Atelier
« Dynamiques invariantes d'échelle et réseaux en neurosciences »
21-24 octobre 2013

Workshop on
Scale-Free Dynamics and Networks in Neurosciences
October 21–24, 2013

Frequency scaling of human and monkey LFP

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Contradictory results have been published about the frequency scaling of local field potential (LFP) signals, ranging from $1/f$ to $1/f^2$ scaling. Here, we attempt to clarify these results by analyzing the LFP recorded by multi-electrode (Utah) arrays in human and monkey during different brain states. As previously found in cats, we show that if the subject is awake and the EEG is strictly desynchronized (no slow-wave), then the power spectrum of the LFP scales as $1/f$ at low frequencies ($< 10\,$Hz) and $1/f^3$ at high frequencies ($> 30\,$Hz), as shown previously in cats (Bédard et al., 2006). However, as soon as slow waves are present in the EEG, the frequency scaling approaches $1/f^2$ at low frequencies. These results were seen for human and monkey recordings, in temporal and motor cortex, respectively, recorded with the same type of multi-electrode system (Utah array). Thus, the $1/f$ frequency scaling of LFP (and possibly EEG) signals is consistently seen in human, monkey and cat, but only for restricted brain states with strictly desynchronized EEG. We discuss possible physical mechanisms of such $1/f$ scaling, and in particular ionic diffusion, which produces a $1/f$ low-pass filter consistent with what is seen experimentally. We show that with ionic diffusion, it is possible to reconstruct LFPs from unit activity, and with power spectra displaying the correct frequency scaling. We conclude that, $1/f$ frequency scaling is consistently present in human, monkey and cat LFP, and can be explained by ionic diffusion.

References

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