Stability-dependent behavioural and electro-cortical reorganizations during bimanual switching tasks

Jessica Tallet[1], Jérôme Barral[2] & Claude-Alain Hauert[3,4]

[1] Laboratoire Adaptation Perceptivo-Motrice et Apprentissage (EA3691) - UFR STAPS - Université Paul Sabatier Toulouse III, France
[2] Institut des Sciences du Sport de l'Université de Lausanne, Suisse
[3] Laboratoire du Développement et des Apprentissages Moteurs, Faculté de Psychologie et des Sciences de l'Éducation, Université de Genève, Suisse
[4] Centre Inter-Facultaire de Neurosciences, Université de Genève, Suisse

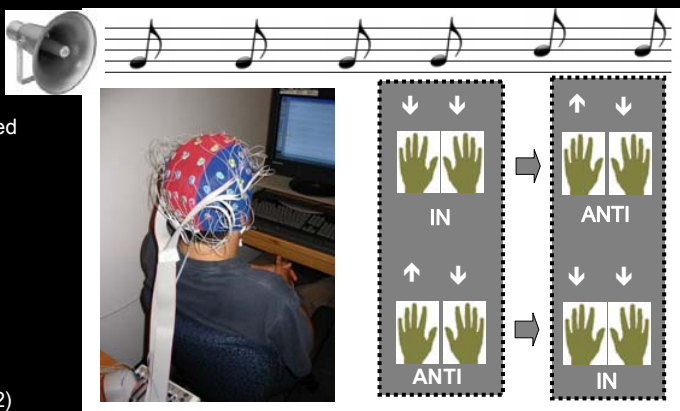
E-mail: tallet@cict.fr

INTRODUCTION

Daily motor tasks require switching between coordinated movements of the upper limbs, i.e. reorganizing the ongoing behaviour in order to engage in a more or less complex one. Bimanual coordination paradigm shows 1) that the switching time depends on the stability of the tapping modes [4] and 2) that alternate or anti-phase tapping (Anti) is less stable than synchronous or in-phase tapping (In) [1]. Anti requires also greater inter-regional coupling than In, as measured by ElectroEncephaloGraphy (EEG) [3]. The goal of the present study is to examine the stability-dependent behavioural and electro-cortical reorganizations induced by bimanual switching tasks. As In-Anti switching requires engaging in a less stable mode, it would induce an increase of behavioural perturbations and additional neural resources than the inverse Anti-In switching. As the functional connectivity seems to depend on the stability of the tapping mode, the In-Anti switching may induce an increase in inter-regional coupling over sensori-motor regions while the Anti-In switching may lead to a decrease in inter-regional coupling.

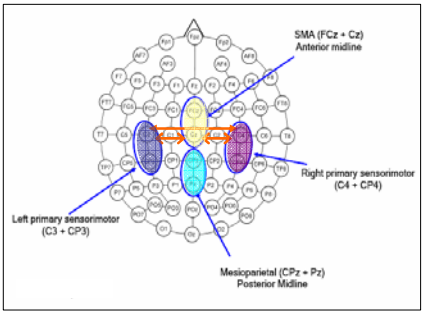
METHODS

- **Participants**: 7 right-handed adults (2 women); mean age: 26 years (+/- 4 years)
- **Tasks**: In-phase or Anti-phase fingers' tapping / auditory metronome (tempo = 700 ms)
- **Experimental conditions:** when the metronome changes from low-pitched to high-pitched tones:
  - 2 switching tasks: In-Anti *vs.* Anti-In switching (each : 2 x 24 trials)
  - 1 rest condition (2 x 24 trials)
- EEG from 64 surface electrodes (BioSemi)
- **Data analyses**:
  - Behavioural data: tempo and its variability
  - EEG data:
    - Task-Related Power : $TRPow = \log(Pow_{act}) - \log(Pow_{rest})$
    - Task-Related Coherence : $TRCoh_{xy} = \tanh(Coh_{xy\,act}) - \tanh(Coh_{xy\,rest})$
    - 2 epochs: the pre-switching tapping (P1) and the very moment of the switching (P2)
    - 4 regions of interest (ROI) and 3 pairs of interest (POI) over the sensori-motor regions
    - 2 ranges of frequencies: alpha (8-12 Hz) and beta (13-30 Hz)



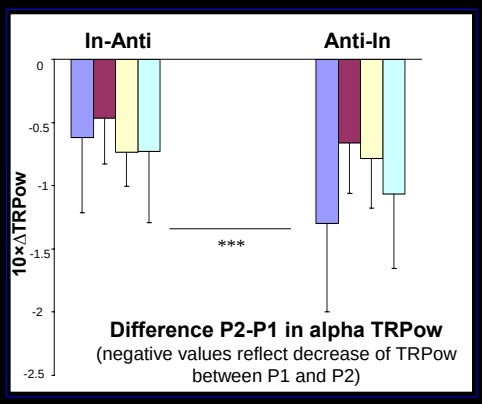
3 POI :
- C3 - C4
- C3 - Cz
- C4 - Cz

4 ROI :
- C3 + CP3
- C4 + CP4
- Cz + FCz
- Pz + CPz

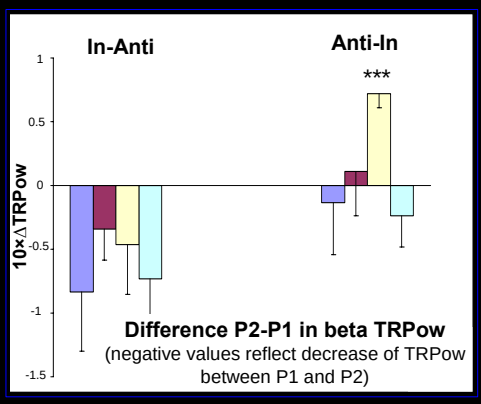


RESULTS

→**Behaviour** : greater deceleration of tempo for the In-Anti switching (*** p<.05)

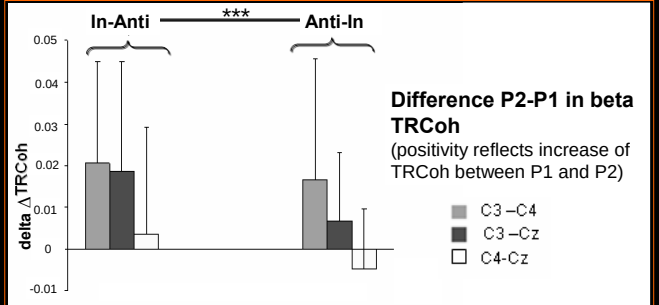


Difference P2-P1 in alpha TRPow
(negative values reflect decrease of TRPow between P1 and P2)



Difference P2-P1 in beta TRPow
(negative values reflect decrease of TRPow between P1 and P2)

→ **alpha TRPow (left panel)** : decrease for all the ROI whatever the switching (*** p<.05)
→ **beta TRPow (right panel)** : increase of FCz-Cz for the In-Anti switching (*** p<.05)



Difference P2-P1 in beta TRCoh
(positivity reflects increase of TRCoh between P1 and P2)

→ **beta TRCoh** : greater increase for the In-Anti switching (*** p<.05)

DISCUSSION

Results suggest that the In-Anti switching was associated to :

- greater behavioural perturbations
- supplementary neural activation over the frontal region
- enhanced inter-regional coupling as compared to the Anti-In switching.

→ Contrary to our predictions, the Anti-In switching led to an increase of functional connectivity. This result can be interpreted as reflecting a strengthening in inter-regional communication along with a non-specific increase in task complexity [2], that is the transient behavioural motor instability at the very moment of the switching.

→ All these results suggest that the amount of the inter-regional coupling increase is stability-dependent.

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