**Project title: “Driving associative plasticity in premotor-motor pathways to enhance motor resonance”**

Motor resonance—the activation of motor circuits during action observation—is a fundamental mechanism of the Action Observation Network (AON), allowing the brain to translate observed movements into corresponding motor representations. This process is thought to depend on the connectivity between the ventral premotor cortex (PMv) and the primary motor cortex (M1), yet direct causal evidence for this interaction remains limited. Additionally, while the supplementary motor area (SMA) is believed to regulate motor resonance by exerting top-down control over M1, its precise role is still unclear.

This project aims to drive associative plasticity in premotor-motor pathways to determine their causal role in motor resonance. Using cortico-cortical Paired Associative Stimulation (ccPAS), an advanced neurostimulation technique that selectively strengthens or weakens connectivity between brain regions, we will manipulate PMv-to-M1 and SMA-to-M1 pathways. The effects of these interventions will be assessed through motor-evoked potentials (MEPs) and EEG responses to TMS pulses over M1 during action observation. If PMv-to-M1 connectivity is a key driver of motor resonance, its potentiation should enhance motor resonance, while its disruption should dampen it. Likewise, investigating SMA-to-M1 connectivity will clarify whether it facilitates or suppresses motor resonance through top-down modulation.

By combining neurostimulation with multimodal neurophysiological recordings, this study will provide direct evidence on how premotor and supplementary motor areas shape M1 activity during action observation. These insights will not only advance theoretical models of motor resonance but also have translational potential for clinical applications, such as enhancing action observation therapy for motor rehabilitation.

**Training plan**

Training activities: literature readings and reviews, discussions with the tutor, direct involvement in laboratory meetings, participation in lectures and workshops, manuscript review.

The activities are aimed at acquiring: 1) theoretical knowledge on cognitive neuroscience of action and action perception, neuroplasticity, behavioral and neurophysiological methods to assess motor and cognitive functions; 2) the ability to design and conduct research projects, use of advanced TMS protocols and implement data analysis; 3) writing and oral communication skills for scientific dissemination; 4) the ability to translate scientific knowledge in the development of new rehabilitation programs.