CORTICOSPINAL EXCITABILITY AND CONDUCTIVITY ARE RELATED TO THE ANATOMY OF THE CORTICOSPINAL TRACT

NEUROSCIENCE OF MOVEMENT LABORATORY

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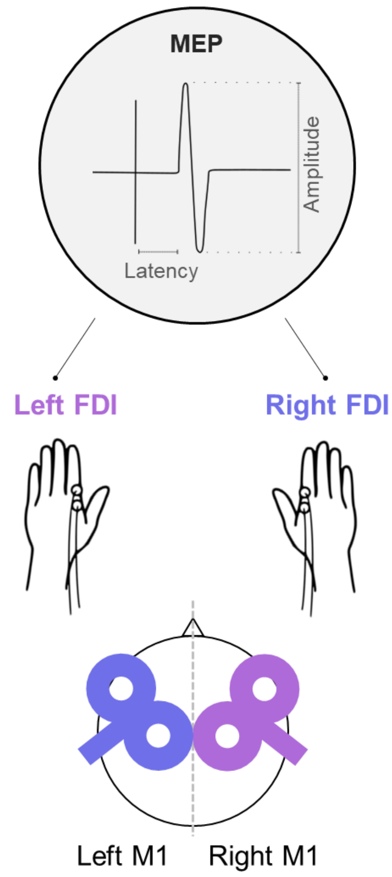
INTRODUCTION

The corticospinal tract (CST) is the principal motor descending pathway for voluntary movements. How the CST inter-individual anatomical variability affects the function of the human motor system is still a matter of investigation (e.g., Herbsman et al. 2009; Hübers et al. 2012). This study aims to explore how microstructural and volumetric properties of the CST modulate the corticospinal excitability and conductivity by means of advanced diffusion magnetic resonance imaging tractography based on the spherical deconvolution and transcranial magnetic stimulation (TMS).



Methods

Participants: nineteen right-handed (10 females, mean age = 27.2 ± 2.6 years).

TMS stimulation of the primary motor cortex (M1) and electromyographic recording acquired from either the first dorsal interosseous (FDI) muscle of the left or right hand to measure motor-evoked potentials (MEP) and extract: *resting Motor Threshold (rMT), MEP amplitude* and *MEP latency*.

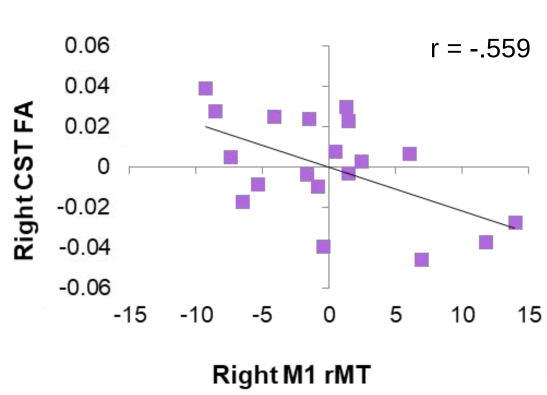
Diffusion MR imaging data were acquired using 1.5T Siements Avanto scanner and EPI sequence with the following parameters: TR = 8500, TE = 97, FOV = 307.2 x 307.2, matrix size = 128 x 128, 60 slices (no gaps) with isotropic (2.4 x 2.4 x 2.4 mm^3) voxels and maximum diffusion weighting of 2000 sec/mm^2 with 64 gradient directions. Using spherical deconvolution approach (Dell'Acqua et al. 2007), tractography dissection of CST (M1 portion) was performed to quantify tract-specific measures: *Fractional Anisotropy (FA) and Number of Streamlines (NoS)*.

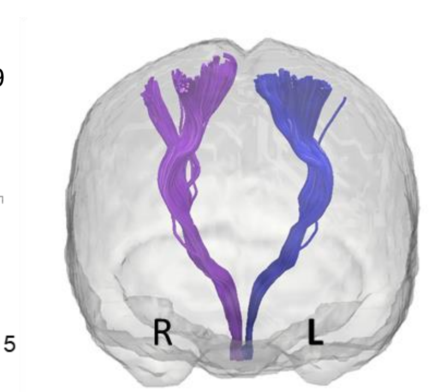
Correlations between functional and anatomical measurements were assessed, with skull-to-cortex distance as a control variable.

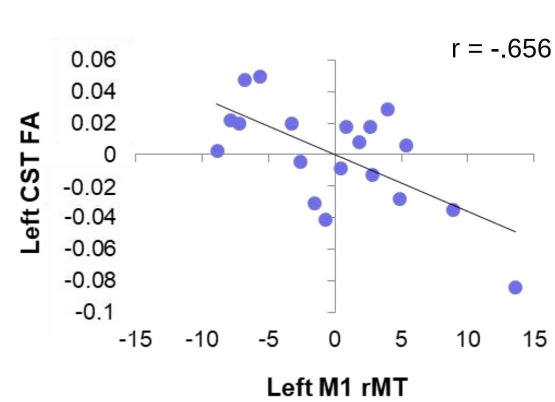
RESULTS

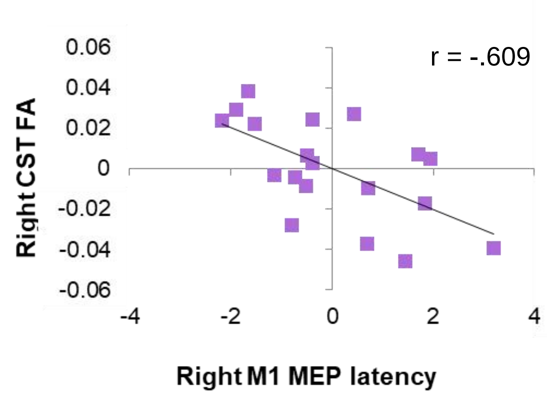
RIGHT HEMISPHERE

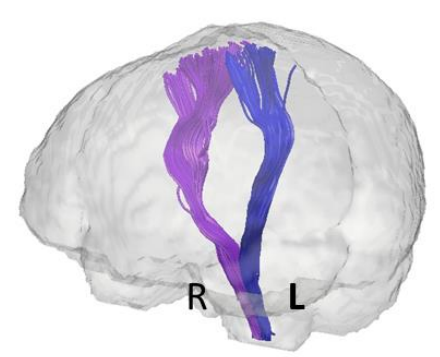
LEFT HEMISPHERE

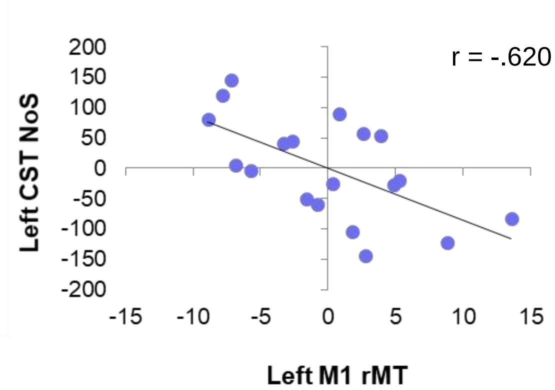












We found a significant negative partial correlation between the left M1 rMT and the NoS and FA of the left CST ($r = -.620$, $p = .006$ and $r = -.656$, $p = 0.003$, respectively). A significant negative correlation was found between the FA of the right CST and the right M1 rMT ($r = -.559$, $p = .016$) as well as the right MEP latency ($r = -.609$, $p = .007$).

References

Herbsman et al. (2009). Motor threshold in transcranial magnetic stimulation: The impact of white matter fiber orientation and skull-to-cortex distance. Hum Brain Mapp 30:2044–2055.

Hübers et al. (2012). The relationship between TMS measures of functional properties and DTI measures of microstructure of the corticospinal tract. Brain Stimulat 5:297–304.

CONCLUSION

Increased corticospinal excitability and conductivity are associated with a bigger corticospinal descending pathway, as well as with increased microstructural coherence and organization. Our findings shed new light on the neurophysiological correlates of the CST inter-individual variability.

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