UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Thesis Project Form

Title (tentative): Characterization of synergistic muscle activation evoked by transcranial magnetic stimulation

Thesis advisor(s): Casadio Maura, Camilla Pierella,Martina Coscia, Dr. Takuya Morishita

E-mail: Maura.Casadio@unige.it

Address: Via Opera Pia 13, 16145 Genova (ITALY)

Phone: (+39) 010 33 52749

Description

Motivation and application domain

Transcranial magnetic stimulation (TMS) is a non-invasive method in systems neuroscience; its usage has provided valuable insight into understanding of the nervous system, especially the motor system. When a TMS pulse is delivered over the motor cortex, an induced electrical field activates neurons underneath the TMS coil and evokes descending volleys, which terminate at the spinal code and produce muscle twitches. The evoked muscle activity recorded via electromyography (EMG) is motor-evoked potential (MEP) and its applications have led to significant advancements in various fields over the past 30 years. Synergistic aspects of multi-muscle MEPs can be studied in a framework of motor compositionality using a muscle synergy approach. With the term synergy, we refer to the possibility of grouping muscles that, because of their similar functions or behavior, are co-activated during a task showing similar activation patterns, or that are simultaneously evoked by the TMS stimulation. In neuroscience, behavioral muscle synergies represent the solution of the redundancy problem of moving organisms. Muscle synergies have been studied to understand human motor control of upper and lower extremity, in young and elderly, healthy and pathological subjects. The study of synergistic aspects of multi-muscle MEPs is recent and promising to improve our understanding of the effects of the TMS and to calibrate the stimulation on single individuals.

General objectives and main activities

The aim of this work is to investigate synergistic aspects of multi-muscle MEPs by translating multidimensional behavioral EMG analysis techniques such as factorization analysis and spinal maps on MEPs in unimpaired individuals. Muscle synergies and spinal maps from MEPs resulting from TMS stimulations in different points and with different impulse features on the same individual will be analyzed to compare the effect of stimulation intensity and location on each individual and across individuals.

Training Objectives (technical/analytical tools, experimental methodologies)

The work includes MEP acquisition during TMS stimulation in healthy participants and MEPs data analysis, including the use of methodologies usually applied for multimodal analysis of EMG signals, such as spinal maps and muscle synergies. Data analysis will be mainly performed by using Matlab.

Place(s) where the thesis work will be carried out: uman Engineering Lab (hepia) and UPHummel Lab (EPFL), Campus Biotech, Chemin des Mines 9 1202 Geneva, Switzerland.

Additional information

Maximum number of students: 1

Financial support/scholarship: bando extra-eu (maybe)