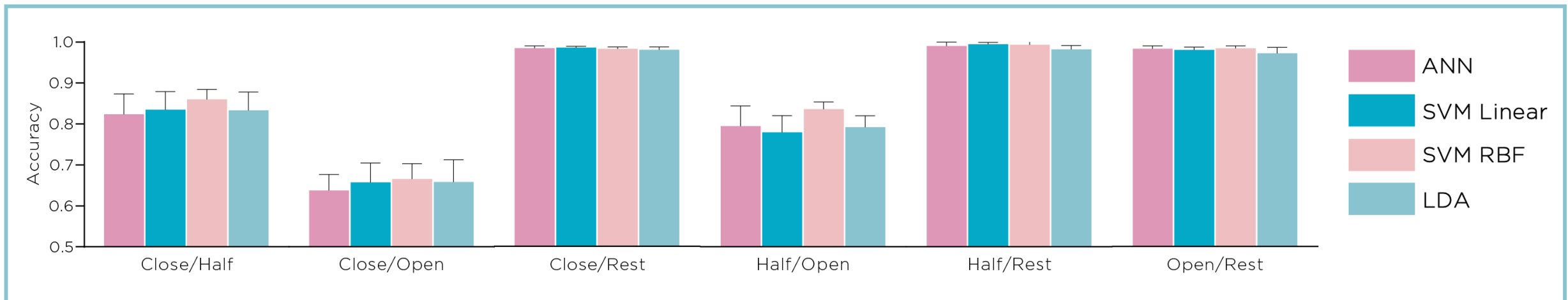
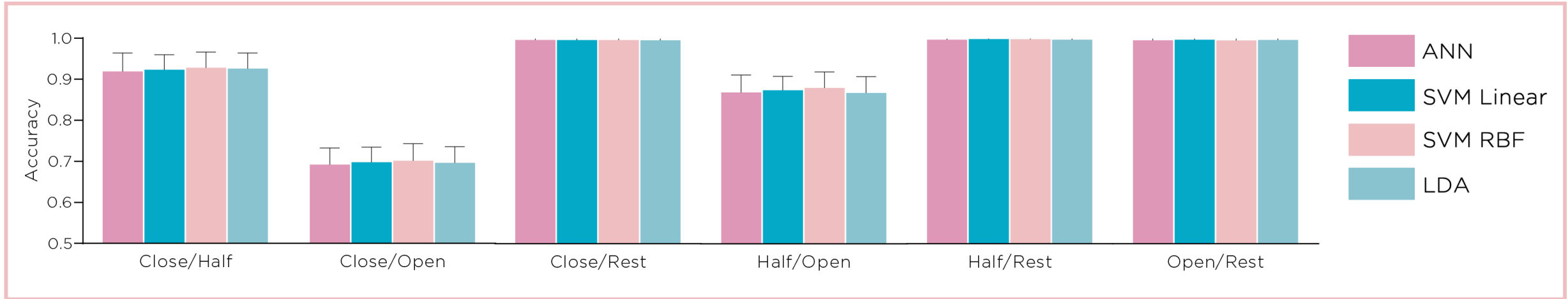
6 classification models to train



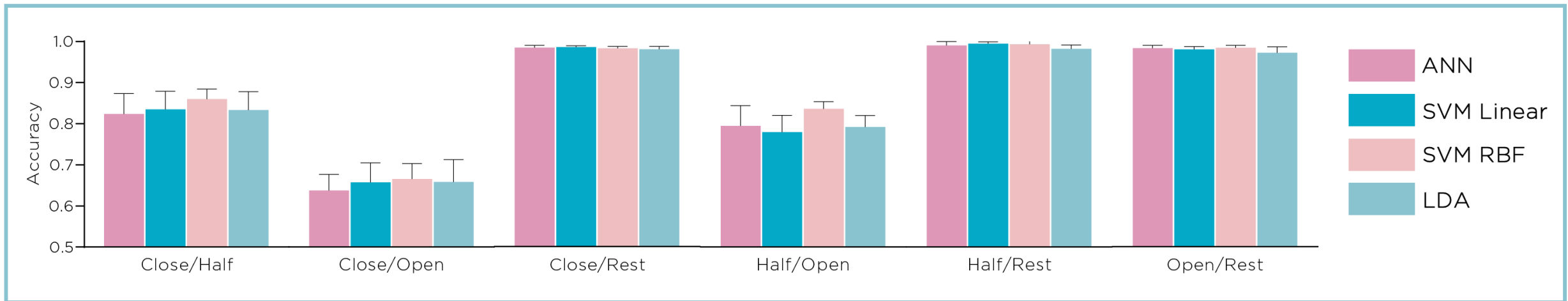
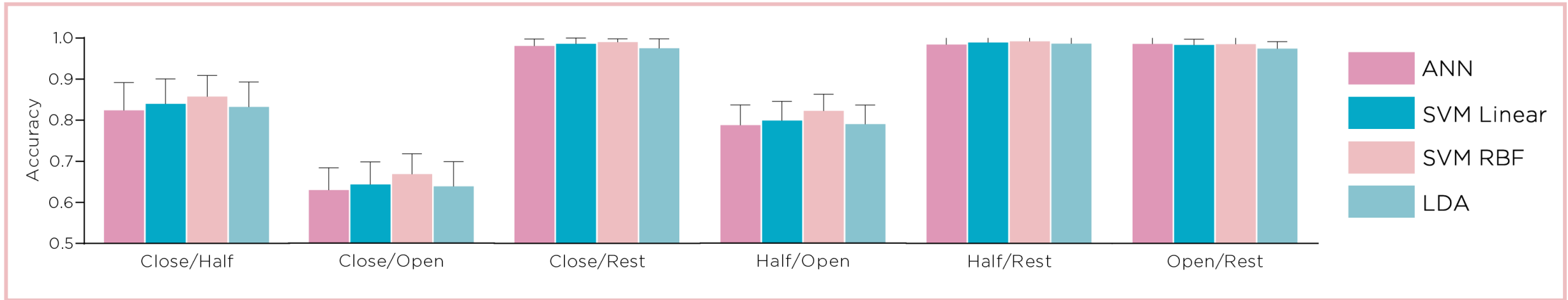
Linear

RBF

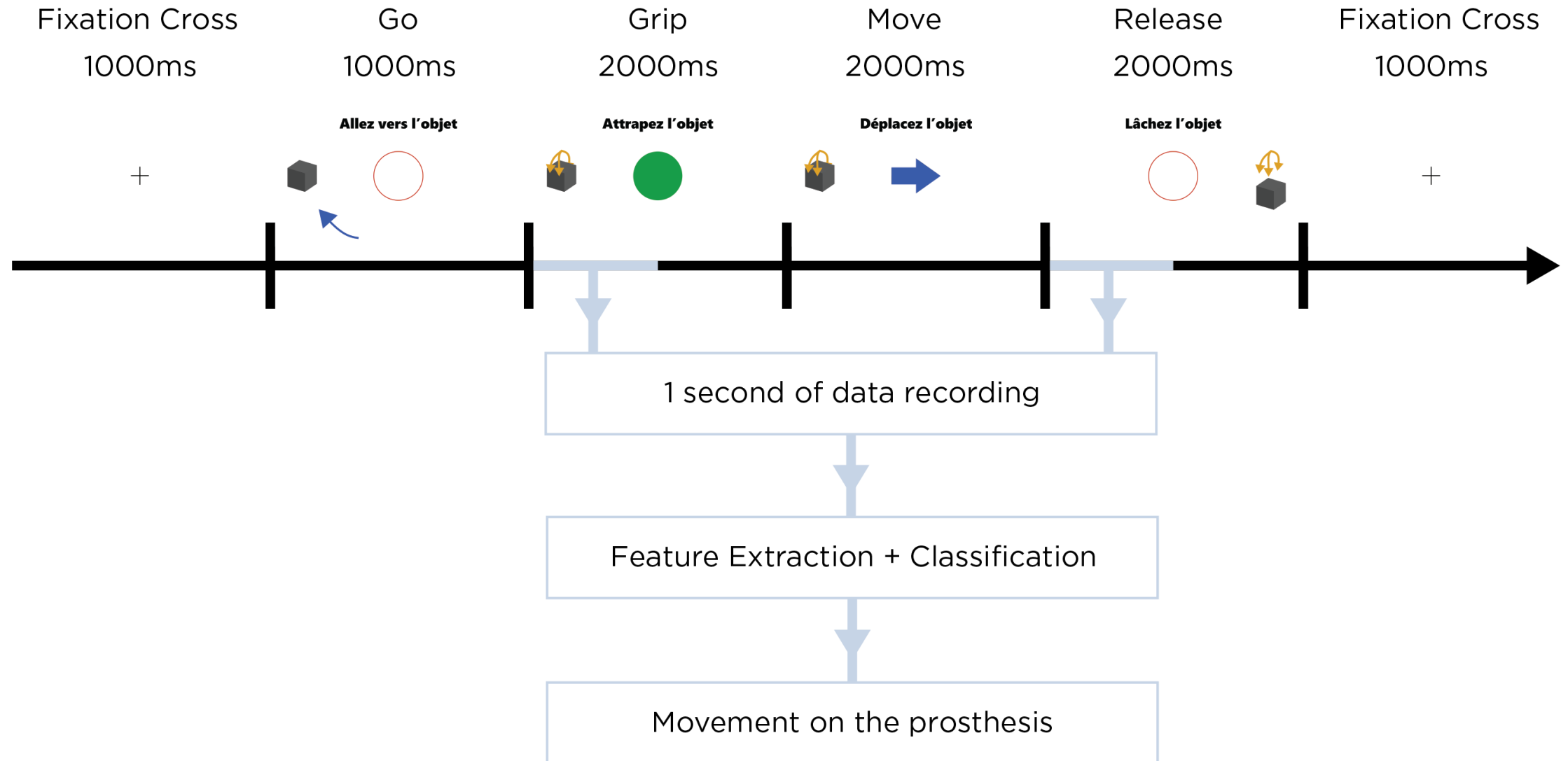
Results | ME S1 *Able-bodied*/*Amputees*



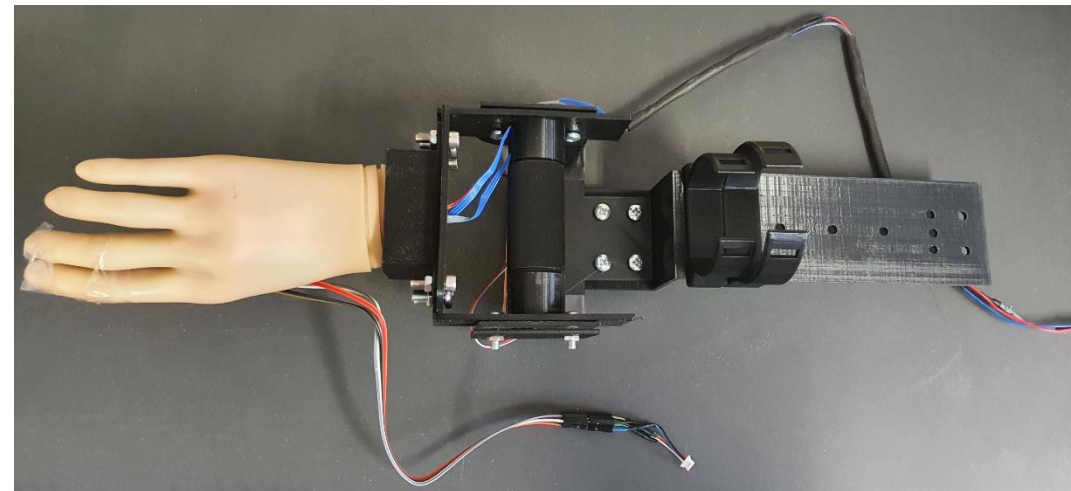
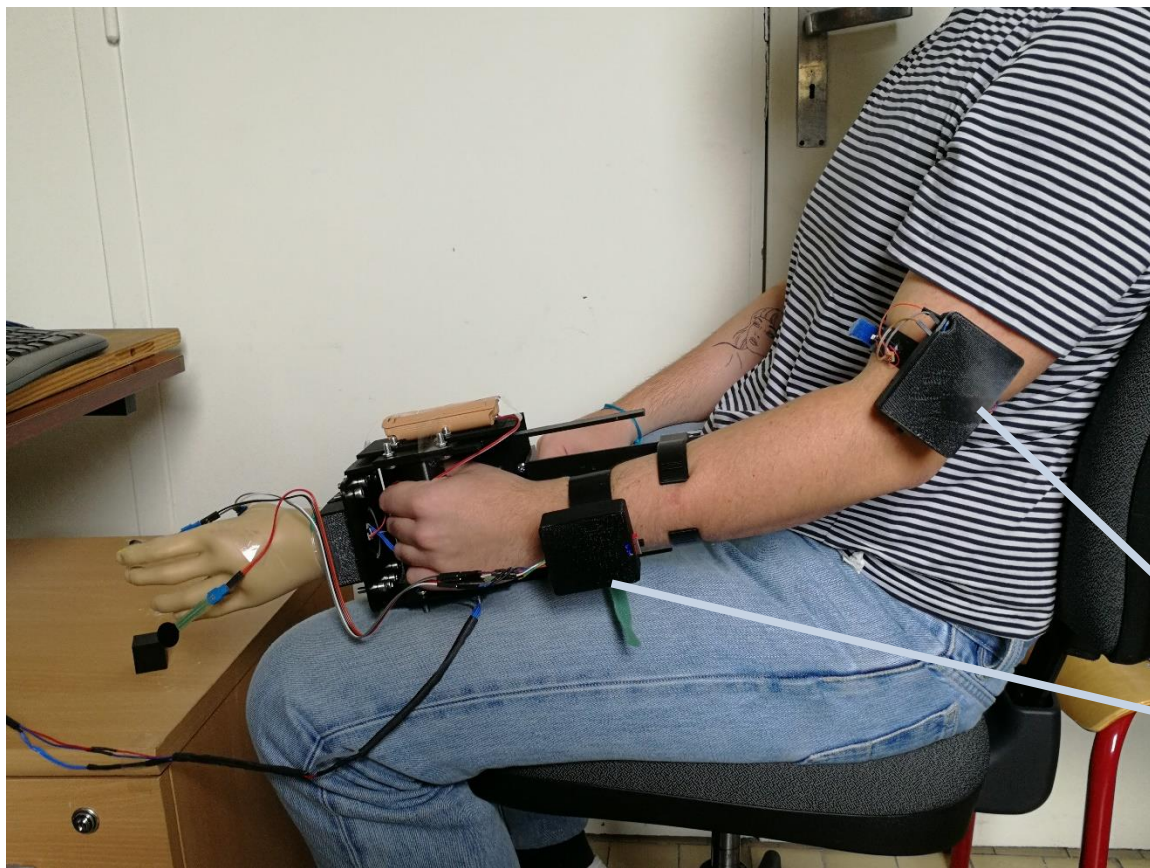
Results | ME S1 Able-bodied/Amputees with electrodes matching



Ongoing work | Online test



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Sensory
Feedback



Conclusion

- combination of CSP+WD gives promising results for the two groups of subjects
- Still need to confirm a possible improvement of the performances over time
- When electrodes are matched on the two recording systems
 - Same range of values for the classification between the groups

→ Proof of concept for the use of BCI for the control of a prosthesis with an affordable EEG system

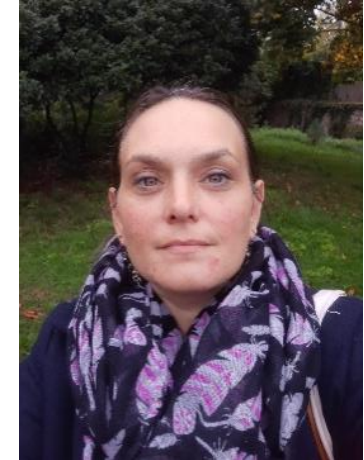
↳ But still need for an Online performance test (ongoing with both groups)

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