Course syllabus

Course title	Advanced research methods and experimental design in neuroscience
Instructor(s)	Agnieszka Pluta, Ph.D., prof. Łukasz Okruszek, Tomasz Wolak, Ph.D.
Contact details	lukasz.okruszek@psych.uw.edu.pl apluta@psych.uw.edu.pl
Affiliation	Faculty of Psychology, University of Warsaw Social Neuroscience Lab, Institute of Psychology, Polish Academy of Sciences
Course format	lecture + class + lab
Number of hours	30 hours + 30 hours
Number of ECTS credits	**5 ECTS credits** 30 hour – EEG classes 45 hour – EEG data preprocessing and analysis (students own work) 30 hour – fMRI classes 45 hour – fMRI data preprocessing and analysis (students own work)
Brief course description	The main aim of this course is to introduce an overview of functional magnetic resonance imaging (fMRI) and EEG methods and applications, highlighting key concepts and strategies to analyze the data.
Full course description	The aim of the course is to familiarize students with two main techniques utilized in cognitive neurosicence field. Functional magnetic resonance imaging (fMRI) and EEG have become the most popular methods for imaging brain function. During the course students will be provided with a comprehensive and practical introduction to the methods used for fMRI and EEG data analysis. During the EEG part of the course students will: - practice EEG data collection - perform full pipeline of EEG signal preprocessing with EEGlab - perform group-level statistical analysis using EEGlab, ERPlab and JASP - prepare ERP visualizations - learn to use mass univariate approach as an alternative for standard ERP component analysis - prepare basic MATLAB script for EEG preprocessing - present EEG data analysis results The fMRI part of the course will outline:

	1. the principles of MRI and functional MRI; 2. MRI safety 3. experimental design; 4. the concepts behind processing fMRI data, focusing on the techniques that are most commonly used in the field; 5. statistical analysis of fMRI data; 6. methods employed by common data analysis packages including SPM and Conn; 7. various applications of fMRI in neuroscience. Some of the newest cutting-edge techniques, including resting state network analysis, will be also discussed.
Learning outcomes	- discuss the use of fMRI and EEG in neuroscience as well as the design of studies and hypothesis testing with fMRI and EEG (K_W01; K_W02; K_W03; K_W06; K_W07; K_U01; K_K01) - understand the process of EEG and fMRI data collection (K_K02) - discuss safety issues related to MRI (K_W09) - develop some of the technical skills required to process and analyze these data (K_U04) - explain the cautions of EEG and fMRI data interpretation (K_K06) - present and discuss functional neuroimaging and neurophysiological data in a written format (K_U06; K_U07)
Learning activities and teaching methods	EEG: The lecture will be interspersed with hand-on exercises during which students will perform full range of activities associated with collecting and analyzing EEG signal. Participants will also perform group presentations of the results. fMRI: Power point presentations, movies, reading the course materials, labs, group projects
List of topics/classes and bibliography	EEG part: 1. EEG registration – 6x45 min hour workshop (Insitute of Psychology, PAS)j S.J. Luck „An Introduction to the Event-Related Potential Technique, Second Edition”: A Broad Overview of the Event-Related Potential Technique [ch. 1] The Design of ERP Experiments [ch. 4] Basic Principles of ERP Recording [ch. 5] 2. Single subject preprocessing – 8x45 min hour workshop (CENT)

S.J. Luck „An Introduction to the Event-Related Potential Technique, Second Edition”:
Artifact Rejection and Correction [ch. 6]
Basics of Fourier Analysis and Filtering [ch.7]
Baseline Correction, Averaging, and Time – Frequency Analysis [ch. 8]

3. Group level analysis – 8x45 min workshop (CENT)

S.J. Luck „An Introduction to the Event-Related Potential Technique, Second Edition”:
Quantifying ERP Amplitudes and Latencies [ch. 9]
Statistical Analysis [ch. 10]

4. EEG data visualization and presentation – 5x 45 min workshop (CENT)

S.J. Luck „An Introduction to the Event-Related Potential Technique, Second Edition”:
Reading, Writing, and Reviewing ERP Papers [ch. 15]

5. Student presentations – 3x45 min session (CENT)

fMRI part:
1. Principles of MRI and Functional MRI:
Brain energy metabolism and the physiological basis of the hemodynamic response, spatial and temporal resolution of fMRI
2. Experimental Designs: block design, event related design, mixed design

3. Preparing fMRI data for statistical analysis

4, 5 Statistical Analysis of fMRI data: introduction to GLM, individual and group analysis, connectivity (functional and effective connectivity)
6. Applications of fMRI in neuroscience
7. Resting-state fMRI
Bibliography:
Jenkinson, M., & Chappell, M. (2018). *Introduction to neuroimaging analysis*.
Glover G. H. (2011). Overview of functional magnetic resonance imaging. Neurosurgery clinics of North America, 22(2), 133–vii. doi:10.1016/j.nec.2010.11.001
Hasson, U., & Honey, C. J. (2012). Future trends in Neuroimaging: Neural processes as expressed within real-life contexts. NeuroImage, 62(2), 1272–1278. doi:10.1016/j.neuroimage.2012.02.004

	Williams, N., & Henson, R. N. (2018). Recent advances in functional neuroimaging analysis for cognitive neuroscience. Brain and Neuroscience Advances. https://doi.org/10.1177/2398212817752727 Bijsterbosch, J., Smith, S., & Beckmann, C. (2017). *An introduction to resting state fMRI functional connectivity*.
Assessment methods and criteria	For each part of the course: as a part of the examination students will be obliged to: 1/ preprocess raw data from a single subject 2/ perform second level analysis 3/ present results from 1/ and 2/ via a group (3-4 students per group) presentation
Attendance rules	Presence during each block of classes is required, absences due to the justified reasons will be addressed individually.
Prerequisites	Statistics and Research Design Methods in neuroscience Statistical skills enabling one to perform and interpret repeated measures ANOVA
Academic honesty	Students must respect the principles of academic integrity. Cheating and plagiarism (including copying work from other students, internet or other sources) are serious violations that are punishable and instructors are required to report all cases to the administration.
Remarks	-