

## INTRODUCTION

- Mirror visual feedback (MVF) has been often used to treat several pain syndromes [1].
- MVF is a technique that avails of a mirror in order to induce the illusion of a limb movement, activating the sensorimotor cortex [2].
- A method to probe the sensorimotor activity is the detection of the anticipatory alpha event-related (de)synchronization (ERD/ERS) [3].
- Anticipatory alpha ERD reflects cortical activity during motor preparation [4], and it is widely used to control mechanical devices through brain computer interface (BCI) improving motor learning rehabilitation [5]. Nevertheless, no studies investigated the effects of MVF on anticipatory alpha ERD/ERS response.

## AIM

The aim of the study is to investigate whether the illusion of a movement performed with MVF method is able to produce an activation of the sensorimotor cortex (contralateral to the reflected limb and ipsilateral to the moving limb) comparable to the activity produced by an actual movement, as reflected by the anticipatory electroencephalographic (EEG) alpha ERD.

## METHODS

- Fifteen right-handed male healthy subjects (mean age = 28.7, SD = ±4.9) participated to the study. The experiment consisted of 3 conditions:



Figure 1 – illustration of MVF procedure during Mirror condition.

- **Mirror (experimental condition)**, subjects performed a right finger movement reflected on a mirror (Fig. 1), in order to induce the illusion of the left finger movement (subject's left hand is placed out of their gaze).
- **No Mirror (control condition)**, subjects performed the same task, but the mirror was removed.
- **Bilateral Movement (control condition)**, subjects performed a bilateral index fingers movement without the mirror.

In each condition, subjects were asked to perform a double tapping of the index finger(s) every time an auditory tone was delivered (80 trials per condition; inter-trial interval=10s).

## METHODS (CONT.)

EEG data was recorded during all the conditions from 64 electrodes, according to the 12-20 international system. Data was filtered to identify the individual alpha peak (IAF). Based on IAF, alpha ERD was calculated by the following formula

$$ERD/ERS\% = \frac{(E - R)}{R} * 100$$

where E represents the power density at the “event” period (1s) and R the power density at “rest” period (1s) [6], as showed in Fig. 2.

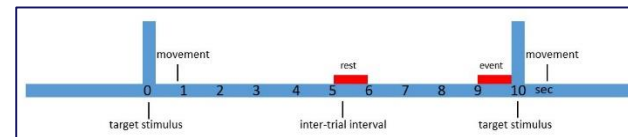


Figure 2 – sketch of the experimental design.

The electrodes C3 and C4 were considered in the analysis, as they reflect the EEG oscillatory pattern of the sensorimotor cortical areas [1].

## RESULTS

Figure 3 shows the anticipatory alpha ERD/ERS pattern over the scalp for each condition:

- In the *No Mirror* condition, the anticipatory alpha ERD occurred over the left centro-parietal cortex (C3, contralateral to the movement), whereas anticipatory alpha ERS occurred over C4, reflecting an inhibitory state of the right sensorimotor area (contralateral to the resting hand).
- In the *Bilateral Movement* condition, ERD occurred in both C3 and C4 electrodes, reflecting a state of activity due to the motor preparation of the right and left fingers.
- In the *Mirror* condition, the anticipatory ERD activity pattern was similar to the *Bilateral Movement* condition, indicating a sensorimotor cortical activation due to the mirror illusion.

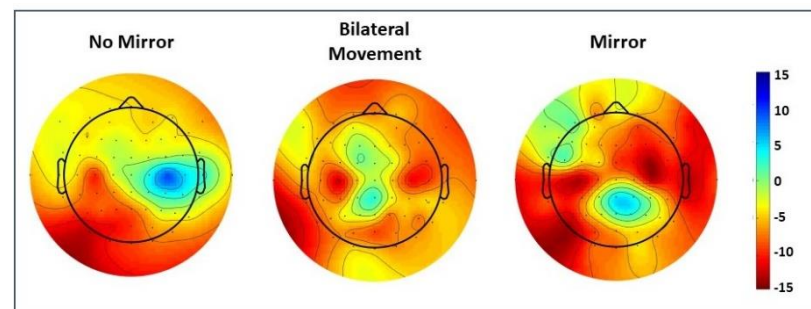


Figure 3 – across subjects mean 2-D maps of anticipatory ERD/ERS distribution over the scalp. The color bar indicates the maximal percentage of ERD (red) and ERS (blue).

## RESULTS (CONT.)

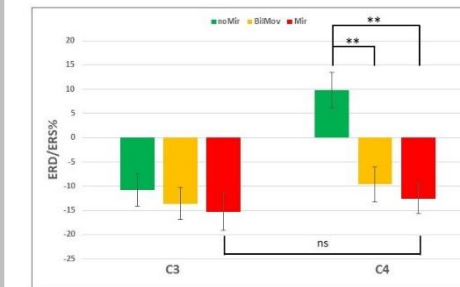


Figure 4 – Groups mean ± SE of the alpha ERD. T-tests showed statistically significant differences in C4 between No Mirror condition (blue) and Bilateral Movement (green) as well as Mirror (red) conditions. Note.- \*\*P=.001.

- The repeated measures ANOVA showed statistically significant main effect for the factor Condition ( $F(2,34)=6,343$ ;  $P<.005$ ) and Channel ( $F(1,17)=18,116$ ;  $P<.001$ ), as well as for the main factors interaction ( $F(2,34)=9,269$ ;  $P<.001$ ).
- A post-hoc (t-tests) analyses indicated statistically significant differences in the ERD amplitude when comparing No Mirror condition with Bilateral Movement and Mirror conditions ( $P<.001$ ) (Fig. 4).
- No statistically significant difference was found between C3 and C4 in the Mirror condition, indicating a similar ERD amplitude for the real and the illusory movement (Fig. 4).

## CONCLUSIONS

- In this EEG study, we investigated the motor anticipatory alpha ERD in response to MVF illusion.
- The results indicated that the movement preparation during MVF involves the same anticipatory cortical patterns of an actual movement.
- This might be crucial for developing individual therapies for chronic patients with motor disorders who cannot rely on the normal movement of on limb.

## REFERENCES

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