Electro-cortical correlates of motor transitions

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

[1] Institut des Sciences du Sport et de l'Education Physique, Université de Lausanne
[2] Laboratoire du Développement et des Apprentissages Moteurs, Faculté de Psychologie et des Sciences de l'Education, Université de Genève
[3] Centre Interfacultaire de Neurosciences, Université de Genève

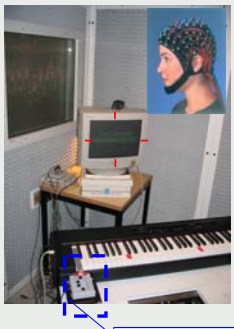
Contact : jerome.barral@unil.ch

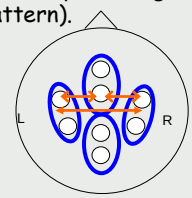
INTRODUCTION

Motor transitions may require selective - or non-selective - inhibition mechanisms. Two experiments were conducted to investigate those mechanisms in which adults switched from bimanual in-phase tapping to different patterns of tapping.

GENERAL METHODS

- **Bimanual in-phase tapping / switching to another condition**
- Responses paced by an auditory metronome = 700 ms (~1.4 Hz).
- **Each experimental conditions** : 2 x 24 trials.
- **Rest condition** : 2 × 24 trials.
- EEG from 64 surface electrodes (NeuroScan Inc.).
- **VD** = Task-Related Power (**TRPow**) and Task-Related Coherence (**TRCoh**).
- Two epochs of the EEG signal were compared (the transition stage versus the preceding bimanual pattern).





4 regions of interest (ROI):
- left central (C3 + CP3) : **ROI 1**
- right central (C4 + CP4) : **ROI 2**
- anterior midline (Cz + FCz) : **ROI 3**
- posterior midline (Pz + CPz) : **ROI 4**

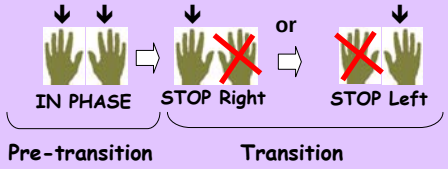
3 Pairs of interest (POI):
- left central to right central (**C3-C4**)
- left central to anterior mid (**C3-Cz**)
- right central to anterior mid (**C4-Cz**)

EXPERIMENT 1

PARTICIPANTS

9 right-handed adults (4 women) aged 24 to 38 years.

Experimental conditions



STATISTICS

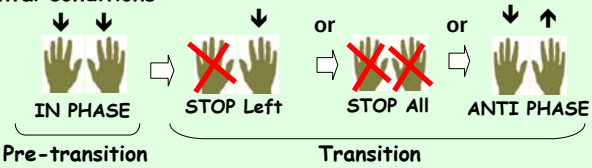
Five specific contrasts were performed on EEG data, with a corrected significant threshold p = .01

EXPERIMENT 2

PARTICIPANTS

11 right-handed adults (6 women), mean age: 29 years (SD = 7,8)

Experimental conditions



STATISTICS

Repeated measures ANOVAs were performed on EEG data, with significant threshold p = .05

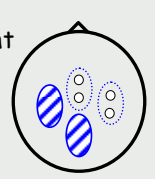
RESULTS

1 / Behavioral performance

Whatever the condition of switching, the stability of the first tapping after the transition was significantly perturbed (**EXP 1** & **EXP 2**).

2 / TRPow

In the **alpha band** (8 – 12 Hz), the transition from in-phase condition to all the conditions (except Stop Right in **EXP 1**) induced a significant decrease of TRPow (in blue, Fig. 1) in **ROI 1** and **ROI 4** (**EXP 1** & **EXP 2**).



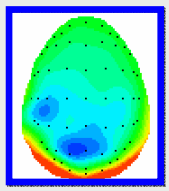


Figure 1

3 / TRCoh

In the **beta band** (13 – 30 Hz), when switching from in-phase pattern to **unimanual right** hand movements, TRCoh decreased during the transition stage for **C4-Cz** but not for **C3-Cz** (**EXP 1** & **EXP 2**, Fig. 1 & 2).

In **EXP 1**, the pattern of results was reversed when switching to the left hand, although this effect was not statistically significant.

In **EXP 2**,
- **Stop All condition**: no effect (Fig. 4)
- **InAnti condition**: both TRCoh of **C3-Cz** and **C4-Cz** links increased (Fig. 4) and TRCoh of **C3-C4** link decreased (Fig. 5).

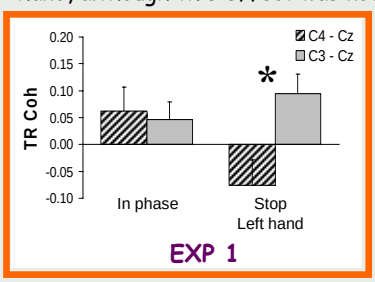


Figure 2

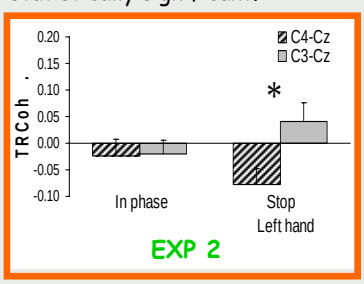


Figure 3

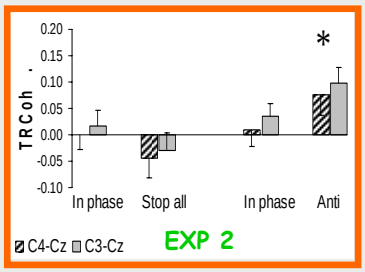


Figure 4

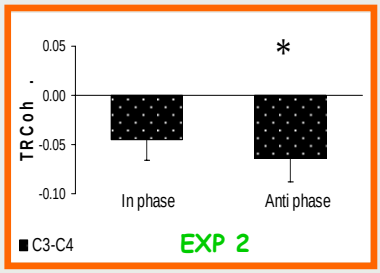
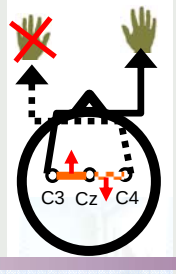


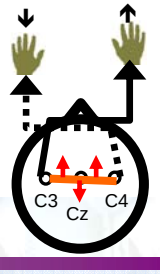
Figure 5

DISCUSSION

The general increase of cerebral activity in the alpha band (TRPow) was not specific to the type of transition, suggesting an overall « *effort of transition* ». In the beta band, the changes in the functional coupling (TRCoh) was specific for the type of transition: **Selective inhibition** mechanisms was characterized by an **asymmetrical pattern** of the **intra-hemispheric coupling**; this was not the case for non-selective inhibition.



The transition **from In-phase to Anti-phase** showed specific changes : there was an **increase of both intra-hemispheric** couplings and a **decrease of inter-hemispheric** coupling.



REFERENCES

Deiber, M.-P., Caldara, R., Ibañez, V. & Hauert, C-A. (2001) Alpha band power changes in unimanual and bimanual sequential movements and during motor transitions. *Clin. Neurophysiol., 112*, 1419-1435..

DeJong, R., Coles, M. G. H. & Logan, G. D. (1995). Strategies and mechanisms in non selective and selective inhibitory motor control. *Journal of Experimental Psychology: Human Perception and Performance, 21*(3),498-511

Wenderoth, N., Debaere, F., Sunaert, S. & Swinnen, S.P. (2005) The role of anterior cingulate cortex and precuneus in the coordination of motor behaviour. *Eur. J. Neurosci., 22*, 235-246.