Cognitive Neuroscience

This teaching programme covers relevant topics of Cognitive Neuroscience (CN) and reflects the research expertise of the Cognitive Neuroscience group at the Maastricht Brain Imaging Center (M-BIC). During theoretical core courses, students build a thorough understanding of how the brain perceives, feels, moves, learns and communicates. Specific course topics include auditory and visual perception, attention, cross-modal integration, speech processing and sensory motor functions. During the neuroimaging core course and skills trainings, students learn to translate this knowledge in empirical research by hands-on training in experimental design, and the measurement and interpretation of human brain activity using fMRI and EEG imaging techniques .

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See HSP

Title	**Problem-Based Learning**
Period	0
Code	PSY4950
ECTS credits	-
Organisational unit	Education Office
Coordinator	Wladimir van Mansum

Is equal to Research Master module PSY4251

Title	**Auditory and Higher Order Language Processing**
Period	1
Code	PSY4051
ECTS credits	4
Organisational unit	Cognitive Neuroscience
Coordinator	Bernadette Jansma
Descriptions	Although the human visual system has been studied extensively in cognitive neuroscience, so far only little is known about the auditory and speech system: How do we segregate the sound of a Ferrari from the background sounds of other running car engines, or the voice of a friend from that of many others in a crowd? How is auditory information integrated with other senses such as vision or touch? In the last few years cognitive neuroscience research has set a number of milestones in our understanding about how our brain manages these tasks. This knowledge is crucial because hearing and communicating with the environment and with others is one of the most essential human cognitive skills. This course aims to develop students' knowledge about the human auditory and speech system. The course starts with basic neural anatomy and considers how this might constrain but also assist auditory processing. Students learn about the basics of speech segregation and perception. Bottom-up and top-down processes are addressed. Finally, the course discusses how the human mind selects relevant auditory, visual and linguistic information in order to communicate.
Goals	Knowledge of: The basic cognitive and neural principles of auditory and speech processing; critical thinking with regard to research in the domain of auditory/speech processing; and employment of event-related potential (ERP) and fMRI studies.
Instruction language	EN
Prerequisites	
Recommended literature	E-reader
Teaching methods	Lecture(s) PBL
Assessment methods	Attendance Written exam
Key words	auditory processing, language comprehension, language production, cross modal integration

Is equal to Research Master module PSY4252

Title	**Perception and Attention**
Period	1
Code	PSY4052
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Peter De Weerd
Descriptions	The objective of the course is to present the current neuro-cognitive theories and experimental methods in the field of visual perception and attention. This will be achieved via discussion of a set of core papers in this field. Vision is a complex cognitive process which provides us with a richer stream of information than any other sense. The primate visual cortex is composed of at least 30 highly interconnected functionally specialised regions. The regions where visual information first enters the cortex are called early visual areas. Neurons in these areas have relatively simple properties, and their small receptive fields are arranged to form retinotopic maps of the environment on the cortex. Higher level visual processing occurs in a ventral and dorsal stream, each of which is composed of regions specialised for representation of more complex visual content (including motion, faces and places). This network of functionally specialised perceptual regions can adapt to the task that the organism is faced with. This is the case, for example, when looking for someone in a crowd and attending to one face at a time. There are many kinds of attention, but attention can be generally described as involving some type of information selection. In this course, neural mechanisms underlying prototypical examples of low and high level perception will be studied, as well as neural mechanisms underlying selective attention. The course will discuss both historically important papers, as well as more recent research in visual perception and attention, involving different empirical methods including psychophysics, neurophysiology, functional brain imaging and evoked potentials, with an emphasis on neurophysiology.
Goals	Knowledge of: Visual system (structure and function), low-level and high-level visual perception, visual attention, animal models perception and attention, neurophysiology and related methods, neurophysiology/psychophysics data analysis methods.
Instruction language	EN
Prerequisites	
Recommended literature	E-reader
Teaching methods	Lecture(s) PBL
Assessment methods	Attendance Written exam
Key words	visual system, illusions, perception, attention, neurophysiology, monkey.

1. PSY4034 EEG and ERP is almost equal to the Research Master module PSY4221 EEG and ERP (CN, NE, FN, NP);
*2. PSY4034 EEG and ERP be offered in the Master **CN** en DP.*

Title	**EEG and ERP**
Period	1
Code	PSY4034
ECTS credits	2
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Fren Smulders
Descriptions	Electroencephalography (EEG) and Event Related Potentials (ERP) offer a combination of precise measurements for the time course of brain processes. These are low cost, non-invasive measurements and are widely available. For these reasons they make a unique contribution to cognitive neuroscience. Scientific interest in EEG and ERP is growing, and results have been increasingly integrated with other neuro-imaging techniques during the last few decades. Lectures and basic literature provide an introduction for students to the basics of EEG and ERP research, EEG and ERP terminology and the possibilities and limitations of EEG and ERP. For a Midterm paper students study an empirical data article from the literature and answer questions about it's EEG and ERP methods and interpretation based on lectures, basic literature and other sources. Students also study practical measurement issues, such as electrode placement and types of artefacts. Finally, students must interpret the resulting data. Successful measurement requires an understanding of the basics of EEG and ERP signal analysis techniques, such as artefact management, spectral analysis, filtering, ERP averaging, time-frequency analysis etc. Students also receive hands-on training in smaller groups in running an ERP experiment, including electrode application, minimising artefacts, and health and safety in the lab. A number of simple experimental paradigms will be used that provide interesting and reliable results. Data processing will include a number of common EEG analyses, e.g. analyses in the time and frequency domain.
Goals	Knowledge of: Basic EEG/ERP paradigms, EEG recording systems, measurement settings, electrode application, data quality verification, analogue-digital conversion, basic EEG / ERP components, interpreting topographical plots, neural origins of EEG, time domain analysis, frequency domain analysis, time-frequency analysis, filtering, ocular artefact control, muscle artefact control, choice of reference, re-referencing.
Instruction language	EN
Prerequisites	none
Recommended literature	Journal articles, handbooks.
Teaching methods	Lecture(s) Paper(s) Skills Training(s) Work in subgroups
Assessment methods	Attendance Final paper
Key words	Electroencephalography (EEG), Event-related potentials (ERP), electrophysiology, measurement, analysis of brain potentials.

Is equal to Research Master module PSY4253

Title	**Neuroimaging: Functional MRI**
Period	2
Code	PSY4054
ECTS credits	4
Organisational unit	Cognitive Neuroscience
Coordinator	Elia Formisano
Descriptions	The investigation of human brain functions using a range of imaging methods (such as electro- and magneto- encephalography, Positron Emission Tomography and Magnetic Resonance Imaging) represents the most influential development in Cognitive Neuroscience in the last years. In this course, students will learn about the essential facts of functional Magnetic Resonance Imaging (fMRI). FMRI presents clear advantages over the other methods, particularly in terms of increased spatial resolution. Since its invention in 1992, fMRI has led to major advances in understanding the neural mechanisms that underlie higher levels of human mental activity and has established a strong link between cognitive psychology and neuroscientific research. The other Cognitive Neuroimaging programmes confront student with several applications of fMRI in specific cognitive domains (visual perception and attention, sensorimotor integration, auditory perception). In this course, however, students will gain a deeper knowledge of fundamental and methodological aspects of fMRI. The tasks will address questions such as: How can the fMRI signal be related to neural activity? How are functional images obtained with an MRI scanner? What do I need for performing a good fMRI measurement? How are "activation maps" created? Some of the tasks are directly linked to a practical part of the course and are intended to provide the necessary theoretical framework for the design, analysis, measurement and interpretation of results in fMRI investigations. Practical sessions on acquisition and analysis of fMRI data of cognitive functions such as auditory and visual processing will be integrated in to the group meetings.
Goals	Knowledge of: Nuclear Magnetic Resonance, Magnetic Resonance Imaging, functional MRI, physical basis (f)MRI, neurophysiologic basis fMRI, neuronal firing, local field potentials, blood oxygenation level dependent contrast, fMRI design, blocked designs, event related designs, fMRI analysis, motion correction, spatial and temporal filtering, univariate statistics, general linear models, single-subject statistics, multi-subject statistics, correction for multiple comparisons, false discovery rate, brain comparison and normalisation, Talairach transformation.
Instruction language	EN
Prerequisites	
Recommended literature	Huettel, S.A., Song, A.W., & McCarthy, G. (2009). *Functional Magnetic Resonance Imaging. (2nd ed.). Sunderland,* MA: Sinauer, Associates, Inc. Publishers; Jezzard, P., Matthews, P.M., & Smith, S.S. (2001*). Functional MRI: An introduction to methods.* Oxford, UK: Oxford University Press; Journal articles, book chapters.
Teaching methods	Lecture(s) PBL

Assessment methods	Attendance Written exam
Key words	functional neuroimaging, Magnetic Resonance Imaging, experimental design, analysis methods.

Is equal to Research Master module PSY4254

Title	**The Cognitive Neuroscience of Sensory and Motor Systems**
Period	2
Code	PSY4055
ECTS credits	4
Organisational unit	Cognitive Neuroscience
Coordinator	Joel Reithler, Amanda Kaas
Descriptions	Every day activities such a riding a bicycle, typing a summary and drinking a cup of coffee require the continuous interaction of brain systems that serve sensory perception and systems that control the body's muscles. In other words, most of the things people do require sensorimotor integration. In this course, several important aspects of sensorimotor integration in the brain will be studied, particularly in the context of visual perception. Since sensory perception (visual as well as auditory) is covered extensively in other courses, the main focus here will be on the motor system and in the transformation and processing of sensory information for motor control. Initially, basic processes are covered, such as types of motor control (since visual perception takes time, how should individuals use past information to control future actions?), the representations used by primary and secondary motor areas (which parameter is under ultimate control: muscle contractions, joint angles or whole movements?) and coordinate transformations (how to get from incoming visual information, coded with respect to our current eye position, to motor commands, coded with respect to our current body posture). Later in the course, the focus will shift to higher level issues such as motor learning, action selection and decision making, and predicting the actions of others. All topics will be discussed in the context of cognitive neuroscience research so that students learn how these topics can be investigated both with classical behavioural experiments and with modern techniques such as functional Magnetic Resonance Imaging.
Goals	Knowledge of: Processing involved in sensorimotor coordination, neural mechanisms behind sensorimotor integration, brain anatomy of action representations, neuro-behavioural correlates of motor learning, relevant research methods.
Instruction language	EN
Prerequisites	
Recommended literature	Journal articles, book chapters.
Teaching methods	Lecture(s) PBL
Assessment methods	Attendance Written exam
Key words	sensorimotor coordination, reference frames, coordinate transformations, mirror neuron system

Is equal in credits to the Research skills training PSY4227. In the Master's degree it is a practical training; in the RM it is a skills training

Title	**Practical training: fMRI**
Period	2
Code	PSY4056
ECTS credits	2
Organisational unit	Cognitive Neuroscience
Coordinator	Elia Formisano
Descriptions	The primary goal of this course is to provide hands-on experience in experimental design, acquisition and analysis of fMRI experiments. In the first tutorial, each student group will separately formulate an experimental question/hypothesis to be tested with fMRI and will select an appropriate experimental design. In a subsequent meeting, each group will give an oral presentation to the other groups. The proposal will comprise of an fMRI study. All studies are to be discussed and evaluated; at the end of the meeting one study is selected. In the group meetings and independent study, all students are involved in implementing the experimental set-up required for performing the selected study (e.g. selection and preparation of stimuli, implementation of the design) and participating in the fMRI measurements. During the latter course meetings, all students must perform the statistical analysis of the datasets. Assistance and prior preparation, especially in the implementation stage (stimulus programming) and data analysis stage (preparation of data in usable format for analysis in Brain Voyager QX), is provided by the tutors. Finally, students describe and discuss their findings in an individually written report.
Goals	Knowledge of: Experimental design, hypothesis formulation, operationalisation, fMRI blocked designs, fMRI event related designs, parameters for MRI scanning, MR safety and procedures, fMRI measurements, pre-processing fMRI data, statistical analysis fMRI data, results interpretation.
Instruction language	EN
Prerequisites	
Recommended literature	Huettel, S.A., Song, A.W., & McCarthy, G. (2009). *Functional Magnetic Resonance Imaging. (2nd ed.).* Sunderland, MA: Sinauer, Associates, Inc.; Jezzard, P., Matthews, P.M., & Smith, S.S. (2001). *Functional MRI: An introduction to methods*. Oxford, UK: Oxford; University Press; Journal articles, book chapters.
Teaching methods	Lecture(s) Presentation(s) Research Skills Work in subgroups Working visit(s)
Assessment methods	Attendance Final paper
Key words	functional MRI, experimental design, fMRI data acquisition, fMRI data analysis

See HSP

Title	**Academic Skills & Research Proposal**
Period	Period 3
Code	PSY4098
ECTS credits	5
Organisational unit	Clinical Psychological Science
Coordinator	Janneke Giesen/Dilana Schaafsma