UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Neuroimaging and Neurostimulation Techniques

2526-1-F5110P008

Learning area

Psychological functioning: models and methods for assessment.
Intervention and rehabilitation models and techniques.
Methods, techniques, and tools of psychology.

Learning objectives

The course aims to impart the following knowledge and skills:

Knowledge and understanding:
• Methodological and neurobiological foundations of neuroscientific inference with neuroimaging and neurostimulation techniques.
• Structural and functional neuroimaging techniques (CT, PET, MRI, fMRI, EEG).
• Neurophysiological basis of invasive and non-invasive brain stimulation techniques (DES, DBS, TMS) and neuromodulation approaches (rTMS, tES).
• Main applications in neuropsychology and cognitive neuroscience of the aforementioned techniques.

Applying knowledge and understanding:
• To promote the ability to acquire and process data from neuroimaging techniques in neuropsychological and cognitive neuroscience settings.
• To promote the ability to apply brain stimulation and neuromodulation in neuropsychological and cognitive neuroscience settings.
• To promote the ability for an integrated use of neuroimaging and brain stimulation techniques in neuropsychological and cognitive neuroscience settings.

Making judgements:
Through the discussion of issues related to neuromodulation and neuroimaging techniques, the course aims to

provide a critical and autonomous perspective on the use of the methods discussed, as well as the ability to personally develop experimental solutions and interpretative hypotheses in research and clinical settings.

Communication skills:
The detailed attention to the terminological aspects of the methods presented and discussed with the students during the course aims to enable them to acquire the specialized scientific language and to develop the ability to use a communicative register appropriate to the academic and professional context.

Learning skills:
The addition of scientific articles in English to the course teaching material aims to stimulate autonomy in study and the ability to critically explore the topics covered through the use of authoritative scientific sources, also promoting the ability to independently explore and interpret the specialist literature concerning neuroimaging and neurostimulation techniques.

Contents

Neuroimaging methods: CT, PET, MRI, EEG.
Methods of invasive and non-invasive neurostimulation and neuromodulation: TMS, tES.
Applications in cognitive neuroscience and neuropsychology.

Detailed program

• Historical and methodological introduction on neuroimaging techniques
• Computerized Axial Tomography (CT)
• Physics of PET measurements and clinical applications
• Physics of MRI measurements
• Structural MRI: brain morphometry and brain lesion analysis
• Structural connectivity with MRI: Diffusion Tensor Imaging
• Physics and physiology of functional MRI (fMRI) measurements
• Experimental design of fMRI studies
• fMRI data processing, and univariate and multivariate statistical analysis
• Functional connectivity with fMRI data
• Physics of electrophysiological measurements and clinical applications

• Historical introduction of invasive and non-invasive stimulation techniques (NIBS)
• Methodological foundations of NiBS
• Direct Electrical Stimulation, DES
• Deep Brain Stimulation, DBS
• Transcranial Magnetic Stimulation (TMS): spTMS (single pulse), ppTMS (paired pulses), rTMS (repetitive), pattern stimulation
• Transcranial Electric Stimulation (tES): tDCS (transcranial Direct Current Stimulation), tACS (transcranial Alternate Current Stimulation), tRNS (transcranial Random Noise Stimulation)
• NIBS and brain plasticity
• NIBS in cognitive neuroscience
• NIBS in motor and neuropsychological rehabilitation
• NIBS in the treatment of psychiatric deficits

Prerequisites

Notions of biology, neurophysiology and physiological psychology are useful for the fruition of the course.

Teaching methods

The course will mainly consist of:

- 13 frontal room lessons of 2 hours each on neuroimaging techniques, in presence.
- 1 frontal exercise lesson of 2 hours on neuroimaging techniques, in presence.
- 13 frontal room lessons of 2 hours each on neurostimulation techniques, in presence.
- 1 frontal exercise lesson of 2 hours on neurostimulation techniques, in presence.
  Teaching will be in Italian, with audio-visual materials in either Italian or English.

Assessment methods

The evaluation of the course will be based on a final exam, in written-only modality, aimed at verifying the understanding of all the topics covered in the course, and including the following:

1. 30 multiple choice questions with 4 alternatives and 1 correct choice (15 questions about neuroimaging and 15 about neurostimulation). One point will be assigned for each correct answer, with no penalty. The minimum score for a successful assessment is 18 correct answers out of 30. Example: “A brain stimulation is invasive: 1: if no incision of the skull and insertion of objects in the brain are made; 2: if it decreases heart rate; 3: if incision of the skull and insertion of objects in the brain are made (correct choice); 4: if it increases body temperature.
2. Two open questions (1 question about neuroimaging and 1 about neurostimulation) to which a complete and concise response is to be provided. Example: “Briefly summarize the main physiological features of 1 Hz rTMS”. The score assigned to each open question ranges from 0 to 15 points. To obtain the total score of the written exam, the score obtained in the two open questions will be averaged with the score obtained in the multiple-choice questions.
   As per the regulations, students or the teacher have the right to optionally request an oral exam in addition to the written exam. The evaluation of the oral exam may determine positive or negative changes, or no modification of the final grade.
   Erasmus students can contact the teacher to agree on the possibility of carrying out the project work and taking the exam in English.

Textbooks and Reading Materials

The lecture handouts and other relevant teaching materials will be made available online on the e-Learning website of the course. The textbooks for the course are:

- Sacco K. (a cura di) [2020], Neuroimaging per lo studio del cervello umano. Napoli, Idelson Gnocchi.
- Bolognini N., & Vallar G. (a cura di) [2015], Stimolare il cervello. Bologna, Il Mulino.

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING