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Cortical alternating generators of sleep spindles: electrical source imaging using high-density EEG (256-channels) recordings

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Introduction: Sleep spindles are the hallmark of N2 sleep, with a frequency between 10-16Hz and a duration of 0.5-2sec, localizing over the fronto-centro-parietal cortical areas. Anterior spindles have a relative slower frequency compared to posterior ones, although no consensus exists on the cortical localization of spindles' generator.

Methods: 136 spindles were obtained by visual inspection from a 256 channels EEG (Geodesic, Eugene, USA) sleep recordings from 6 healthy volunteers. Offline analysis filtered the marked traces at 10-12Hz (slow spindles) and 12-14Hz (fast spindles); traces of each category were segmented, baseline-corrected, bad channels rejected by visual inspection and replaced, and averaged. Averaged traces were used to reconstruct on the MNI (Montreal Neurological Institute) magnetic resonance template via an inverse solution method (LORETA algorithm) cortical generators of slow and fast spindles.

Results: A total of 64 slow and 70 low spindles, temporally alternating on the EEG, were analyzed. Visual rendering of spatial distribution of spindles by EEG-signal projection on a cortical flat map confirmed the fronto-central distribution of slow spindles and the centro-parietal localization of fast ones. The source generator reconstruction localized the generator in the anterior prefrontal cortex (middle frontal gyri, Brodmann area 10) for the slow spindles and in the parietal cortex (paracentral lobule, Brodmann 5; posterior parietal cortex, 7; supramarginal gyrus, 40) for the fast ones.

Conclusion: Sleep spindles show different, alternating cortical generators according to their frequency and topographical distribution on the scalp. This observation suggests the existence of different cortical networks for slow and fast spindles.

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Role of the cerebellum in the motor control of Donders' law during human pointing tasks: an rTMS study with kinematic analysis of the wrist

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Introduction: Donders' law well represents intrinsic strategies of motor control system during pointing tasks, executed through eye, head or arm movements [1-2]. The central nervous system (CNS) removes the degrees of freedom that are not essential (solution of the redundancy problem). Aim of the present study is to identify the CNS regions involved in the control of Donders' law applied to the motor control of human pointing tasks.

Material and methods: 11 healthy subjects underwent a session of inhibitory rTMS (1Hz) of right cerebellar hemisphere, while 13 control volunteers, underwent a sham cerebellar rTMS session. Each subject executed a kinematic analysis of the wrist during pointing tasks to evaluate Donders' law [2] before and after the rTMS session. The orientation matrix R of the wrist was measured by means of inertial magnetic unit.

Results: The MANOVA analysis shows significant modifications in the curvature of Donders' plans obtained before and after rTMS cerebellar neuromodulation, in 78% of healthy subjects that underwent to real rTMS session, while no significative differences were found in sham group.

Discussion: The present data suggest a cerebellar control of Donders' law applied to the redundancy problem solution in human pointing tasks. This method could have an application in clinical practice, particularly for functional evaluation. Since the curvature of Donders' plan is like an individual "fingerprint", these findings could be useful in many neurodegenerative diseases, in which neuronal loss occurs earlier than the onset of clinical symptoms and in individually-tailored and neurophysiology-based rehabilitation.