LABORATORY OF COMPUTATIONAL NEUROSCIENCE (LCN)

Prof. Wulfram Gerstner
EPFL – IC & SV– LCN
SG –AAB119 (Bâtiment SG-AAB)
Station 15
CH - 1015 LAUSANNE, Switzerland

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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15h15, Room

Computational Neuroscience Seminar

Kristofer BOUCHARD,
University of California, San Francisco

Functional Organization of Sensory-Motor Cortex During Speech Articulation

No behavior is as unique to humans as the ability to produce spoken language, and few behaviors that every human performs are as complicated to control as speech. Understanding the spatio-temporal organization of cortical signals that control the articulators of the vocal plant during the production of basic speech elements (consonants and vowels) is fundamental to our understanding of how the brain produces the complex sequence of movements that compose spoken language. We recorded cortico-electrical activity from the surface of speech somato-motor cortex using high-density electrocorticography (ECoG) in neurosurgical patients during the production of a large and expansive set of American English consonant-vowel (CV) syllables. These recordings revealed that different syllables are produced by the graded activation of multiple cortical sites in overlapping spatio-temporal patterns. Across subjects, we found that the functional temporal structure of speech somato-motor cortex is sequenced to first shape the upper vocal tract, through movement of the lips and tongue, filtering the sound produced at the larynx and released from the vocal tract by the jaw. Furthermore, the functional modulations of cortico-electrical activity underlying speech production are somatotopically organized, with both anatomically well isolated as well as overlapping representations of the speech articulators. Analysis of the spatial patterns of activity (cortical state-space) at both consonant and vowel time point's reveals a hierarchically clustered structure that is primarily organized by the pattern of articulatory engagements. Finally, the cortical state-space exhibits divergent and convergent dynamics that smoothly reflect the time dependent relationship between cortical and articulatory states for both consonants and vowels. Preliminary analysis suggests that cross-frequency coupling may play a role in coordinating spatially segregated articulators during speech production. Together, our results lay the foundations of an electro-cortical understanding of speech production in humans. More generally, our results provide insight into how the human neocortex dynamically controls complex, multi-articulator behaviors, which is crucial to our understanding of basic nervous system function.