Done in 100 ms : using intermuscular coherence to investigate the engagement of neural binding between muscles in mediating fast motor corrections

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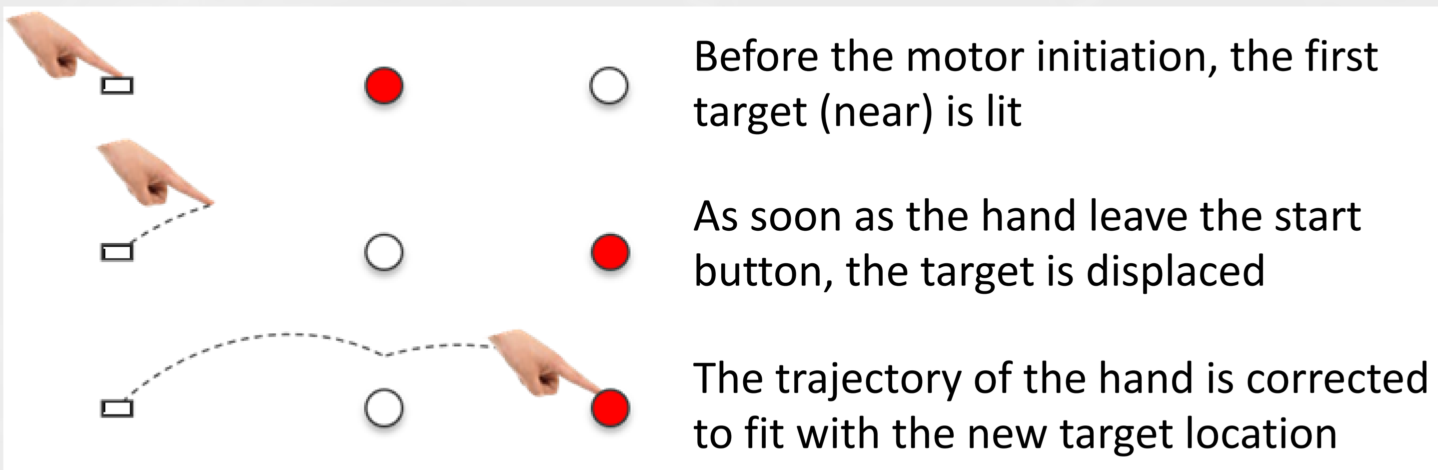
Introduction

→ During an ongoing pointing movement, it is possible to **correct the hand trajectory if the target is displaced** after the movement initiation.

(Desmurget and Grafton, 2000)



Schematic view of an online motor correction

→ These **online motor corrections** are visible within **100ms** on the electromyographic (EMG) recording of the effector muscles (Fautrelle et al., 2010)

→ This latency is nearly **half of the time required to a simple motor initiation**, which is about 190ms (Keele and Posner, 1968)

Hypothesis

Fast motor corrections could be linked with a change of the intermuscular coherence, which may reflect a change in the neural mechanism between motor initiation and correction. This change may appear as an increase of the coherence in the gamma frequency band (35-60 Hz).

Method

→ 14 right-handed men (age : [21-34] years, height : [175-181] cm)

→ They were told to **reach as fast as possible** the target that lights up on the table

→ 55 movements : 5 sets of 11 trials each
- → 5 on the NEAR target
- → 5 on the FAR target
- → "1 target jump"

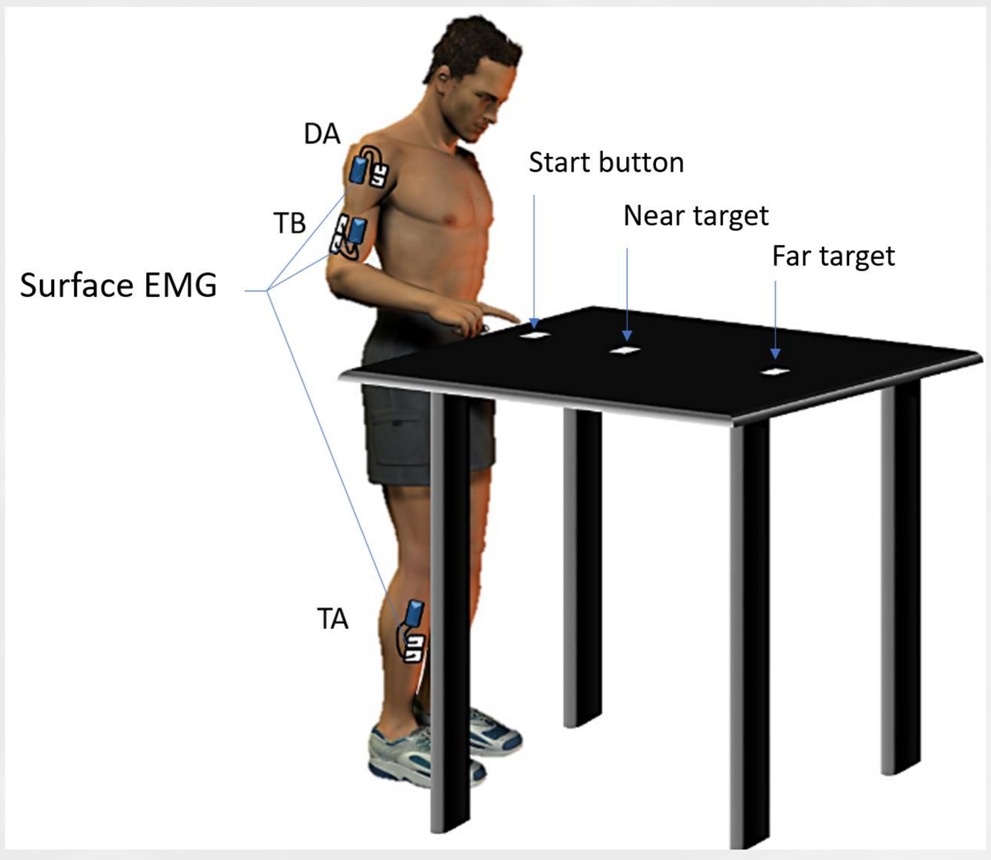
"target jump" = The NEAR target is lit, replaced by the FAR target when the hand leaves the "Start" button

→ Surface EMG on 3 muscles :
- TA : Tibialis anterior
- DA : Anterior deltoid
- TB : Triceps brachii

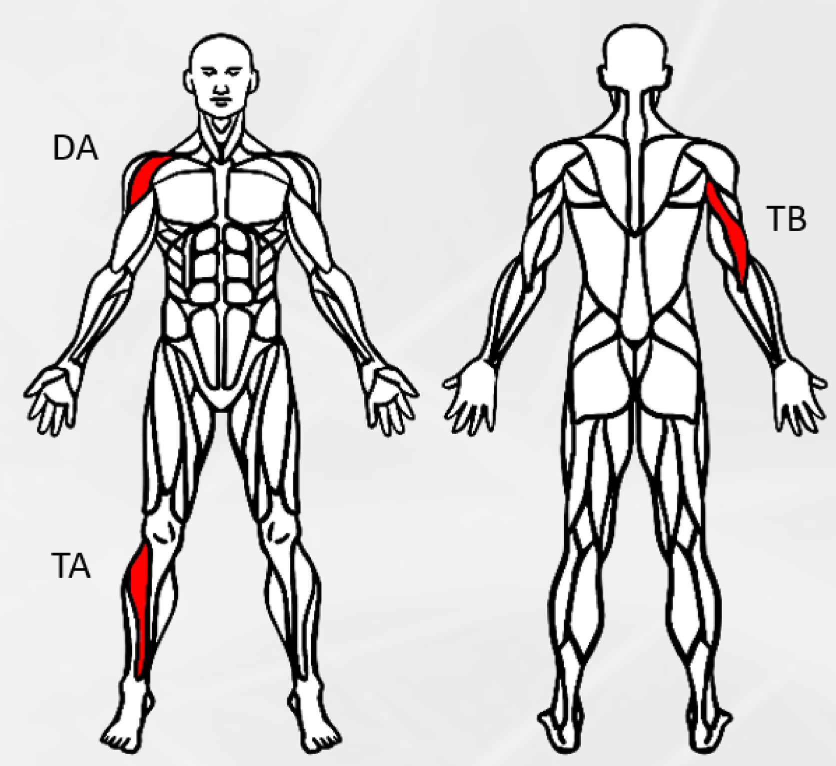
3 first surface muscles to be activated (Fautrelle et al., 2011)

→ Intermuscular time-frequency (wavelet) coherence analysis (Charissou et al., 2016)

Experimental setting :

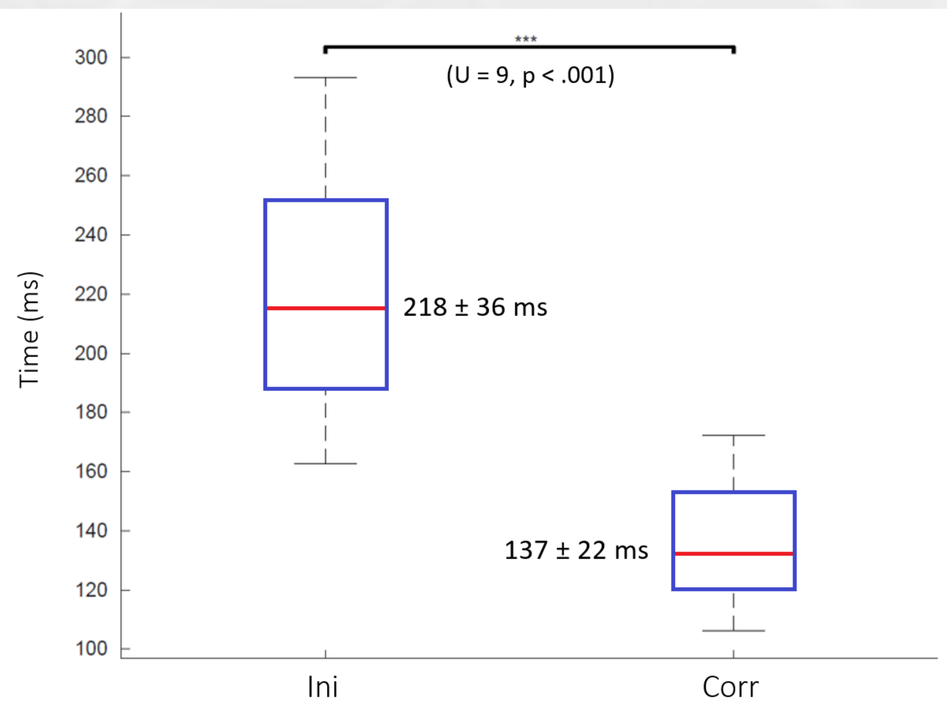


Recording muscles :



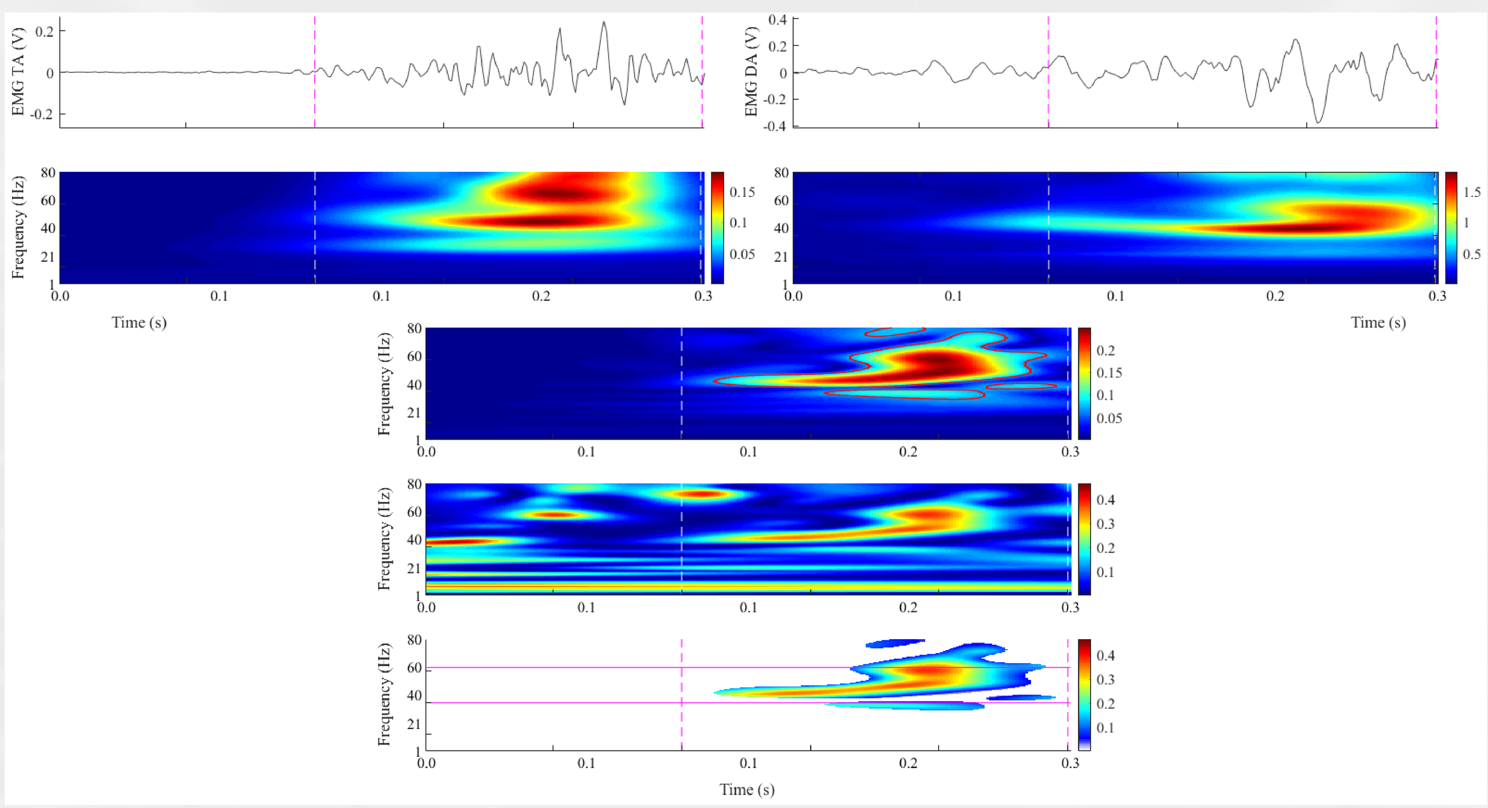
Results and discussion

Initiation (Ini) and correction (Corr) latencies on the EMG of the Tibialis anterior



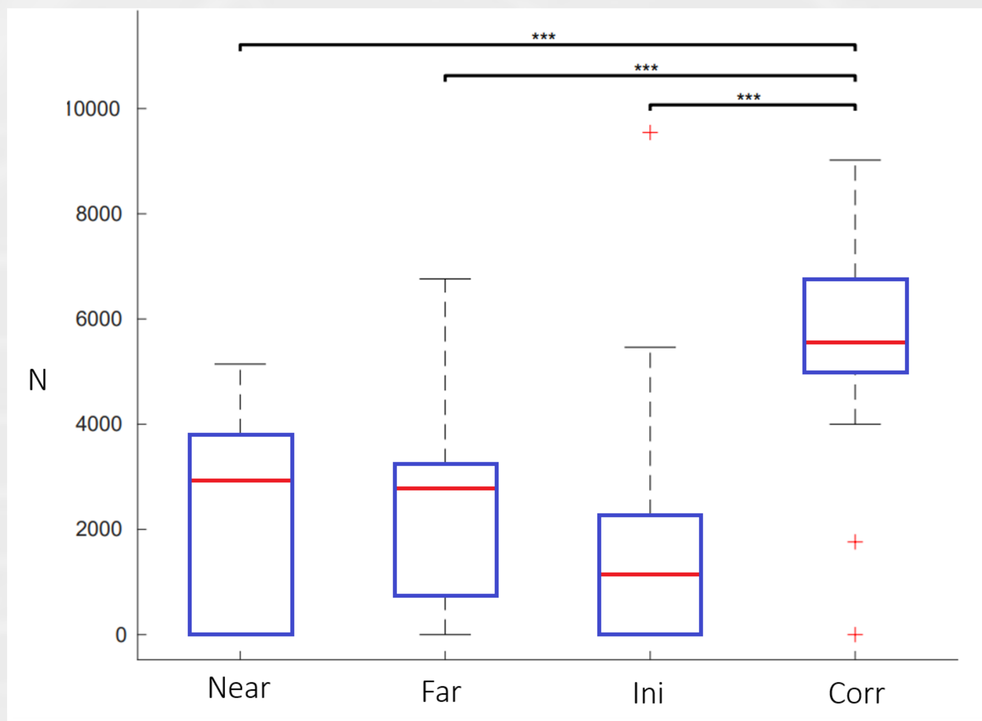
→ The motor correction time appears to be nearly half of the time needed for a motor initiation

Typical coherence map obtained for the TA-DA muscle pair during the motor correction



→ The first row represent the raw EMG for each muscle, the second one shows the wavelet auto-spectra of the previous signals. The third row is the wavelet cross-spectrum between the two EMG signals, on which significant values of correlation are circled in red. Fourth row shows the wavelet magnitude-squared coherence between the two signals. Finally, the last row represents only the values of significant correlation between the two signals on the wavelet coherence spectrum.

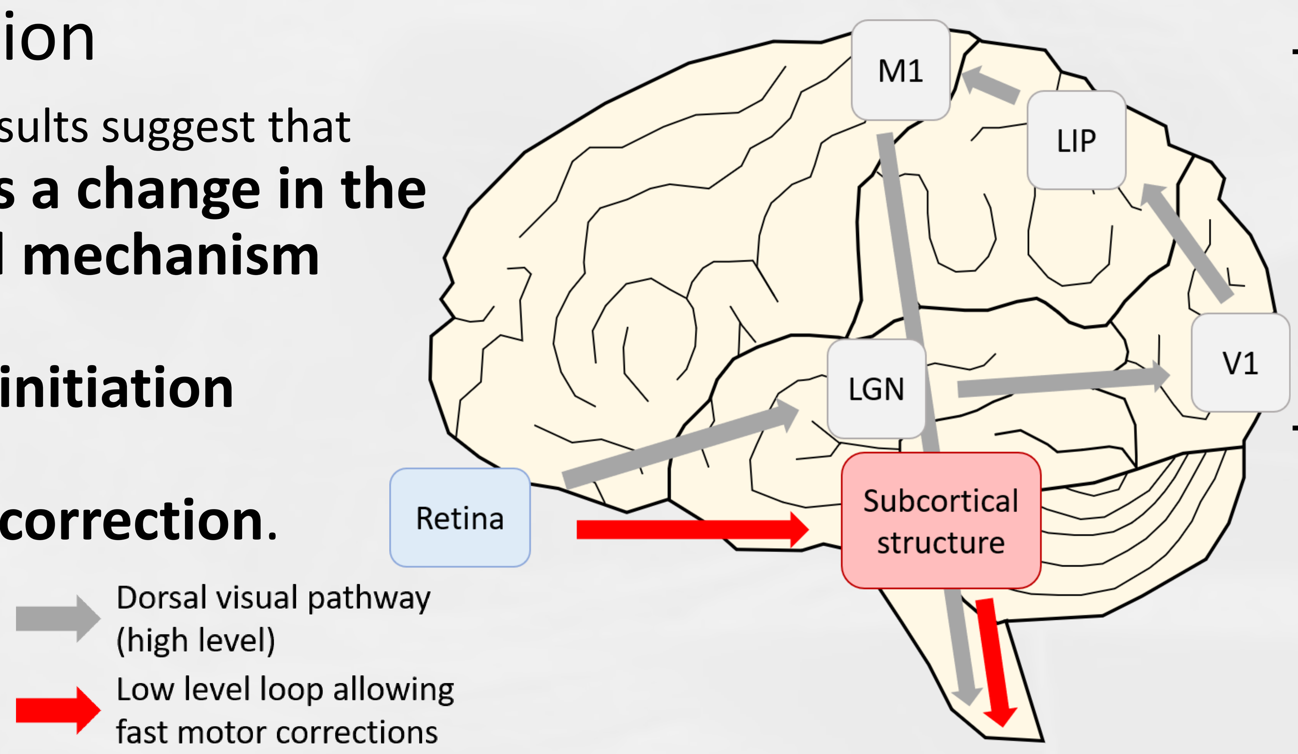
Coherence (N) between the tibialis anterior and the deltoidus in the γ frequency band (35-60 Hz)



→ Significant increase of the coherence in the gamma frequency band for the TA-DA muscle pair when the motor correction occurs (Chi² = 15.493, ddl = 3, p<.01)

Conclusion

→ These results suggest that **there is a change in the control mechanism** between **motor initiation** and **motor correction.**

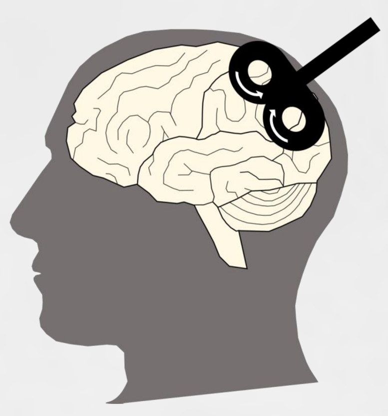


→ Such a change could be related to a **modification in the oscillatory activity of the corticospinal system** in order to allow a **fast processing** of visual information. (Omlor et al., 2007)

→ This could also reveal the involvement of a **subcortical structure** as an alternative pathway for these online motor corrections, because of the temporal pressure. (Cheyne et al., 2008)

Perspectives

→ Other studies are needed to identify whether a subcortical structure is involved in these fast motor corrections. Transcranial Magnetic Stimulation could be a solution to block the activity of the parietal posterior cortex when the target is displaced.



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