

## Cerebello-cortical Loops Differ Between Essential, Parkinsonian and Voluntary Tremor

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**Objective:** Topographical comparison of subcortico-cortical oscillating loops between different tremors.

**Background:** Cerebellum and cortical motor regions are involved in Essential, Parkinsonian and Voluntary tremor, three oscillatory motor outputs with substantially different clinical characteristics. These have been attributed to the type of subcortico-cortical interaction and modulation by the basal ganglia. How all of these tremors can emerge from the same subcortico-cortical loops remains unclear.

**Methods:** Postural tremor in 34 ET, 34 PD patients and voluntary tremor in 34 healthy subjects were recorded by surface EMG from forearm muscles in parallel to high resolution EEG (EGI Geodesic, 256 channels). Groups were age- and sex-matched. EEG signals were band pass filtered from 0.1 to 100 Hz, EMG signals between 30 and 500 Hz and full-wave rectified. The predominant tremor frequency was detected in the power spectrum. The brain area with the strongest coherence at this tremor frequency (2–6 Hz) was identified using dynamic imaging of coherent sources (DICS). Furthermore, iteratively all the other coherent sources were identified by taking the EMG as the reference signal. To find the significant sources that are coherent to the tremors we used data driven surrogate analyses.

**Results:** Coherent cortical, thalamic/basal-ganglia and cerebellar sources were found in all three groups. Cortical sources in primary sensorimotor and secondary motor areas were similar. In the cerebellum a circumscribed medial ipsilateral region was involved in all three groups, but these cerebellar sources differed significantly. Projection of these sources on the map of intrinsic functional cerebello-cortical connections as described by the Buckner group (1) shows that the cerebellar and cortical sources match these preformed but different intrinsic connections in all three groups. PD tremor showed involvement of the basal ganglia (caudate), in ET and Voluntary tremor the thalamus showed coherence.

**Conclusions:** We demonstrate for the first time that the cerebellar and cortical involvement follows pre-existent intrinsic, functional connections in ET, PD and voluntary tremor. However, the connections/loops involved differ significantly between the three groups. Basal ganglia involvement only in PD-tremor is confirmed. Thus the clinical difference between the three tremors is reflected by differences in the activated subcortico-cortical loops.