**Project: Boosting and hindering action imitation by modulating spike-timing dependent plasticity**

**Supervisor: Alessio Avenanti**

The ability to imitate others is crucial for social life. The tendency to mimic the actions of other people is so rooted in humans that it can be observed even when imitation is maladaptive. Automatic imitation is defined as an impulse to reproduce observed actions even when they are not relevant to the current task (Heyes, 2011), and copying them impairs performance, as shown in the imitation inhibition task (Brass et al., 2000, 2001), a well-known stimulus-response compatibility task in which task-irrelevant action stimuli interfere with the execution of dissimilar actions – assessing covert imitation tendencies. Although automatic imitation has been widely investigated at the behavioral level (Cracco et al. 2018), its neural mechanisms are still unclear. In this project, we aim to establish the malleability and causal role of cortico-cortical connections supporting and/or controlling automatic imitation. We take advantage of an advanced TMS protocol called cortico-cortical Paired Associative Stimulation (ccPAS). The ccPAS is an information-based TMS protocol tailored to the physiology of the targeted cortico-cortical pathways and relying on the Hebbian principle. ccPAS involves targeting 2 inter-connected cortical areas to induce spike-timing-dependent-plasticity (STDP) in the pathway between them. Here, we propose to use ccPAS to modulate the strength of the projections from premotor regions of the AON (i.e., the IFC) to M1 and from key frontal regions involved in top-down cognitive control (i.e., the dlPFC) to M1. By modulating the strength of IFC-to-M1 and dlPFC-to-M1 pathways, we aim to establish the modulatory influence that prefrontal/premotor regions exert over M1. We will investigate ccPAS-induced changes in such influence in two distinct research streams (RS), focusing on neurophysiological indices of covert imitation/motor resonance (RS1) and their behavioral counterpart (RS2). Our project promises to deepen our mechanistic understanding of one of the main AON functions and its regulation by higher-order cognitive control brain networks. This will offer a significant breakthrough for theoretical models of imitation, with potential clinical implications for enhancing the impact of action-observation rehabilitation techniques on patients with motor deficits (Ertelt et al. 2007).

**Training plan and activities of the research fellow:**

**Training activities:** readings, discussions with the supervisor, direct involvement in lab meetings, attendance of lectures and workshops, revision of manuscripts; activities aimed at acquiring: 1) theoretical knowledge about key models and thematic areas related to cognitive neuroscience of action and perception, cortico-cortical connectivity, neural plasticity, behavioral and neurophysiological evaluation of motor and visual functions; 2) skill for designing and conducting scientific research projects, data analysis and use of advanced image-guided TMS protocols, including TMS-EMG and TMS-EEG coregistration and ccPAS; 3) writing and oral communication skills for scientific dissemination; 4) skills for translation of scientific knowledge into development of novel rehabilitation programs.

**Project activities:** literature review to acquire relevant theoretical knowledge and to define stimulation parameters and behavioral procedures, recruitment of participants with the aid of master students and PhD candidates, execution of pilot studies to assess experimental duration and participant’s compliance, data collection and analysis, writing of a draft of the main findings to be submitted to a scientific journal and research dissemination at national/international congresses.