Electrical modulation of cerebral cortical activity

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The control and precise spatiotemporal modulation of brain activity is a necessary strategy to restore normal brain function in local or global brain alterations, to interact with interfaces and effectors such as prostheses, or as a tool in basic neuroscience. Pharmacological, optogenetic, or electrical stimulation are potential ways to achieve such control. Activity control requires not only stimulation, but also neural recordings. In this talk I will discuss our work on modulation of cortical activity by electrical stimulation on both ends: from the recordings with electrodes and graphene microtransistors[1] to the endogenous[2] and exogenous[3] electric field modulation. Both ends can be connected or not by a close-loop[4], which can allow us to set the emergent activity at the desired selected frequency of oscillation. Computer models of the network are valuable to investigate the involved mechanisms and to predict the potential outcomes and will also be discussed. Still in an early stage, in particular with regard to clinical applications, the development of reliable modes of control of neural activity is an expanding area of research in neuroscience.

[1] Hébert et al. "Flexible graphene solution-gated field-effect transistors: efficient transducers for micro-electrocorticography." Advanced Functional Materials 28.12 (2018): 1703976.
[2] Rebollo et al. "Modulation of intercolumnar synchronization by endogenous electric fields in cerebral cortex." Science Advances 7.10 (2021): eabc7772.
[3] D'Andola et al. "Modulation of slow and fast oscillations by direct current stimulation in the cerebral cortex in vitro." bioRxiv (2018): 246819.
[4] D'Andola, M., Giulioni, M., Dante, V., Del Giudice, P., & Sanchez-Vives, M. V. (2019). Control of cortical oscillatory frequency by a closed-loop system. Journal of neuroengineering and rehabilitation, 16(1), 1-14.