Specialisation in Cognitive Neuroscience (CN)

The specialisation in Cognitive Neuroscience provides students with an extensive and in-depth knowledge of CN theories, cutting-edge neuroimaging and brain research. Students build a thorough understanding of how the brain perceives, feels, moves, learns and creates a conscious mind. Specific course topics range from basic principles of auditory and visual perception and sensory-motor functions, to higher cognitive functions such as attention, language, consciousness, learning and memory. Importantly, students learn to translate this knowledge in fundamental and applied (clinical) research. The CN program is embedded in the international and multidisciplinary environment of the Maastricht Brain Imaging Center (MBIC). This center offers a unique research infrastructure hosting the newest ultra-high field MRI scanning facilities, as well as fully equipped EEG, fNIRS and TMS laboratories. Students spend substantial amounts of time in these laboratories and receive extensive hands-on training in all aspects of the experimental cycle, including experimental design, recording and manipulating brain activation as well as advanced data analysis.

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Overview of RM in Cognitive Neuroscience (CN)

Period	Research Master's in Cognitive Neuroscience (CN) Year 1 (2015-2016): Milene Bonte
Period 0	Introduction week **PSY4950** Problem-Based Learning (training for non-UM students*) (- credits)
Period 1 31-08-2015 – 23-10-2015	**Core Courses: **** **PSY4251** Auditory and Higher Order Language Processing (4 credits): Bernadette Jansma **PSY4252** Perception and Attention (4 credits): Peter De Weerd **PSY4106** Advanced Statistics I (3 credits): Nick Broers *Practical training:* PSY4119 SPSS I and Lisrel: Nick Broers
	Skills training: **PSY4221** EEG and ERP (2 credits): Fren Smulders
Period 2 26-10-2015 – 18-12-2015	**Core courses:** **PSY4253** Neuroimaging: Functional MRI (4 credits): Elia Formisano **PSY4254** The Cognitive Neuroscience of Sensory and Motor Systems (4 credits): Joel Reithler, Amanda Kaas **PSY4106** Advanced Statistics I: Nick Broers *Practical training:* PSY4119 SPSS I and Lisrel: Nick Broers
	Skills training: **PSY4227** fMRI (2 credits): Elia Formisano
Christmas break	
Period 3 04-01-2016 29-01-2016	**Core course:** **PSY4216** Noninvasive Brain Stimulation (NIBS) (4 credits): Alexander Sack
	Skills training: **PSY4108** Neuroanatomy (1 credit): Jos Prickaerts
	Workshop: **PSY4233** Methods of Deactivation (1 credit): Teresa Schuhmann
	PSY4100 Colloquia (total of 1 credit): Milene Bonte, Arno Riedl, Jos Prickaerts, Eric Vuurman, Nancy Nicolson
Period 4 01-02-2016 01-04-2016	**Core course:** **PSY4215** Advanced fMRI (4 credits): Rainer Goebel **PSY4255** Brain Connectivity and Connectomics (4 credits): Alard Roebroeck, **PSY4107** Advanced Statistics II (total of 3 credits): Gerard van Breukelen *Practical training:* PSY4117 SPSS II: Gerard van Breukelen
	Workshop: **PSY4231** Real-Time fMRI and Neurofeedback (1 credit): Rainer Goebel
	Skills training: **PSY4228** Diffusion Weighted Imaging and Fibre Tracking (1 credit): Alard Roebroeck
	PSY4100 Colloquia: Milene Bonte, Arno Riedl, Jos Prickaerts, Eric Vuurman, Nancy Nicolson

Period 5 04-04-2016 – 27-05-2016	**Core course:** **PSY4257** Translational Neuroscience and beyond: from fundamental brain research to clinical and further applications (4 credits): Bettina Sorger **PSY4256** Timing Neural Processing with EEG and MEG (4 credits): Fren Smulders **PSY4107** Advanced Statistics II: Gerard van Breukelen *Practical training:* PSY4117 SPSS II: Gerard van Breukelen	
	Workshop: **PSY4110** Scientific Writing (1 credit): Jim Schumacher **PSY4237** Basic Mathematical Methods (2 credits): Giancarlo Valente	
	Skills training: **PSY4224** Programming in Matlab Basic Course (2 credits): Giancarlo Valente	
	PSY4100 Colloquia: Milene Bonte, Arno Riedl, Jos Prickaerts, Eric Vuurman, Nancy Nicolson	
Period 6 06-06-2016 01-07-2016	**Core course:** **PSY4257** Translational Neuroscience and beyond: from fundamental brain research to clinical and further applications: Bettina Sorger	
	Workshop: **PSY4112** Research Grant Writing Workshop (1 credit): Saartje Burgmans en Pauline Aalten	
	PSY4100 Colloquia: Milene Bonte, Arno Riedl, Jos Prickaerts, Eric Vuurman, Nancy Nicolson	

**Students from Erasmus Rotterdam receive an exemption for PBL training*
*** Electives: 3 credits,* throughout year 1: Vincent van de Ven

Period	**Research Master's in Cognitive Neuroscience (CN) Year 2**
Period 1 31-08-2015 – 23-10-2015	**Core course:** **PSY5112** Research Grant Writing Course (3 credits): Saartje Burgmans en Pauline Aalten **PSY5213** The Brain's Engram: Memorising Experiences and Experiencing Memory (4 credits): Vincent van de Ven, Peter de Weerd
	Workshop: **PSY5231** Signal Analysis (2 credits): Giancarlo Valente
	Skills training: **PSY5223** Programming in Matlab Advanced Course (1 credit): Giancarlo Valente
32 weeks	**PSY5107** Research proposal**, PSY5120/5121** Research internship **& PSY5103** master's thesis (50 credits): Sandra Mulkens

PSY4950 will be offered in all RM specialisations

Title	**Introduction in Problem-Based Learning**
Period	0
Code	PSY4950
ECTS credits	-
Organisational unit	Education Office
Coordinator	Wladimir van Mansum
Descriptions	The choice for Maastricht as a place to study also means a choice for an educational approach quite different to what is offered elsewhere. In Maastricht, education is based on the Problem-Based Learning (PBL) method. As opposed to other traditional educational approaches, Problem-Based Learning is not centred around the transfer of information from the lecturer to the student, but rather based on the learning process of the student. In small groups of approximately 12 members who meet once or twice weekly, students discuss specific problems in depth. These problems are formulated in such a way that students are led to pose all types of explanatory questions; e.g. how did the phenomenon presented come about? Based on this discussion, students formulate the subject matter to be studied. The PBL approach and group discussions stimulate students to acquire relevant knowledge, insight and skills relatively independently. This emphasis on self-motivation is a core feature of Problem-Based Learning. After individually acquiring the relevant knowledge, it is shared with the other group members and discussed. To get to know the basics of the way PBL groups work, this module addresses the way the problem are dealt with during the sessions: the 7-step approach. Also the skills needed to function within these groups are an important feature of this module. Working together as a team, making sure all group members get the opportunity to join the discussion. How to communicate with each other, taking into account the different backgrounds of all group members. And how to lead a discussion, as a student discussion leader during these sessions.
Goals	Getting to know the PBL system, the 7 step approach, functioning in groups. Communication skills, leading a discussion, reflecting on group processes, and own functioning as a group member
Instruction language	Eng
Prerequisites	
Recommended literature	
Teaching methods	PBL Training Work in subgroups
Assessment methods	Attendance
Key words	PBL, 7 step approach, communication skills, feedback, reflection

Colloquia

PSY4100 Colloquia will be offered in all RM specialisations.

Title	**Colloquia**
Period	3-6
Code	PSY4100
ECTS credits	1
Organisational unit	Cognitive Neuroscience (FPN), Department of Economics (SBE), Psychiatry and Neuropsychology (FHML), Neuropsychology and Psychopharmacology (FPN)
Coordinator	Milene Bonte, Arno Riedl, Jos Prickaerts, Eric Vuurman, Nancy Nicolson
Descriptions	Colloquia are presented per specialisation (CN, NE, FN, NP and PP) by senior researchers from the UM faculties or visiting guest lecturers. Each colloquium focuses in depth on one of a wide range of topics, with issues transcending the courses and specialisations. Each colloquium lecture will be followed by active discussion, prepared and chaired by the lecturer (the UM host may fill this role for guest lecturers). A total of ten colloquia will be offered during the first year.
Goals	Knowledge of: Key research domains from different specialisations, Interdisciplinary research, interacting with students from different specialisations.
Instruction language	EN
Prerequisites	
Recommended literature	
Teaching methods	Lecture(s)
Assessment methods	Attendance
Key words	interdisciplinary knowledge

Core courses

Is equal to the Master's module PSY4051

Title	**Auditory and Higher Order Language Processing**
Period	1
Code	PSY4251
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
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 the Master's module PSY4052

Title	**Perception and Attention**
Period	1
Code	PSY4252
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.

Title	**Advanced Statistics I**
Period	1 - 2
Code	PSY4106
ECTS credits	3
Organisational unit	Faculty Office (FPN)
Coordinator	Nick Broers
Descriptions	The course consists of six units. In the first four units, participants will be given an in-depth training in the following standard statistical methods: factorial ANOVA for between-subject designs, analysis of covariance (ANCOVA), multivariate ANOVA (MANOVA), discriminant analysis and multiple linear regression. Students are assumed to have background knowledge of balanced two-way factorial ANOVA and multiplere regression. These methods will be briefly reviewed. The following advanced topics will then be covered: unbalanced factorial designs, contrast analysis, interaction, simple slope analysis, dummy coding, centring covariates, different coding schemes, collinearity and residuals checks and data transformation. The distinction between confounders and mediators in regression and ANCOVA is also discussed, forming a bridge from regression to structural equations modelling (SEM). The latter is an advanced multivariate method that is gaining importance in psychology but still requires special software (such as Lisrel, EQS, AMOS or Mplus). SEM is introduced in two units, starting with causal modelling and mediation analysis in cross-sectional research and then extending to longitudinal research and latent variables (factors). Special attention is given to identifying models, model equivalence, global and local goodness of fit indices, parsimony, model modification and cross-validation. Some concepts from matrix algebra are needed for SEM, and these will be briefly discussed without going into technical detail.
Goals	Knowledge of: Oneway analysis of variance, contrast analysis, unbalanced designs, multivariate analysis of variance, discriminant analysis, linear regression with interaction terms, linear regression with dummy variables, data transformations, simple slope analysis, analysis of covariance, path analysis, structural equation modeling, confirmatory factor analysis, structural models with latent variables.
Instruction language	EN
Prerequisites	
Recommended literature	Diamantopoulos, A. (1994). Modelling with LISREL: A guide for the uninitiated. Journal of Marketing Management, 10, 105-136; Field, A. (2009). Discovering statistics using SPSS (3rd ed.). London: Sage; Howell, D.C. (2007). Statistical methods for psychology (6th ed.). Belmont (CA): Thomson/ Wadsworth; Kleinbaum, D.G., Kupper, L.L., Muller, K.E., & Nizam, A. (1998). Applied regression analysis and other multivariable methods (3rd ed.). Pacific Grove (CA): Brooks/Cole.
Teaching methods	Assignment(s) Lecture(s) Skills Training(s)
Assessment methods	Attendance Written exam

Key words	univariate analysis of variance, multivariatie analysis of variance, regression analysis, structural equation modeling

The practical training associated with PSY4106 Advanced Statistics I is PSY4119. Practical training: SPSS I and Lisrel will be offered in all RM specialisations.

Title	**Practical training: SPSS I and Lisrel**
Period	1-2
Code	PSY4119
ECTS credits	-
Organisational unit	Faculty Office (FPN)
Coordinator	Nick Broers
Descriptions	In order to make practical use of the statistical models that form the topic of the Advanced Statistics course, researchers must make use of statistical software. This course will utilise the traditional SPSS program, but also the specialised LISREL software. LISREL is a statistical program that allows structural equations models to be tested.
Goals	Defining contrasts, building regression models, doing multivariate analyses, transforming data, testing simple slopes, creating and testing SEM models
Instruction language	EN
Prerequisites	
Recommended literature	Handouts given during practicals.
Teaching methods	Assignment(s) Training(s)
Assessment methods	Attendance
Key words	SPSS, LISREL, statistical software

Is equal to the Master's module PSY4054

Title	**Neuroimaging: Functional MRI**
Period	2
Code	PSY4253
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
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 the Master's module PSY4055

Title	**The Cognitive Neuroscience of Sensory and Motor Systems**
Period	2
Code	PSY4254
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Joel Reithler, Amanda Kaas
Descriptions	Every day activities such as 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, in the context of visual and somatosensory perception. Since sensory perception (visual as well as auditory) is covered extensively in other courses, the main focus here will be on the somatosensory and motor system as well as on the transformation and processing of sensory information for motor control. Initially, basic processes are covered, such as the representations used by primary and secondary somatosensory and motor areas (which parameters are represented e.g. muscle contractions, joint angles or whole movements?), types of motor control (since processing perceptual feedback takes time, how should individuals use past information to control future actions?) 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	Somatosensory perception, sensorimotor coordination, reference frames, coordinate transformations, motor learning, mirror neuron system

PSY4216 is the same for CN and NE.

Title	**Noninvasive Brain Stimulation (NIBS)**
Period	3
Code	PSY4216
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Alexander Sack
Descriptions	This course will provide students with an in-depth knowledge of; noninvasive brain stimulation techniques, including transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS). Students will learn more about the mechanisms of action; the physico-physiological principles; various application protocols; functional brain stimulation paradigms and approaches for combining brain stimulation with brain imaging techniques both within and between experimental session(s). Since the very beginning of experimental brain research, neuro-scientists have dreamed about not only observing the brain at work, but actually changing and modulating the neuronal activity in the brain without causing harm to patients or subjects. With the development of noninvasive brain stimulation (NIBS) it is now possible to reach into the skull of a patient or healthy subject and to temporarily alter brain activity at a specific location. This possibility opens the door to a wide range of experimental and clinical applications. In combination with methods of functional imaging, it is not only possible to measure the brain activity during the execution of a particular function, but NIBS enables the researcher or clinician to increase or decrease the neuronal activity in the task-related brain area and reveal behavioural changes in the actual task performance. This enables identification of those brain areas that are functionally relevant to a particular function. In a clinical context, NIBS has also been used to treat neurological, psychiatric, and psychological disorders that are accompanied by a pathologically increased or decreased activity in a specific brain region. Since NIBS offers the possibility to increase or decrease neuronal activity beyond the stimulation itself, it might, in the future, become a powerful therapeutic tool to help treat diseases like depression, epilepsy, or schizophrenia.
Goals	Knowledge of: Physics and mechanisms of action of NIBS, physiological effects of NIBS, NIBS protocols and application paradigms, NIBS in human cognitive neuroscience, combining NIBS with functional imaging, clinical applications of NIBS.
Instruction language	EN
Prerequisites	
Recommended literature	Journal articles.
Teaching methods	Assignment(s) Lecture(s) Presentation(s) Work in subgroups PBL
Assessment methods	Attendance Presentation Written exam
Key words	non-invasive brain stimulation, functional magnetic brain interference, multi-modal imaging.

Title	**Brain Connectivity and Connectomics**
Period	4
Code	PSY4255
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Alard Roebroeck
Descriptions	This course introduces the fields of human brain connectivity and connectomics. The human brain is one of the largest and most complex biological networks known to exist. It contains about 85 billion neurons each making on average *ten thousand* connections with other neurons. Today, the map or annotated graph of all connections in the brain is called the connectome and the emerging field of connectomics endeavours to measure and understand the connectome. It has become increasingly clear over a century of neuroscience endeavours since Ramon y Cajal that the particular organisation of brain *connectivity* plays a crucial role in enabling human abilities. Two general principles of this organisation became clear early on and remain important to this day: i) the multi-scale organization of brain connectivity (from macroscale white matter organization to microscale cortical circuits) and ii) the interplay between structure and function (with structure determining function and function driving structural plasticity). With recent advances in methods, neuroimaging investigations of human perception and cognition are increasingly interpreted in terms of connectivity, inter-areal interactions and cortical circuit computations. This course will discuss both structural connectivity and functional interactions, with an emphasis on the human brain, and how these can be measured and analysed in cognitive neuroscience experiments. The different spatial and temporal scales at which connectivity is organized will be treated in depth, with an emphasis on neuroanatomy of layered cortical circuits and the large scale organization of white matter fiber tracts.
Goals	Knowledge of: Structural connectivity, Functional connectivity, Effective connectivity, Resting state experiments and networks, Layers in the neocortex, Cytoarchitecture, Myeloarchitecture, Receptor architecture, Canonical cortical microcircuits, Cortical computation, Realistic neural network models, Diffusion MRI tractography and connectomics, Graph analysis, Connectivity analyses in fMRI and M/EEG, Independent Component Analysis , Granger causality, Dynamic Causal Modeling, Histology and microscopy, Tracer studies, Polarized Light Imaging, White matter organization, Myelination, White matter plasticity
Instruction language	EN
Prerequisites	
Recommended literature	Journal articles, book chapters.
Teaching methods	Lecture(s) Paper(s) Presentation(s)
Assessment methods	Attendance Written exam
Key words	Brain connectivity, Connectomics, Functional connectivity, Effective connectivity, Cortical microcircuits, White matter organization

Title	**Advanced fMRI**
Period	4
Code	PSY4215
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Rainer Goebel
Descriptions	Building on the course Neuroimaging, this course will examine advanced topics of fMRI methodology and applications. In the first week, students learn how knowledge about vascular effects may help to detect BOLD artefacts. In the second week, the principles of real-time fMRI will be presented. This is followed by an overview of fMRI neurofeedback studies and a discussion of its use as a new therapeutic tool. In addition, machine learning techniques for the real-time decoding of mental states and the application of these techniques in brain-computer interfaces will be discussed. In the third week, students examine advanced methods to establish correspondence between different brains. This includes a discussion of the importance of brain normalisation for random-effects statistical analysis, creation of probabilistic atlases and meta-analyses. In the fourth week, the possibilities and challenges of ultra-high field fMRI will be discussed focusing on studies with sub-millimeter spatial resolution aiming to unravel the columnar and laminar organization of the cortex.
Goals	Knowledge of: Effects of vascular system on the interpretability of the BOLD fMRI signal; real time fMRI data analysis during ongoing experiments; possibilities and limitations of fMRI-based brain-computer interfaces (BCIs); fMRI neurofeedback training as a new therapeutic tool; real-time decoding of mental states; advanced methods of brain normalisation; opportunities and challenges of high-resolution fMRI at ultra-high magnetic field strengths.
Instruction language	EN
Prerequisites	Research master course 'Neuroimaging'
Recommended literature	Journal articles, book chapters.
Teaching methods	Paper(s) PBL Presentation(s)
Assessment methods	Attendance Presentation Written exam
Key words	neurovascular coupling, real-time fMRI, neurofeedback, BCI, brain normalisation, ultra-high field fMRI, columnar-level imaging, cortical layers

PSY4107 Advanced Statistics II will be offered in all RM specialisations.

Title	**Advanced Statistics II**
Period	4-5
Code	PSY4107
ECTS credits	3
Organisational unit	Faculty Office (FPN)
Coordinator	Gerard van Breukelen
Descriptions	The course consists of seven units. The first three units cover classical repeated measures ANOVA for the one- and two-way within-subject design and the split-plot (between x within) design. Special attention is given to: a) the choice between multivariate and univariate data formats and method of analysis, and the sphericity assumption; b) the distinction between the within-subjects and between-subjects part of a split-plot ANOVA, and how to obtain both using regression analysis; c) the surprising consequences of including covariates into repeated measures ANOVA; and d) the choice between different methods of analysis for randomised versus non-randomised group comparisons. Subsequently, a further three units are devoted to mixed (multilevel) regression for nested designs and longitudinal studies. This mixed regression starts with a unit on marginal models for repeated measures as an alternative to repeated measures ANOVA in cases of missing data or within-subject covariates. Students are shown the pros and cons of various models for the correlational structure of repeated measures, such as compound symmetry and AR1. The second unit covers the random intercept model for repeated measures as a method to include individual effects in marginal models for longitudinal data (growth curves) or single trial analyses of lab data (response times, ERP, fMRI). Students learn how this can be combined with e.g. ARMA modelling to distinguish between interpersonal and intrapersonal outcome variation. The random intercept model will also be applied to a cluster randomised trial, i.e. an RCT where organisations like schools or companies instead of individuals are randomised. The third and last unit on mixed regression covers random slope models for longitudinal data (individual differences in change over time), single trial analysis (individual differences in stimulus effects) and multicentre trials (RCT within each of a number of organisations). Finally, the topic of optimal design, sample size and power calculations is introduced in a seventh unit.
Goals	Knowledge of: Repeated measures ANOVA for within-subject and split-plot (between x within) designs, including factorial designs and covariates in repeated measures ANOVA; Mixed (multilevel) linear regression with random effects and autocorrelation; Optimal design and sample size calculations for experimental and observational studies.
Instruction language	EN
Prerequisites	Good understanding of descriptive and inferential statistics at the elementary and intermediate level, including t-tests, factorial ANOVA and multiple linear regression. Skilled in the use of SPSS for statistical data analyses.
Recommended literature	Lecture handouts and a suitable book chapter or article per unit.
Teaching methods	Assignment(s) Lecture(s)

	Training(s)
Assessment methods	Attendance Written exam
Key words	within-subject designs, repeated measures ANOVA, mixed (multilevel) regression, marginal versus random effects models, optimal design, sample size, power

The practical training associated with PSY4107 Advanced Statistics II is PSY4117. Practical training SPSS II will be offered in all RM specialisations

Title	**Practical training: SPSS II**
Period	4-5
Code	PSY4117
ECTS credits	-
Organisational unit	Faculty Office (FPN)
Coordinator	Gerard van Breukelen
Descriptions	This practical training forms part of the PSY4107 Advanced Statistics II course. The practical consists of six sessions in the computer rooms in which SPSS procedures for repeated measures and multilevel data are practised. The goal is to understand how proper analyses of such data can be done using SPSS.
Goals	Knowledge of: How to run with SPSS: repeated measures ANOVA for within-subject and split-plot (between x within) designs, including factorial designs and covariates; How to run SPSS for: mixed (multilevel) linear regression with random effects and autocorrelation.
Instruction language	EN
Prerequisites	Good understanding of descriptive and inferential statistics at the elementary and intermediate level, including t-tests, factorial ANOVA and multiple linear regression. Skilled in the use of SPSS for statistical data analyses.
Recommended literature	Field A (2009). Discovering statistics with SPSS (3rd ed.). London: Sage, plus the mandatory assignments on EleUM.
Teaching methods	Training(s)
Assessment methods	Attendance
Key words	within-subject designs, repeated measures ANOVA, mixed (multilevel) regression, marginal versus random effects models

PSY4256 is the same for CN and NE.

Title	Timing Neural Processing with EEG and MEG
Period	5
Code	PSY4256
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Fren Smulders
Descriptions	Cognitive neuroscientists can currently choose from a range of different imaging methods to investigate human brain function. Each of these methods has its own strengths and limitations, which determine its suitability for studying a particular research question. Both electroencephalography (EEG) and magnetoencephalography (MEG) are important in characterising the time course of activation of neural systems involved in perceptual and cognitive processes. Relevant topics include auditory and visual perception, attention, language, memory and their development. EEG and MEG signals reflect complementary aspects of brain activity, with MEG having some advantages over EEG in the localisation of underlying neural sources. This course provides detailed knowledge on EEG and MEG, both of which have a clear advantage over other neuroimaging methods in terms of temporal precision. The study of EEG and MEG experimental design, data acquisition and data analysis will be combined with detailed literature discussions on theoretical and methodological issues. Based on different types of empirical questions, there will be discussion of the potential of a range of methods for advanced EEG and MEG analysis, including analysis in the time and frequency domain, source localisation, the combination with functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation (TMS) methods, independent component analysis and analyses of functional connectivity.
Goals	Knowledge of: Electro-encephalography, event-related potentials, magneto-encephalography, dipole source analysis, distributed source analysis, Fourier analysis, wavelet analysis, independent component analysis, connectivity analysis, application: mental chronometry, attention, lateralised event-related potentials, combination electro-encephalography and functional magnetic resonance imaging, combination electro-encephalography and trans-cranial magnetic stimulation.
Instruction language	EN
Prerequisites	
Recommended literature	Journal articles, book chapters.
Teaching methods	Lectures Paper Presentation Working visit PBL
Assessment methods	Attendance Final paper Presentation
Key words	electroencephalography, magnetoencephalography, biological signal analysis, source localisation

Title	**Translational Neuroscience and beyond: from fundamental brain research to clinical and further applications**
Period	5 and 6
Code	PSY4257
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Bettina Sorger
Descriptions	Translational Neuroscience aims at expanding our understanding of brain structure, function, and disease in order to finally translate this knowledge into clinical applications and novel diagnostics and therapies of nervous system disorders. After the students had been introduced with the main state-of-the-art neuroimaging methods (EEG, TMS, [real-time] fMRI, DWI *etc.*) in previous courses and workshops, this core course focuses on the (multi-modal) application of these neuroscientific tools in one particular context: the neuroscientific investigation of (disorders of) consciousness and the development of related clinical neuroscientific applications (diagnostics and treatment). After a general introduction to Translational Neuroscience, the students will look at the concept of consciousness from various perspectives (philosophical, psychological, neuroscientific *etc.*). They will discuss questions like “How can we study consciousness?” and “What is a neural correlate of consciousness?” After several theories and empirical studies of (healthy) consciousness will have been addressed, the students will be familiarized with the different disorders of consciousness. Then, the students will present and critically review several Translational Neuroscience (including brain-computer interface) studies focusing on improving diagnostics and treatment for patients with disorders of consciousness. At the end of the course, we will discuss (un-)related novel ideas for Translations Neuroscience research.
Goals	Knowledge of: Introduction to Translational Neuroscience, Intensive discussion of Translational Neuroscience possibilities in the context of studying consciousness and its disorders, Critical evaluation of empirical Translational Neuroscience articles, Practical application of methodological knowledge in a clinical context, Generation of own Translational Neuroscience ideas
Instruction language	English
Prerequisites	
Recommended literature	Journal articles
Teaching methods	Presentation(s) Assignment(s) PBL
Assessment methods	Attendance Presentation Final paper
Key words	Translational Neuroscience, Clinical Neuroscience, consciousness, neural correlates of consciousness, disorders of consciousness, brain imaging methods, brain-computer interfacing

PSY5112 Research Grant Writing Course will be offered in all RM specialisations.

Title	**Research Grant Writing Course**
Period	1
Code	PSY5112
ECTS credits	3
Organisational unit	Neuropsychology and Psychopharmacology (FPN)
Coordinator	Saartje Burgmans en Pauline Aalten
Descriptions	In this course, students will apply what they have learned during the Research Grant Writing Workshop (PSY4112). Students will work together (groups of max. 5) to write a research proposal on their selected topic, including an original research hypothesis, experimental design and methods. This proposal should promote interdisciplinarity; therefore students are encouraged to think across boundaries of different scientific fields. A senior researcher will guide students during this writing process. The students will write their proposal in 3 steps, and they will receive feedback from their mentor and peers. The resulting proposals will be presented during a symposium by way of a poster or an oral presentation.
Goals	Knowledge of how to: Review literature, formulate a research hypothesis, design a research study, write a research proposal, present the proposal at a symposium (oral or poster).
Instruction language	EN
Prerequisites	This course is a continuation of the Research Grant Writing Workshop (PSY4112).
Recommended literature	
Teaching methods	Work in subgroups
Assessment methods	Attendance Final paper Presentation
Key words	research proposal, interdisciplinary, hypothesis, design, methods, research symposium, peer review

Title	**The Brain's Engram: Memorising Experiences and Experiencing Memory**
Period	1
Code	PSY5213
ECTS credits	4
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Vincent van de Ven, Peter de Weerd
Descriptions	The brain is able to retain a myriad of perceptual experiences in the memory for shorter and longer durations of time. Memory formation requires the selection of relevant items in working memory, and the consolidation of the experience into a lasting neural representation. At the same time, memory retrieval appears to involve the reactivation of the neural processes of memory formation. In this course, students will discuss the neuroscience of working memory and episodic memory, and in how far these types of memory rely on similar neural mechanisms and brain networks. The role of prefrontal cortex as well as the hippocampal complex in memory formation and retrieval will be discussed in detail. The literature comprises cutting-edge empirical research papers from various neuroscience disciplines, including cognitive neuroimaging, neurophysiological recording, pharmacological manipulation and neurobiological fields.
Goals	Knowledge of: neuroscience of memory formation, consolidation and retrieval; Hippocampal anatomy and function; neurophysiology of memory; neuroscience methods; brain activity and connectivity; fleshing out cutting-edge empirical research papers
Instruction language	EN
Prerequisites	
Recommended literature	
Teaching methods	Lecture(s) Paper(s) PBL Presentation(s) Work in subgroups
Assessment methods	Attendance Written exam
Key words	working memory, episodic memory, hippocampus, prefrontal cortex, neurophysiology, LTP, consolidation, reactivation, neuroscience

Skills training

1. PSY4221 EEG and ERP is equal to the Master's module PSY4034 EEG and ERP (DP & CN)
2. PSY4221 EEG and ERP (in CN, NE, FN, NP. In NP it will be offered as an Elective)

Title	**EEG and ERP**
Period	1
Code	PSY4221
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 in credits to the Master's course PSY4056. In the Master's degree it is a practical training; in the RM it is a skills training.

Title	**fMRI**
Period	2
Code	PSY4227
ECTS credits	2
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Elia Formisano
Descriptions	The primary goal is to provide hands-on experience in experimental design, acquisition and analysis of fMRI experiments. In the first tutorial, each student group separately formulates an experimental question/hypothesis to be tested with fMRI and elaborates an appropriate experimental design. In a subsequent meeting, each group present to the other groups (in an oral presentation) its proposal for an fMRI study and all studies are 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. In the last meetings, all students 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

PSY4108 Neuroanatomy will be offered in CN, NE, NP and PP

Title	**Neuroanatomy**
Period	3
Code	PSY4108
ECTS credits	1
Organisational unit	Psychiatry and Neuropsychology (FHML)
Coordinator	Jos Prickaerts
Descriptions	The aim of this practical training is to make you acquainted with the neuroanatomical terminology and to gain insight into the spatial and functional organisation of the brain. It is essential to have a basic knowledge of the brain anatomy when working in the field of neuropsychology or neurobiology. Many specific brain areas can be linked to particular functions. Thus, knowledge of the brain anatomy and its main functions allows direct linkage of specific neurological or psychiatric disorders to particular brain areas. After a short theoretical introduction, you will study whole brains and brain material of mammals at both macroscopical (visual inspection) and microscopical level. The emphasis will be on major brain systems, including the basal ganglia and limbic system.
Goals	Knowledge of: Limbic system, basal ganglia, plastinated human brains, brain dissection, microscopical slices.
Instruction language	EN
Prerequisites	
Recommended literature	Papers from scientific journals and book chapters from books are provided.
Teaching methods	Lecture(s) Skills Work in subgroups
Assessment methods	Attendance Written exam
Key words	neuroanatomy, limbic system, basal ganglia

Title	**Diffusion Weighted Imaging and Fibre Tracking**
Period	4
Code	PSY4228
ECTS credits	1
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Alard Roebroeck
Descriptions	Diffusion weighted imaging and fibre tracking are a set of techniques that use the Magnetic Resonance (MR) scanner to probe fibre-bundles which connect different regions of the brain. Thus, instead of the cerebral grey matter, it is the white matter that is the object of study. The connections between brain-regions are the substrate of the interaction and communication between different brain systems. Thus, knowledge about the anatomy of these anatomical connections is of great importance to cognitive neuroscientists. The anatomy of fibre-tracts is imaged indirectly, by measuring the diffusion of water in the brain. Water diffuses more easily in a parallel way rather than perpendicular to the direction of surrounding axon bundles. Thus, by measuring the direction of local diffusion of water, inferences about the trajectories of fibre-bundles can be drawn. After completing this training, student will have knowledge of: i) how the MR scanner can be made sensitive to directed diffusion of water and how the resulting diffusion weighted images can be processed; ii) different models for local water diffusion within a voxel, along with useful quantities that can be derived from these models; iii) fibre tracking or tractography- how to get from local models of water diffusion to measures of global connectivity between brain regions. Furthermore, student will gain hands-on experience in analysing and visualising diffusion weighted MR data and in using tractography algorithms and assessing the results.
Goals	Knowledge of: How to make the MR scanner sensitive to directed diffusion of water and how the resulting diffusion weighted images can be processed; different models for local water diffusion within a voxel, along with useful quantities that can be derived from these models; fibre tracking or tractography - how to get from local models of water diffusion to measures of global connectivity between brain regions.
Instruction language	EN
Prerequisites	
Recommended literature	Journal articles, handouts.
Teaching methods	Assignment(s) Lecture(s) Skills Training(s)
Assessment methods	Assignment Attendance
Key words	diffusion, MRI, DTI, tractography

PSY4224 is the same for CN and NE

Title	**Programming in Matlab Basic Course**
Period	5
Code	PSY4224
ECTS credits	2
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Giancarlo Valente
Descriptions	Matlab provides a powerful environment for numerical computation, data analysis and visualisation. It is, in essence, a programming environment that has built-in primitives for common scientific tasks that in other languages, such as C or Pascal, require many operations. Examples are tasks such as matrix algebra (used in statistical analysis of data), Fourier transforms (used in signal processing) and 2D or 3D plots for visualisation of data or analysis-results. Many complete packages for the analysis of cognitive neuroimaging data (e.g. fMRI data or EEG/MEG data) are implemented in Matlab. Thus, usage of these packages requires at least a basic understanding of Matlab. Furthermore, if more advanced analysis or visualisation is needed than what is offered by existing packages, developing new functionalities in Matlab is often the most convenient option. The first part of the course will deal with how Matlab primarily represents and processes data, i.e. as matrices. Subsequently, attention is focused on the usage of the environment: the prompt; the workspace; the help options; and loading, saving and visualising data. The principles behind programming will be introduced, with particular emphasis on neuroimaging applications.
Goals	Knowledge of: Matlab environment, Matlab variables, vectors, matrices, matrix algebra, 2D and 3D plots, conditional loops, scripts, functions, file Input-Output, structures, cells.
Instruction language	EN
Prerequisites	
Recommended literature	Andrew Knight – Basics of Matlab and beyond – Chapman and Hall/CRC, (Selected Chapters); Wallisch et al. Matlab for Neuroscientists , Associated Press (Selected Chapters)
Teaching methods	Assignment(s) Lecture(s) Skills Work in subgroups
Assessment methods	Attendance Take home exam
Key words	programming principles, scripts and functions, data analysis

Title	**Programming in Matlab Advanced Course**
Period	1
Code	PSY5223
ECTS credits	1
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Giancarlo Valente
Descriptions	This course deals with advanced topics in Matlab programming. In particular, it will focus on how to implement efficient and re-usable programs for neuroimaging applications. Students will learn how to put the principles of efficient programming, such as debugging and profiling, into practice. Advanced topics in graphics and user interfaces will also be discussed.
Goals	Knowledge of: Debugging, efficient programming, graphical objects, graphical user interfaces.
Instruction language	EN
Prerequisites	PSY4224 Programming in Matlab Basic Course
Recommended literature	Material provided by the coordinator.
Teaching methods	Assignment(s) Lecture(s) Skills Work in subgroups
Assessment methods	Attendance Take home exam
Key words	efficient programming, debugging, graphical user interfaces

Methodological and technical workshops

*PSY4233 is the same for **CN** and NE.*

Title	**Methods of Deactivation**
Period	3
Code	PSY4233
ECTS credits	1
Organisational unit	Cognitive Neuroscience (FPN)
Coordinators	Teresa Schuhmann
Descriptions	In three consecutive practical training sessions, students acquire direct hands-on experience with non-invasive magnetic brain stimulation (transcranial magnetic stimulation (TMS)). Students learn how to use the brain stimulator devices, how to evoke muscle responses and how to induce visual experiences. Students act as both the experimenter, applying the brain stimulation, and the participant, receiving the magnetic pulses. Practical I: Technical introduction/motor thresholds/motor excitability Practical II: TMS-induced visual experiences (phosphenes) Practical III: TMS Neuronavigation (frameless stereotaxy) There are a variety of ways in which activity in a brain region can be prevented or influenced. Some studies use anatomical lesion methods (in animals), while others use reversible methods such as cooling, and pharmacological or genetic manipulations in animals, or TMS in human participants. The training will end with a lecture that provides an overview of these different methodologies, including a discussion of the advantages and limitations of the different techniques and of the issues related to data interpretation.
Goals	Knowledge of: Transcranial magnetic stimulation, application of TMS, motor threshold determination, phosphene threshold determination, Neuronavigation, cooling, various other deactivation methods.
Instruction language	EN
Prerequisites	
Recommended literature	Journal articles, book chapters.
Teaching methods	Assignment(s) Lecture(s) Skills Training(s)
Assessment methods	Attendance Assignment
Key words	Transcranial magnetic stimulation, Non-invasive brain stimulation, fMRI-guided Neuronavigation

Title	**Real-time fMRI and Neurofeedback**
Period	4
Code	PSY4231
ECTS credits	1
Organisational unit	Cognitive Neuroscience (FPN)
Coordinators	Rainer Goebel and Bettina Sorger
Descriptions	Recent progress in computer hard- and software allows real-time analysis of functional magnetic resonance imaging (fMRI) data which provides the basis for brain-computer interface (BCI) applications such as neurofeedback, control of external devices and motor-independent communication. In fMRI-based neurofeedback studies, subjects can observe representations of their own brain activitivation while being measured in the MRI scanner. FMRI-based neurofeedback is performed by reading, analysing and visualising the hemodynamic brain signals in real-time during an ongoing experiment. This real-time approach is in contrast to the standard analysis approach in which the huge amount of incoming fMRI signals are recorded first and then analysed hours or days after the experiment. During this workshop, there will be an introduction into the real-time fMRI methodology and a discussion of fMRI neurofeedback applications which have demonstrated that with sufficient practice, subjects are indeed able to learn to modulate activity in certain brain areas. These results are extremely important for basic neuroscience research, because they allow researchers to study the degree to which the brain can modulate its own activity and to potentially unravel the function of *hitherto* unknown brain areas. Neurofeedback research also touches on deep philosophical issues, such as the neural correlates of free will. It might also be possible in the future to help people with pain or depression by regulating at will neural activity in relevant brain areas. In fMRI-based communication studies, activation patterns evoked by participants are ‘decoded’ and interpreted online, e.g. as letters of the alphabet, offering the possibility for people with severe motor impairments to ‘write’ letters purely controlled by mental imagery. In this workshop, a number of online analysis strategies will be discussed for decoding mental states, including analysis of the mean signal of regions-of-interest (ROIs) and the use of pattern classifiers operating at the voxel level.
Goals	Knowledge of: Principles of real-time fMRI, setup and conduction of real-time fMRI experiments, serving as subjects (two students) in a real-time BCI session, basics of real-time fMRI data analysis (Turbo-BrainVoyager software).
Instruction language	EN
Prerequisites	
Recommended literature	Articles and a user’s guide for the real-time analysis software.
Teaching methods	Lecture Work in subgroups
Assessment methods	Attendance Final paper
Key words	real-time fMRI, neurofeedback, brain-computer interface (BCI), brain reading

Scientific Writing will be offered in all RM specialisations. Offering times vary according to RM specialisation:
CN: Period 5
NE: Period 5
NP: Period 5
FN: Period 1 other PSY 4113
PP: Period 1 other PSY 4113

Title	**Scientific Writing**
Period	5
Code	PSY4110
ECTS credits	1
Organisational unit	Maastricht University Language Centre
Coordinator	Jim Schumacher
Descriptions	The course is delivered in a series of one lecture and four tutorials, during which students produce and revise a short research proposal or research article. The lecture aims to cover the ethical issues surrounding the production of scientific texts (for example, plagiarism and non-biased writing). In tutorials students apply principles in the linguistic sense and discover how these apply to their own writing. In particular, the 'doors and windows' (abstracts, introductions, hypotheses and discussions) of scientific papers are analysed for their linguistic and stylistic content. In the tutorials, students develop the language awareness and critical skills required to review their own work as well as that of their peers. Individual feedback on parallel block assignments is given at the end of the course by the instructor.
Goals	Knowledge of: Principles of scientific writing, conventions in scientific writing, the structure of scientific texts, ethics in scientific writing, plagiarism, editing skills, ethics, language in scientific writing, academic writing style, coherence in scientific writing, reporting sources.
Instruction language	EN
Prerequisites	
Recommended literature	Literature is provided in the course materials.
Teaching methods	Assignment(s) Lecture Paper(s) Research Skills Training(s) Work in subgroups
Assessment methods	Attendance Final paper
Key words	Scientific writing, research proposal, empirical research article, literature review, peer review, language awareness.

Title	**Basic Mathematical Methods**
Period	5
Code	PSY4237
ECTS credits	2
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Giancarlo Valente
Descriptions	Neuroscientific research has greatly benefited from recent developments in data analysis methods. The aim of this course is to provide participants with the basic 'tools' needed to gain a better understanding of the data analysis methodologies and to help them develop methods and strategies to tackle their research problems. The course will cover the basic aspects of number representation, with an emphasis on complex numbers, needed for Fourier analysis, and will then focus on basic algebra. The course will cover in detail vectors and matrices and their operations, including sums, products, inversion and eigenvalue decomposition and linear systems of equations. The course will also focus on the basic concepts of calculus, including infinitesimals, differential and integral calculus. Each session of the course has a practical component attached, in which the participants solve, with the aid of the tutor, a number of exercises. These are both pen-and-paper and MATLAB computer-based exercises. Furthermore, a selected range of applications of the illustrated concepts in the field of neuroscience are provided throughout the course.
Goals	Knowledge of: Trigonometry, exponentials and logarithms, complex numbers, polar representation, functions of one variable, algebra, solution of a system of linear equations.
Instruction language	EN
Prerequisites	
Recommended literature	Material provided by the coordinator.
Teaching methods	Assignment(s) Lecture(s) Skills Work in subgroups
Assessment methods	Attendance Take home exam
Key words	algebra, complex numbers, pre-calculus

PSY4112 Research Grant Writing Workshop will be offered in all RM specialisations.

Title	**Research Grant Writing Workshop**
Period	6
Code	PSY4112
ECTS credits	1
Organisational unit	Neuropsychology and Psychopharmacology (FPN)
Coordinator	Saartje Burgmans en Pauline Aalten
Descriptions	During this workshop students will learn why and how to apply for research grants. The need for acquiring funding for research, the opportunities for, and availability of grant application funding will be discussed. Several researchers who have experience in applying for different types of grants will provide students with first-hand knowledge and tips. Students will learn fundamentals of good grant writing, general preparation of the grant application and how to deal with reviewer comments. These skills will be practiced during the workshop. Students will subsequently choose a topic (provided by senior researchers) on which they will write a research proposal during the second-year Research Grant Writing Course (see description of PSY5112).
Goals	Knowledge of: Opportunities for funding, how grants can be acquired, grant writing skills.
Instruction language	EN
Prerequisites	
Recommended literature	
Teaching methods	Assignments Lecture(s)
Assessment methods	Attendance Final paper
Key words	funding possibilities, grant applications, proposal writing

Title	**Signal Analysis**
Period	1
Code	PSY5231
ECTS credits	2
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Giancarlo Valente
Descriptions	Traditional and advanced statistics provide essential knowledge and tools for the correct formulation of scientific inferences and for summarising a research work. Nonetheless, modern techniques in neuroscience research have strongly increased the amount of information that can be extracted from experimental data and analysed, especially on account of the improved spatial and temporal resolution of the acquisition methods. Most of the new information can be recovered by including in the statistical modelling the 'signal' structure of the data, generally due to the physical dimensions of data, time and space. This Signal Analysis course introduces the practical implementation of the traditional and latest research approaches to time and space signal analysis in the context of neuroscience research. The course focuses on time series analysis from one- and multi-dimensional data. The basics of discrete time and space signal acquisition and modelling are presented and discussed in their practical neuroscience applications. The course has the objective to provide the participants with an operational understanding of the classical signal analysis techniques like preprocessing, analysis in the frequency, time and amplitude domains, Fourier series, Fourier Transform and FFT, spectral analysis, linear system theory and implementation of filters in time and frequency domains. Practical demonstrations from real world data reinforce concepts introduced in the lectures. MATLAB implementation of these techniques is also addressed throughout the meetings.
Goals	Knowledge of: Statistical modeling, stationary signals, sampling theorem and frequency, harmonics, Fourier Series, Fourier Transform, Discrete Fourier Transform, Linear Systems, Filters.
Instruction language	EN
Prerequisites	
Recommended literature	W. van Drongelen. Signal processing for neuroscientists: An Introduction to the analysis of physiological signals. Academic Press.(selected chapters) S. W. Smith. The Scientist and Engineer's Guide to Digital Signal Processing. California Technical Pub (selected chapters)
Teaching methods	Assignment(s) Lecture(s) Paper(s) Presentation(s) Skills Training(s) Work in subgroups
Assessment methods	Attendance Written exam
Key words	frequency representation, linear systems, filters

Electives

The following electives will be offered in all RM specialisations

Title	**Elective: Course**
Period	throughout
Code	PSY4156
ECTS credits	3
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Vincent van de Ven
Descriptions	Students can attend a course offered by an RM specialisation or a course from a regular master's programme at Maastricht University (local courses) or a course that is organised at a different university in The Netherlands or abroad (external courses). The content, format and organisation of local courses are described in this catalogue or in the course descriptions of other UM master's programmes. The content, format and organisation of external courses are determined by the host university. Elective courses do not overlap with required RM courses, but instead offer new knowledge and insights. Enrollment in an elective course is subject to approval by the RM Electives Coordinator, for which you must complete an online application form. Elective courses do not substitute for mandatory courses.
Goals	Knowledge of: Extracurricular interests, broadening academic scope, taking specialised courses.
Instruction language	EN
Prerequisites	
Recommended literature	
Teaching methods	Assignment(s) Lecture(s) Paper(s) Presentation(s) Skills Training(s)
Assessment methods	Attendance Computer test Final paper Observation Oral exam Participation Portfolio Presentation Take home exam Written exam
Key words	electives, external courses, external workshops

Title	**Elective: Review**
Period	throughout
Code	PSY4157
ECTS credits	3
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Vincent van de Ven
Descriptions	Students write a critical literature review based on a specialised topic, under the supervision of a member of the scientific staff of Maastricht University. Students take the initiative to locate and arrange a supervisor for the review. The review topic, content and format will be determined by mutual agreement between student and supervisor. Students are expected to devote 84 hours to the Review Elective. Each student may complete maximally one Review or one Research elective (PSY4158). The Review Elective must be completed and assessed prior to the start of the internship.
Goals	Knowledge of: Extracurricular interests, specialisation on topic of interest, supervised scientific writing, literature review.
Instruction language	EN
Prerequisites	
Recommended literature	
Teaching methods	Paper(s)
Assessment methods	Final paper
Key words	elective, review paper, paper assignment, literature review, writing assignment

Title	**Elective: Research**
Period	throughout
Code	PSY4158
ECTS credits	3
Organisational unit	Cognitive Neuroscience (FPN)
Coordinator	Vincent van de Ven
Descriptions	Students can participate in (parts of) an empirical research project that is conducted and supervised by a member of the FPN or FHML scientific staff. Students can apply for an available project from the list of project descriptions; available on the 'RM Electives' section on EleUM, which is published and updated in December of each year. The application procedure is also described on the 'RM Electives' section on EleUM. Students who are selected to participate in a research elective may assist in designing the experiment or observational study, acquire empirical data, be trained in using measurement equipment, analyse empirical data, or take part in other parts of the research project. Students must write a short research report of maximally 5 pages about the practical experience obtained. Students are expected to spend 84 hours on the Elective: Research course, which includes time spent on practical work and the research report. The principal investigator of the project will supervise the practical work and grade the research report. Each student may complete maximally one Elective: Research course. The Elective: Research course must be completed and graded before the start of the internship.
Goals	Knowledge of: Planning or designing empirical research, empirical data analysis, writing research report, quantitative methods, conducting research, skill learning of data acquisition techniques, functioning in a research team.
Instruction language	EN
Prerequisites	
Recommended literature	
Teaching methods	Assignment(s) Lecture(s) Paper(s) Patient contact PBL Presentation(s) Research Skills Training(s) Work in subgroups
Assessment methods	Final paper Participation
Key words	elective, practical research, empirical research

Research Internship and Master's Thesis

Internships

1. PSY5107 Research Proposal, PSY5120/5121(research option) PSY51222/5123 (clinical option), Research Internship and PSY5103 Master's Thesis -> for [CN, NE, FN->50 credits] and [NP and PP->30 credits]. Internship coordinators differ per specialisation.

50 credits apply to: CN, NE and FN and for PP and NP students who choose to do only a research internship (not including the clinical part)

NP and PP students doing a clinical internship in addition to the research internship will obtain 30 credits for the Research Proposal + Research Internship + Master's Thesis + 20 credits for Clinical Internship, Clinical Research Proposal and Minor's Thesis.

2. Clinical Internship, Clinical Research Proposal and Minor's Thesis PSY5104, PSY5108, and PSY5105 Descriptions are the same for NP and PP. Only the internship coordinators differ per specialisation.

See NP

Title	**Clinical Internship, Clinical Research Proposal and Minor's Thesis**
Period	2-6
Code	PSY5104, PSY5108, and PSY5105
ECTS credits	**20** (15, 1, and 4, respectively)
Organisational unit	Clinical Psychological Science (FPN)
Coordinator	Sandra Mulkens

Title	**Research Proposal, Research Internship and Master's Thesis**
Period	2-6
Code	PSY5107, PSY 5120/5121 (research option) PSY5122/5123 (clinical option), and PSY5103
ECTS credits	**50 EC (1, 10/25, and 14, respectively)** for RM CN, NE, FN, NP and PP students who do *not* complete a clinical internship and minor's thesis. The duration of the research internship is expected to be around 34 weeks. The total research internship will be assigned 50 credits: 36 credits for the research activities, including the research proposal (1 credit; graded pass/fail), and the practical execution of the internship (10 credits graded included in GPA; 25 credits pass/fail and thus not included in the GPA) and 14 credits (graded assessment) for the master's thesis. **30 EC** (1, 10/9, and 10, respectively) for RM PP and RM NP students who choose to conduct both a research and a clinical internship (plus minor's thesis). The duration of the research internship is expected to be around 19-21 weeks. The total research internship will be assigned 30 credits: 20 credits for the research activities, including the research proposal (1 credit; graded pass/fail) and the practical execution of the internship (10 credits graded included in GPA; 9 credits pass/fail and thus not included in the GPA), and 10 credits (graded assessment) for the master's thesis.
Organisational unit	Clinical Psychological Science (FPN)
Coordinator	Sandra Mulkens
Descriptions	The second part of the second year of the research master's programme is devoted to conducting a research internship. As a result of the many international research contacts that faculty

	members have established, a substantial number of students will conduct their research internship abroad. Students start their internship with the writing of a research proposal. Students finish the master's programme by writing a thesis based on their internship research project. The internship can be completed at Maastricht University or at external research institutes. In all cases, a student's research proposal and master's thesis will be evaluated by two assessors. At least one of these assessors must be a member of the Faculty of Psychology and Neuroscience (FPN), the Faculty of Health, Medicine and Life Sciences (FHML), or the School of Business and Economics (NE). Both assessors must have a PhD degree. A detailed guide on research internships and the master's thesis can be found on EleUM > Students Research Master Faculty of Psychology and Neuroscience > internships. - RM Cognitive Neuroscience Internships Coordinator: Amanda Kaas, Cognitive Neuroscience (FPN), Phone: (0)43 38 82172, 55 Oxfordlaan, Room 2.019, Email: a.kaas@maastrichtuniversity.nl - RM Neuroeconomics Internships Coordinator: Amanda Kaas, Cognitive Neuroscience (FPN), Phone: (0)43 38 82172, 55 Oxfordlaan, Room 2.019, Email: a.kaas@maastrichtuniversity.nl - RM Fundamental Neuroscience Internships Coordinator: Pilar Martínez, Psychiatry and Neuropsychology (FHML), Phone: (0)43 38 81042, 40 Universiteitssingel,Room 2.574, Email: p.martinez@maastrichtuniversity.nl - RM Neuropsychology Internships Coordinator: Esther Keulers, Neuropsychology and Psychopharmacology (FPN), Phone (043) 38 82932, 40 Universiteitssingel East, Room 2.761, Email: esther.keulers@maastrichtuniversity.nl - RM Psychopathology Internships Coordinator: Nicole Geschwind, Clinical Psychological Science (FPN), Phone (043) 38 81487, 40 Universiteitssingel East, Room 2.767, Email: nicole.geschwind@maastrichtuniversity.nl
Goals	Knowledge of: Conducting a (supervised) empirical research project and summarising the research and findings in the form of a master's thesis.
Instruction language	EN
Prerequisites	. The research internship cannot be started until: • At least 60 credits have been attained during the programme; • The above mentioned 60 credits must include the courses Advanced Statistics I and II
Recommended literature	
Teaching methods	Assignment(s) Paper(s) Research Skills Working visit(s)
Assessment methods	Attendance

	Final paper Observation Participation
Key words	internship, research, master’s thesis