Electro-cortical correlates of bimanual coordination in adults : motor inhibition in a selective stop task

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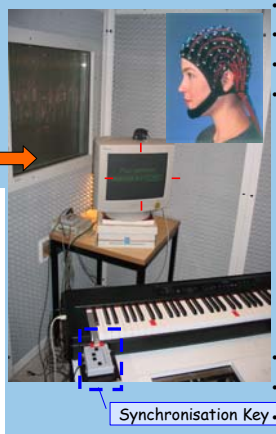
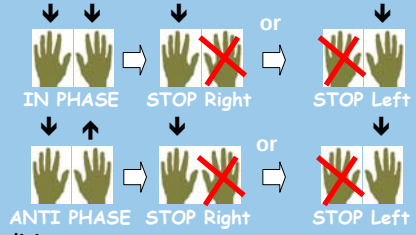
INTRODUCTION

Successfully performing a bimanual task requires the simultaneous activation of homologous and/or non-homologous muscles of the two limbs. To avoid interference between the two motor commands, selective motor inhibition mechanisms are necessary. **The aim of this study is to identify the cortical areas involved in these mechanisms.**

PROCEDURE AND METHODS

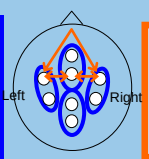


- **Indexes tapping / switching from bimanual to unimanual**
- Tempo of the auditory metronone = 700 ms (~1.4 Hz).
- 9 right-handed adults (4 women) aged from 24 to 38 years.
- **4 experimental conditions of switching** (each : 2 x 24 trials)



- **Rest condition**
- EEG from 64 surface electrodes (NeuroScan Inc.)
- **VD** = Task-Related Power (**TRPow**) & 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**



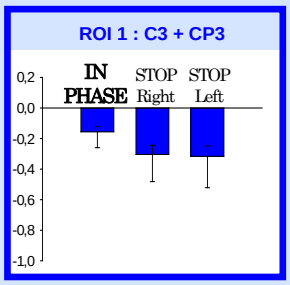
3 Pairs of interest (POI):
- left central to right central (**C3-C4**)
- left central to anterior mid (**C3-Cz**)
- right central to anterior mid (**C4-Cz**)

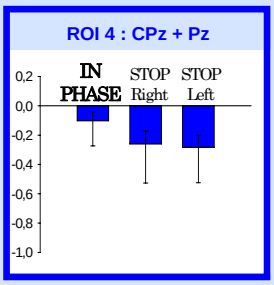
RESULTS

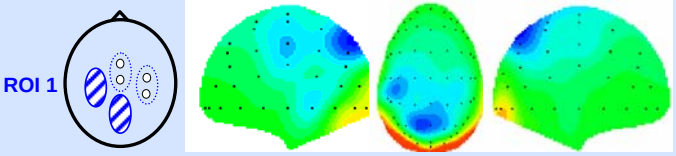
1 / behavioral performance

Whatever the condition of switching, the stability of the first unimanual tapping, immediately following the transition, is significantly perturbed.

2 / TRPow







Grand average of the TRPow values (n = 9). Maps correspond to transitional state from in-phase bimanual to unimanual movements. TRPow decreases (area of `activation', negative TRPow values) are coded in **blue** and TRPow increases (positive TRPow values) are coded in red.

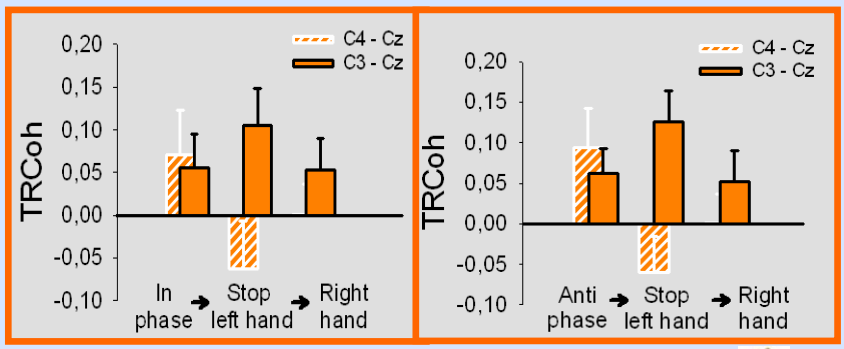
In the **alpha band** (8 – 12 Hz) :

- The transition from in-phase to right hand stop shows significant increase in **ROI 1**, ($F(1, 8) = 17.34$, $p < .01$) only.
- The transition from in-phase to left hand stop shows significant increase in **ROI 1**, ($F(1, 8) = 14.65$, $p < .01$) and **ROI 4**, ($F(1, 8) = 15.71$, $p < .01$).
- The transitions from anti-phase pattern do not yield significant changes, whatever the ROI.

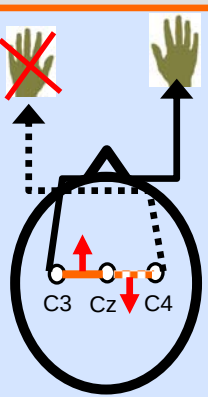
STATISTICAL ANALYSIS

Using ANOVA, we opted for specific contrasts to test our hypotheses. Five contrasts were performed on EEG data, with a corrected significant threshold of $p = .01$.

3 / TRCoh



In the **beta band** (13 – 30 Hz), when switching from both bimanual patterns to unimanual right hand movements, **TRCoh** decreases during the transition stage for **C4-Cz** (in-phase, $F(1, 8) = 14.74$, $p < .01$; anti-phase, $F(1, 8) = 11.47$, $p < .01$) but not for **C3-Cz**. The pattern of results is reversed when switching to the left hand, although not statistically significant.



DISCUSSION

These results provide an electrocortical correlate to recent EEG and fMRI findings suggesting the involvement of the posterior parietal cortex in motor transitions either to enable the change of motor program (Deiber et al., 2001) and/or for resisting to motor interferences between the two limbs (Wenderoth et al., 2005). In addition, they suggest that selective motor inhibition manifests itself as changes in the functional coupling between lateral and mesial cortical areas.

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. *Clinical Neurophysiology, 112*, 1419-1435.

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