Motor Imagery of Linked Movements Might Enhance Motor Learning

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Introduction

- Movements in sports, rehabilitation and everyday life are usually linked together in motion sequences.
- Previous studies have used force field adaptation to investigate factors influencing motor learning.
- A linked movement (e.g., pre-movement) associated with force field direction can facilitate the learning process of force field adaptation[1,2].
- On the other hand, other cues (e.g., static visual) do not allow motor adaptation to interfering forces[3,4].
- **Linked movements** seem to be planned and represented together[5] and thus can influence the learning process of the goal movement[6,7].

This project tries to answer:

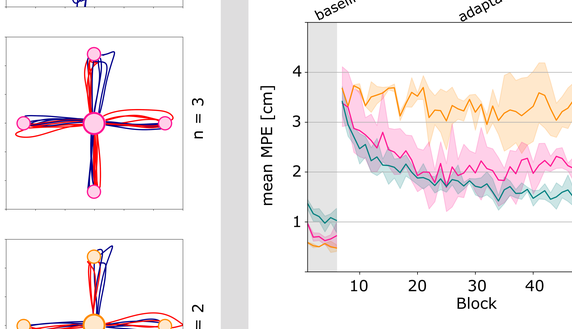
A) Can the mental representation of a pre-movement (e.g., motor imagery) facilitate motor learning?

B) What are the neural signatures underlying successful performance of linked movements?

Methods

1 Experimental setup

- Participants performed reaches in an exoskeleton robot[8].



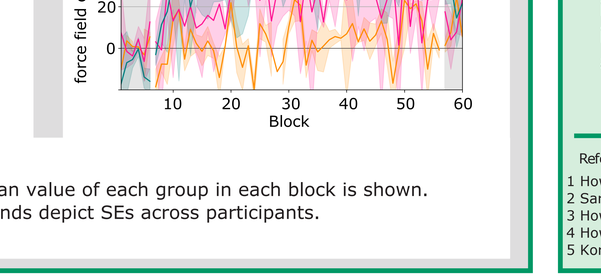
- EEG (64 channels) was recorded during the whole experiment[9].

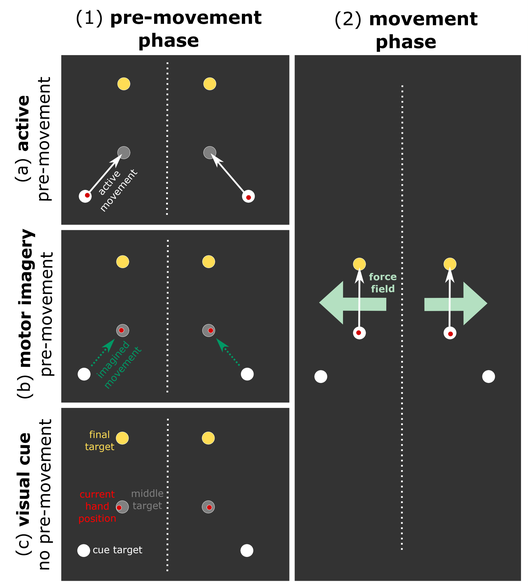
3 Experimental flow

- Each block consisted of 18 trials: 16 normal + 2 clamp trials. (for clamp trials see results 3)
- Force fields were only present in adaptation trials.

2 Force field task

- Three experimental groups:
  (a) **active** pre-movement
  (b) **motor imagery** pre-movement
  (c) **visual cue** (no pre-movement)
- Two movement phases:
  (1) In the **pre-movement phase,** participants were instructed to
  (a) make an active reach to the middle target,
  (b) imagine a reach, or
  (c) wait.
  (2) In the movement phase, all participants reached from the middle to the final target. In some trials, a velocity dependent curl force field perturbed these reaches.

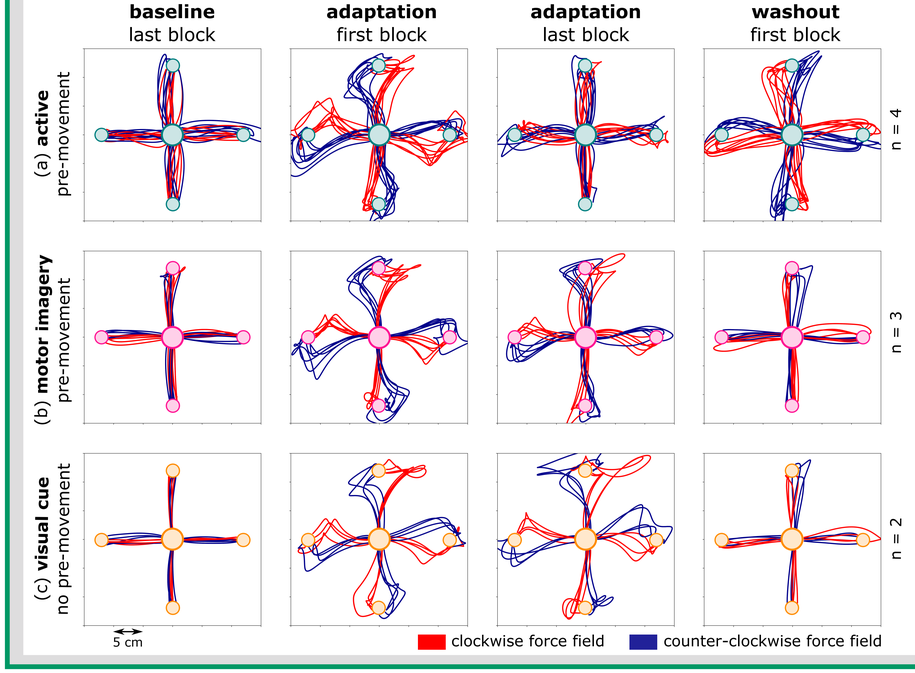




- For each final target, the two opposite cue target locations were possible. The cue's location was associated with the direction of the force field.

Results

1 Movement trajectories (hand paths from middle to final targets)



2 Maximum perpendicular error (MPE)

- The MPE measures the maximal deviation from the straight line between middle and final target.

- The mean value of each group in each block is shown. Error bands depict SEs across participants.

3 Force field compensation

- In clamp trials, no force fields were present regardless of the phase of the experiment. Instead, channel walls forced participants to reach in a straight line from the middle to the final target.
- The force field compensation value reflects how well a force field would have been counteracted.

Discussion

Preliminary results:

- We replicate previous findings that pre-movements allow force field adaptation while visual cues do not.

A) Motor imagery of linked pre-movements does facilitate motor learning.

Future plan:

- More data needs to be collected.

B) We will analyze EEG data to shed light on neural mechanisms during learning of linked movements. In particular, we will look at oscillitatory activity in alpha and beta bands. We predict that changes in beta power during pre-movement defines motor adaptation.

References

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