Investigating phase synchrony of sensorimotor cortices while learning a novel bimanual motor task

Marleen J. Schoenfeld[1,2,3], Ioana Grigoras[1,2,3], Charlotte J. Stagg[1,2,3], Catharina Zich[1,2]

1. Wellcome Centre for Integrative Neuroimaging, FMRIB, Nuffield Department of Clinical Neurosciences, University of Oxford
2. Oxford Centre for Human Brain Activity, Wellcome Centre for Integrative Neuroimaging, Department of Psychiatry, University of Oxford
3. Medical Research Council Brain Network Dynamics Unit, Nuffield Department of Clinical Neuroscience, University of Oxford

1. INTRODUCTION

- Many tasks require the skilled interaction of both hands, e.g. eating with knife and fork
- However, our understanding of the neurophysiological mechanisms underpinning bimanual motor learning is sparse
- Aims: 1) characterize learning-related changes of different levels of bimanual interaction
  2) investigate if transcranial alternating current stimulation (tACS) modulates these learning-related changes

2. METHODS

2.1 Characterising levels of bimanual interaction

- 40 right-handed healthy participants (24 females, mean age=25.3years, *std*=3.55years)
- Practice for 45min and minimum of 100 trials

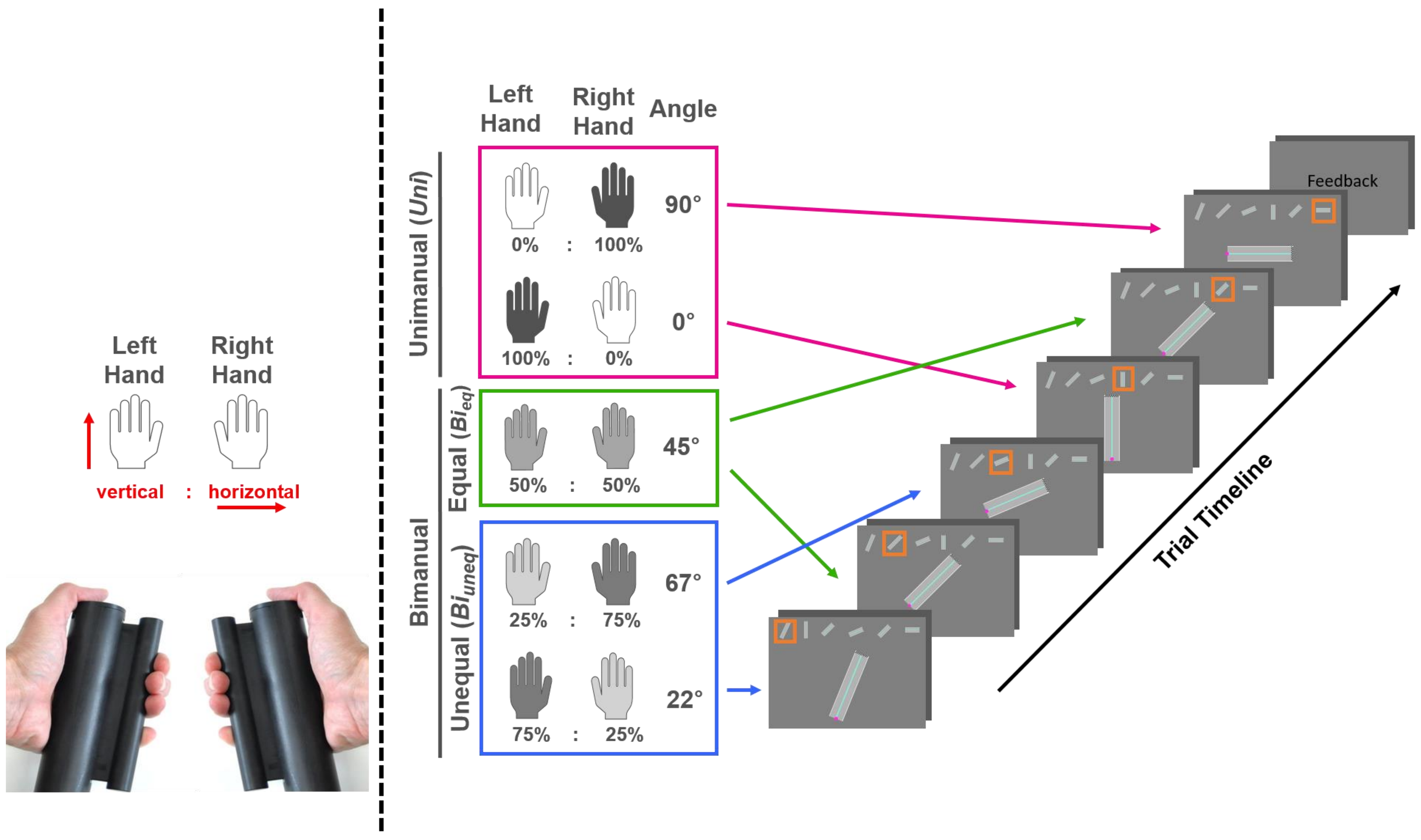

Fig. 1. We designed a complex, multi-stage motor task with different levels of bimanual interaction. The design was implemented as a racing game, whereby a cursor had to be navigated through a path consisting of six streets. Cursor movement was enabled by two force grippers (controlling the x- and y-axis separately). Each path (i.e. trial) comprised unimanual, bimanual equal and bimanual unequal conditions corresponding to different street angles and ideal left-hand:right-hand ratios. Participants were instructed to move the cursor from the starting position to the end of the street as fast and as accurately as possible (the ideal path was the midline). After one path was finished participants received feedback on their performance. The task was self-paced.

2.2 Investigating the phase synchrony of beta tACS

- 54 right-handed healthy participants (28 females, mean age=24.1years, *std*=4.76years)

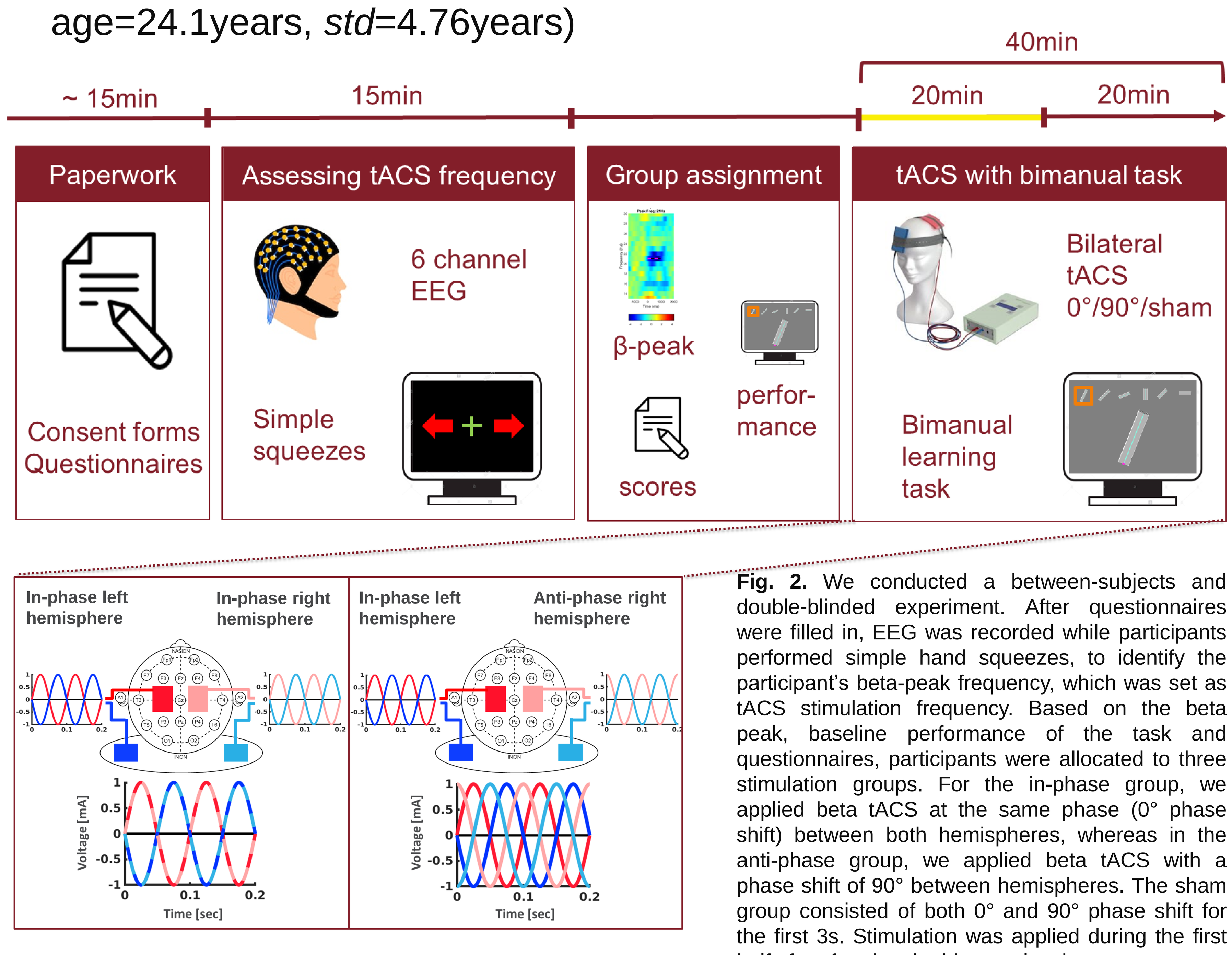

Fig. 2. We conducted a between-subjects and double-blinded experiment. After questionnaires were filled in, EEG was recorded while participants performed simple hand squeezes, to identify the participant's beta-peak frequency, which was set as tACS stimulation frequency. Based on the beta peak, baseline performance of the task and questionnaires, participants were allocated to three stimulation groups. For the in-phase group, we applied beta tACS at the same phase (0° phase shift) between both hemispheres, whereas in the anti-phase group, we applied beta tACS with a phase shift of 90° between hemispheres. The sham group consisted of both 0° and 90° phase shift for the first 3s. Stimulation was applied during the first half of performing the bimanual task.

3. RESULTS

3.1 Novel bimanual motor learning task induces learning with distinct patterns for bimanual interaction (N = 40)

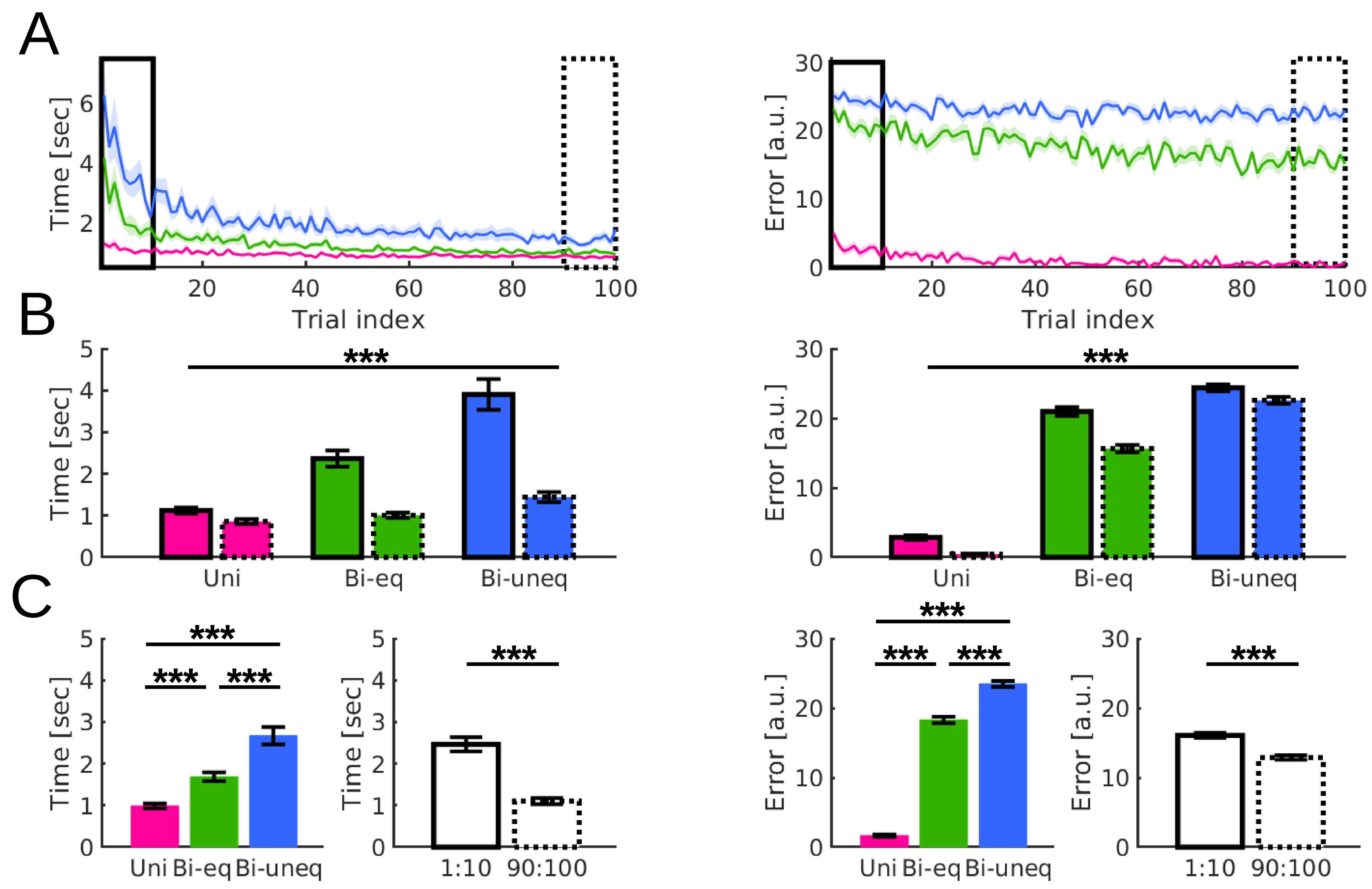

Fig. 3. Results showed distinct learning patterns for the different levels of bimanual interaction (*Uni*: pink; , Bi_{equal}: green; $Bi_{unequal}$: blue) in movement time (Left) and error (Right) qualitatively (**A**) and quantitatively by comparing first (solid frame) and last ten (dashed frame) trials (**B**). This suggests that the three conditions changed differently with learning.
(**C**) Comparison of the three conditions averaged over time (C left) suggested conditions are distinct. Comparison of the first and last ten trials averaged over conditions suggested learning was present (C right).

3.2 Replication of effects in 3.1, but no main effect or interaction with beta tACS (N = 54)

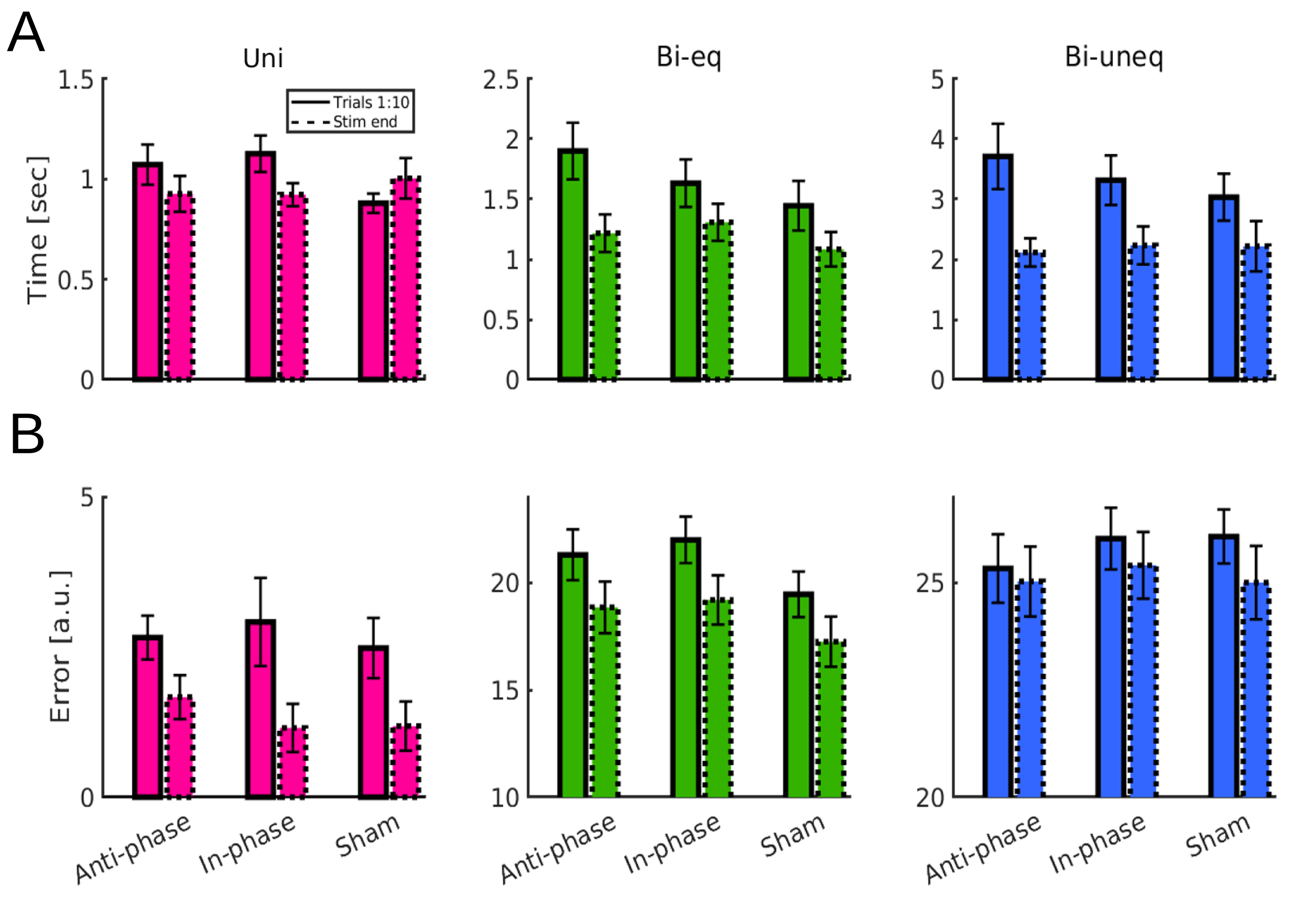

Fig. 4. Comparison of the first ten (solid frame) and last ten trials before the end of stimulation (dashed frame) showed that learning yields distinct learning patterns for the different levels of bimanual interaction (*Uni*, Bi_{equal}, $Bi_{unequal}$) in movement time (**A**) and error (**B**), but beta tACS did not modulate these learning patterns.

4. CONCLUSION

- The novel bimanual motor task induces learning with distinct patterns for the different levels of bimanual interaction which was replicated in a larger sample.
- However, beta tACS did not modulate the learning-related changes.
- Neuroimaging studies needed to investigate underlying mechanisms of bimanual motor learning.

Contact:
marleen.schoenfeld@ndcn.ox.ac.uk

Poster Presentation:
https://youtu.be/jWQWC6sRTug