UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Neuroimaging and Neurostimulation Techniques

2425-1-F5108P008

Learning area

Psychological functioning: models and methods for assessment.

Learning objectives

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.

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 EEG 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)
• NIBS and brain plasticity
• TMS-EEG
• NIBS in cognitive neuroscience
• NIBS in motor and neuropsychological rehabilitation
• NIBS in the treatment of psychiatric deficits

The use of neuro-functional techniques will be presented in a clinical-experimental context. Students will learn to design simple experiments and to critically evaluate the literature in the field of neuroimaging and neurostimulation.

Prerequisites

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

Teaching methods

The course will mainly consist of frontal room lessons in Italian and of audio-visual materials in either Italian or English.

Assessment methods

1. The evaluation of the course will be based on a written exam aimed at verifying the understanding of the topics covered in the course, including multiple choice-questions, and two open questions on the topics of the course.
   a) 30 multiple choice questions with 4 alternatives and 1 correct choice (15 questions about neurostimulation and 15 about neuroimaging). 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.
   b) Two open questions 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, and the total score of the two open questions will be averaged with the score obtained in the multiple-choice questions.
2. Oral assessment (optional upon the student’s or teachers’ request). The evaluation of the oral assessment may result in a modification of the final score of the exam with a positive or negative sign, or in no change.
   Although this course is held in Italian, Erasmus or foreign students can contact the teachers to agree on the possibility of studying on course materials in English, and/or on the possibility of taking the exam in English, if they wish to do so.

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