COGNITIVE NEUROSCIENCE GRADUATE SCHOOL

(Marie-Curie funding, Partners JFZ, ULg, GSK, UM)

Contact:
Prof. P. de Weerd
Email: p.deweerd@maastrichtuniversity.nl
Phone: +31 43-38 84513

Course registration and information:
Els Merken
Email: els.merken@maastrichtuniversity.nl
Phone: +31 43-38 81747

*The courses are **open for registration**. The deadline for registration is 10 weeks before the start of each course. Please contact Els Merken for more information on how to register.*

Goal

The goal of the programme is to offer PhD students the opportunity to take courses that will facilitate their research. The goal of the programme is explicitly to offer high-level, specialised courses, workshops and electives that are of direct relevance for the research. The goal is not to offer a broad education or background. This is assumed upon entry of the graduate school. To be considered for admission, a master's or research master's degree is required.

Formal aspects

Credit system: Students that are part of the graduate school are expected to gather 25 credit points in course work over the duration of the PhD. In our definition, a credit point assumes 30h of work, and the work includes the time spent in the course, self-study, and initial application of new knowledge in research. Credits can be obtained via participation in Core courses (C), short Workshops (W), Long workshops (LW), Electives (E), Professional activities (P), and selected research master's courses. The maximum of credits that can be obtained from electives and research master's courses is 10 each. Together with promoter, students that enter the graduate school will set up a work plan with a rough outline of research, and a detailed plan on how credit points will be earned. This education plan needs to be balanced with possible teaching requirements, and must be approved by the graduate school coordinator.

Student Evaluation / Honor's System: There will be neither formal exams nor will there be formal controls for attendance. Students that attend a course or workshop will be given a Certificate of Attendance upon entry in the course. With respect to Electives and Professional activities, an Honor's system will be used in which students keep record of their own activities (date, place, time period, title of activity) and obtain a monthly signature from their supervisor for confirmation. Once a total of 25 credits is reached, records and copies of certificates are submitted by the student to the office of the graduate school coordinator. Students obtaining their graduate degree will receive a Cognitive Neuroscience Graduate School Diploma, which will list all activities in which the student participated, in addition to the standard diploma from the home institution.

Partners: Courses in the programme are offered by ULG, GSK, JFZ, or UM. Some of these partners will organise their teaching at the UM, others will organise courses at their own institution or university. The above rules hold for all courses offered by all partners.

Research

Research in the participating partners can be subdivided into methods development and into content domains. Methods-related work focuses on advanced fMRI analysis and acquisition methods, advanced data analysis for multimodal imaging, simultaneous acquisition of MRI/EEG in combination with TMS, and realtime fMRI (e.g., for neurofeedback or surgical monitoring). In addition to research oriented on human methods (TMS, fMRI, EEG, psychophysics), there is also behavioural, neurophysiological and molecular research in animals. These methods support high-level research in a number of content domains, including fundamental topics such as perception, attention, learning, plasticity, all of these topics in various sensory/motor modalities, and higher-level or more applied topics including language, ADHD, autism, social psychology, neuro-econometrics, and literacy.

Overview of Courses/ Workshops

	jan				feb				mar				apr				may				june					sept				oct				nov				dec			
2010																				C1a			w1			LW1						LW2		w2				w3			
2011			w4		C2		w5		C3		w6		C4		w7					C1b						LW3						LW4		w8				w9			
2012																				C1a																					
2013																				C1b																					

Total

Credits

Core courses C1-C4: 16

Format: a full week of teaching (4 credits)
C1a/C1b Spring School fMRI (UM, Milene Bonte)
C2: Neuroimaging of the normal and diseased brain (UM, Francesco Di Salle)
C3: Spring school MR Physics (FZJ, Tony Stöcker & N. Jon Shah)
C4: Spring School PET and molecular imaging (Ulg, André Luxen)

Workshops W1-W9: 18

Introductory day (1 credit) and Advanced day (1 credit)
W1: Advanced Signal processing & ICA (UM, Elia Formisano)
W2: Combining fMRI and EEG (ULG, Christophe Phillips)
W3: Combining fMRI and TMS (UM, Alex Sack)
W4: Consciousness and Coma (ULG, Steven Laureys)
W5: Advanced Real time fMRI & brain-computer interfacing (UM, Bettina Sorger)
W6: Machine learning (UM, Federico Demartino)
W7: Brain connectivity (UM, Alard Roebroeck)
W8: MR pulse sequencing (ULG, Evelyne Balteau)
W9: Pharmacological MR (GSK, Paul Matthews)

Long-format Workshops LW1-LW4:

Format: 10 2h sessions, over 2-5 weeks (6 credits) 24

LW1: Mathematical methods (UM, Giancarlo Valente)
LW2: Advanced modelling of neuroimaging data (UM, Rainer Goebel)
LW3: Advanced MR imaging and spectroscopy (UM, Francesco Di Salle)
LW4: Advanced MR neurovascular coupling (UM, Kamil Uludag)

Electives: Individualised hands-on training by supervisor
Examples: (0,5 credit/days)
E1: training in animal electrophysiology
E2: writing skills (joint writing on papers or grants)
E3: Brainvoyager segmentation training
Etc

Professional activities

Offered by UM:
P1: Five lectures from M-BIC series (1 credit)
P2: Five project proposal meetings (1 credit)
P3: Five Vision Group meetings (1 credit)
P4: Conferences (0,5 credit/day)
P5: Five Brainvoyager Cafés (1 credit)
P6: Certified user training for fMRI plus EEG/TMS in scanner (0,5 credits)
P7: Certified user training for TMS (0,5 credits)
P8: Red Cross training and refreshments (1 credit)

Offered by ULG:
P9: 5 seminars from the CRC-Seminars series (1 credit)
P10: 5 seminars from the CRC-Methods Meetings series (1 credit)
P11: certified user for the 256-channels EEG system (0,5 credit)
P12: certified user for fMRI-EEG (0,5 credit)

Research master's courses

UM research master's courses conditionally available for credits to graduate students:
PSY 4106 406RM Advanced Statistics I (2 credits)
PSY 4107 407RM Advanced Statistics II (3 credits)
PSY 4108 408RM Neuroanatomy (1 credit)
PSY 4224 424CN Programming in Matlab Basic Course (2 credits)
PSY 4225 425CN Programming in Matlab Advanced Course (1 credit)
PSY 5221 521CN Diffusion Weighted Imaging and Fiber Tracking (1 credit)
PSY 4231 431CN Real Time fMRI and Neurofeedback (1 credit)
PSY 4233 433CN Methods of Deactivation (1 credit)
PSY 4235 435CN & PSY 4236 436CN Signal Analysis I & II (4 credits together)
PSY 4217 417CN Tracking the time course of cortical processing using EEG/MEG – 3 credits

ULG research master's courses conditionally available for credit to graduate students:
CHIM0620 - Radiopharmaceutical chemistry (3 credits)
CHIM0653 - Imaging and marking techniques (2 credits)
ELEC0017 - Indirect effects of electromagnetic fields (5 credits)
ELEN0061 - Introduction to stochastic process (2 credits)
ELEN0062 - Applied inductive learning (5 credits)
ELEN0442 - Introduction to statistical training (5 credits)
GBIO0008 - Medical imaging (5 credits)
GBIO0009 - Bio-informatics (5 credits)
GBIO0011 - Biological systems modelling (5 credits)
GBIO0015 - A tour in genetic epidemiology (3 credits)
GBIO0016 - Introduction to systems biology (5 credits)
GENE0434 - Experimental genomic techniques (2 credits)
GENE0436 – Statistics and genetics (2 credits)
PHYS0128 - Magnetic resonance imaging - the basics (3 credits)
PHYS2024 - Transfer and co-registration of medical images (2 credits)
PSYC5834 - Cognitive neuroimaging (3 credits)
SBIM0461 - Radiomarking and the medical and experimental use of tracers (2 credits)
STAT0722 - Introduction to medical statistics (2 credits)
SYST0017 - Non linear systems (5 credits)

Guidelines in assembling course work

The standard strategy to put together course work is to choose from the offerings in the CN graduate school.

Example:

- o 8 points from short-format Workshops (e.g. 4 two-day workshops)
- o 13 points Professional activities
    - § 2 1-week conferences = 5 credits,
    - § 3x5 lectures followed =3 credits;
    - § 3x5 Project Proposal Meetings (or equivalent) =3 credits;
    - § Red cross training and refreshments = 1 credit
    - § Certified user training fMRI and TMS = 1 credit
- o 4-6 points from a single Core Course or Long Workshop

Flexibility in putting course work together:

<u>Electives:</u> offer flexibility in putting a programme together. The main purpose of electives is to allow a promoter/student to emphasise skills that are important for particular research (e.g., animal neurophysiology, or any other form of one-on-one tutoring) and that are not covered within the graduate school course offer. As a guideline, no more than 10 credit point can be collected using electives, but motivated deviations from this will be considered.

<u>Research master's courses</u>: Upon approval by the thesis promoter and graduate school coordinator, credit points may also be collected from research master's courses. This is possible only for methodological, statistical, signal analysis, programming and biologically oriented courses. The goal of allowing this is to permit students with different backgrounds to catch up without overloading the course curriculum. However, when graduate students follow RM courses, they must *participate in the exam*, and pass, in order to collect the associated credits.

<u>Other courses:</u> bachelor's and master's courses as well as any other courses (e.g., centrally offered courses such time management, writing courses, etc.) are available and can be helpful but *cannot* be used to gain credits in the graduate school.

Availability of courses and applicable fees

Courses offered in the Graduate School are free for students funded by the school. For all other students that are not members of the school, but belong to the different faculties/departments of the partners participating in the Marie-Curie grant, 75€ per credit is charged. Seniors from participating faculties/departments pay 100€ per credit, and external seniors (not associated with participating faculties/departments) pay 200€ per credit.

CORE COURSES C1-C4
Format: A single, full week of teaching + selfstudy (4 credits)

C1a: Spring school fMRI
Date: 31 May – 3 June 2010
Location: UM
Coordinator: Milene Bonte, Cognitive Neuroscience (FPN), Phone 38 84036, 40 Universiteitssingel East, Room 4.743, E-mail: m.bonte@maastrichtuniversity.nl

Objective(s)
This workshop aims to give an overview of cutting edge research in the field of fMRI as well as hands-on experience with advanced fMRI data analysis.

Key words
fMRI, physics, neurovascular coupling and BOLD, design, uni and multivariate statistics, multimodal imaging (fMRI, EEG, MEG, TMS), DTI, high-field fMRI, neuro-feedback and clinical applications.

Description of the course
During this four days advanced fMRI workshop, international and FPN/MBIC experts will discuss fundamental issues in fMRI acquisition, design, analysis and applications and will present their ongoing research findings. In addition, participants acquire hands-on experience in advanced fMRI data analysis (Brainvoyager) during combined computer exercises and lectures. These advanced exercises cover multivariate statistics, combining fMRI with EEG/MEG data, DTI, as well as cortical thickness measures and statistics. Prior to these exercises, students can opt to follow a basic introduction to Brainvoyager.

Instructional approach
Lectures and Practical exercises

C1b: Basic fMRI workshop
Date: end of May/ beginning of June, 2011
Location: UM
Coordinator: Milene Bonte, Cognitive Neuroscience (FPN), Phone 38 84036, 40 Universiteitssingel East, Room 4.743, E-mail: m.bonte@maastrichtuniversity.nl

Objective(s)
This workshop aims to give an introductory overview of research in the field of fMRI as well as a first experience with hands-on fMRI data analysis.

Key words
fMRI, physics, neurovascular coupling and BOLD, design, uni and multivariate statistics are covered at an introductory level.

Description of the course
During this four days basic fMRI workshop, international and FPN/MBIC experts will discuss fundamental issues in fMRI acquisition, design, analysis and applications and will present their ongoing research findings at an introductory level. In addition, participants acquire hands-on experience in fMRI analysis (Brainvoyager) of structural and functional data during combined computer exercises and lectures. Prior to these exercises, students can opt to follow a basic introduction to Brainvoyager.

Instructional approach
Lectures and Practical exercises

C2: Neuroimaging of the normal and diseased brain
Date: First week Feb, 2011
Location: UM
Coordinator: Francesco Di Salle, Cognitive Neuroscience (FPN), Phone 38 84038, 40 Universiteitssingel East, Room 4.759, E-mail: francesco.disalle@maastrichtuniversity.nl

Objective(s)
The course aims at providing the graduate students with the needed elements to understand the condition of brain normality within the extremes of physiological variation of many tissue parameters depending on age and on different influences from the general environmental conditions. This knowledge is intended to provide tools to be used in any advanced application of brain imaging as a substrate to a better understanding the structural state of the brains undergoing an examination, the possibility of indicating as "normal" a volunteer's brain, and the basic elements to understand the main brain pathologies that can be incidentally discovered in a volunteer and their correlates on mental states, mental performances, and functional imaging.

Key words
Neuroimaging; brain diseases

Description of the Course
Modern MR imaging and spectroscopy has introduced revolutionary innovations in our knowledge of human brain, and has produced many situations in which a researcher in neuroscience has to be able to understand if a given brain can be considered as normal, and, in case it hosts limited structural abnormalities, if that particular brain is still suitable to undergo a MR examination for scientific purposes.
The course will provide with the necessary ability to recognise the state of brain normality despite variations in age and in many physiological parameters, as well a basic capability of recognising the main brain diseases and their implications for in vivo functional studies.

Literature
Selected chapters from Neuroimaging books.

Instructional Approach
One full week of teaching, given by the coordinator, with simultaneous hands on sections of practise on MR images and spectra from normal and diseased human brains.

C3: Spring school MRI Physics
Date: first week March, 2011
Location: UM
Coordinators: Tony Stöcker and N. Jon Shah, Institute of Neuroscience and Medicine – 4, Medical Imaging Physics – MRI, Forschungszentrum Juelich 52425 Juelich, Germany, Tel: +49(0)2461-61-8772, E-mail: t.stoecker@fz-juelich.de

Objective(s)
This course gives a basic introduction to the physical principles of MRI. It does not require detailed knowledge of classical physics or quantum mechanics. The course tries to give an overview at the beginner level. Knowledge of basic mathematical concepts (calculus, vectors) is sufficient to attend the course.

Key words
Nuclear Magnetic Resonance; Magnetic Resonance Imaging

Description of the Course
NMR Basics: Mathematical basis of MR physics, classical and quantum mechanical description of spins in a magnetic field, Excitation of the spin system, Larmor frequency, relaxation mechanisms, Bloch equations. MRI Basics: basic principals of imaging, spatial encoding and gradient fields, signal equation and k-space formalism, Fourier imaging, selective excitation. Basic Procedures: spin echoes and gradient echoes, contrast mechanisms, fast and ultrafast imaging, parallel imaging, spectroscopic imaging. MR Hardware: super conducting coil, gradient coils, RF coils, spectrometer, shimming.

Literature
E.M. Haacke et al, Magnetic Resonance Imaging: Physical Principles and Sequence Design, John Wiley 1999;
Z.P. Liang, P.C. Lauterbur, Principles of Magnetic Resonance Imaging: A Signal Processing Perspective, SPIE 1999
M.T. Vlaardingerbroek, J.A. den Boer, Magnetic Resonance Imaging: Theory and Practice, Springer, 20

Instructional Approach
Lectures given by the coordinators; computer visualisation of NMR and MRI; individual problem solving of basic questions; group discussion of results

C4: Spring School: PET and molecular imaging
Date: first week April, 2011
Location: Ulg
Coordinator: André Luxen, Université de Liege, Centre de Recherches du Cyclotron, B30, 4000 Liège. E-mail: aluxen@ulg.ac.be

Objective(s)
This spring school will familiarise PhD students with the current state of Positron Emission Tomography (PET) and its application to the diagnosis of neurologic and psychiatric disease.

Key words
Positron Emission Tomography (PET); contrast agents; MRI; luminescence; fluorescence; multi-modal imaging

Description of the Course
The lectures will cover all the aspect of the imaging technique including:
PET isotope production
Radiochemistry
Radioprotection-legal aspect
GMP production
PET scanner
In vivo validation in rodents
Mathematical models
Human applications
Contrast agents for MRI
Molecular imaging with other modalities (fluorescence, bioluminescence)

Literature
Journal articles and reference textbooks.

Instructional Approach
Lectures and laboratory visit.

WORKSHOPS

Format Workshops W1-W9: Introductory day (1 credit) and Advanced day (1 credit) (plus selfstudy)

W1: Advanced Signal Processing and ICA

Date: 3rd week June, 2010

Location: UM

Coordinator: Elia Formisano, Cognitive Neuroscience (FPN), Phone 38 84267, 40 Universiteitssingel East, Room 4.738, E-mail: e.formisano@maastrichtuniversity.nl

Objective(s)

To develop skills in mathematical/statistical analysis of neuroimaging signals (fMRI, EEG/MEG).

Key words

Functional brain signals, time-series analysis, independent component analysis, data mining,

Description of the Course

In all functional neuroimaging modalities the mathematical/statistical analysis of collected data represents a cumbersome and relevant part of the research effort. This workshop will introduce the application in functional neuroimaging of various advanced methods of signal and time-series analysis. Selected examples from functional MRI and/or EEG/MEG will be illustrated and discussed. Particular focus will be on non-inferential data-mining techniques such as independent component analysis.

Literature

Journal articles and book chapters

Instructional Approach

Overview lecture(s) given by the coordinator and group discussion. Demonstration of different types of analyses and some hands-on experience.

W2: Combining fMRI and EEG
Date: first week November, 2010
Location: Um/Ulg
Coordinator: Christophe Phillips, Cyclotron Research Centre, B30, ULg, 4000 Liège. Phone +32 4366 2366, E-mail: c.phillips@ulg.ac.be

Objective(s)
The aim of this course is to present the possibilities, limitations and pitfalls of simultaneously acquiring "functional Magnetic Resonance Imaging" (fMRI) and electroencephalographic (EEG) data, as well as their processing. We intend to cover the hardware/setup aspect of data acquisition, the pre-processing of the data, and some applications.

Key words
EEG; fMRI; multi-modal imaging; trial-by-trial coupling; simultaneous EEG-fMRI

Description of the Course
The combination of fMRI and EEG promises to provide both high spatial resolution (fMRI) and high temporal resolution (EEG) for the study of brain function. The full benefit of combining EEG and fMRI is particularly obvious when one is interested in spontaneous brain states or events characterised by specific EEG oscillations or transients, the time course of which is hardly predictable. In the basic part of the workshop the students will be introduced to different methods used for integrating fMRI and EEG such as fMRI constrained EEG analysis, EEG constrained fMRI analysis and trial-by-trial coupling. Furthermore knowledge on the methodological and technical challenges posed by simultaneous EEG-fMRI measurements will be provided. Applications to the characterisation of the cerebral correlates of normal brain oscillations as waking brain rhythms, EEG-defined sleep states, or sleep transients, as well as in localising the hemodynamic correlates of epileptic activities will be shown.

Literature
Journal articles, book(s) chapter(s)

Instructional Approach
Both days will start with an overview lecture given by the coordinator, followed by a group discussion. The second day will also include a demonstration/hands-on on the analysis of combined EEG fMRI data.

W3: Combining fMRI and TMS
Date: first week December, 2010
Location: UM
Coordinator: Alexander Sack, Cognitive Neuroscience (FPN), Phone 38 84267, 40 Universiteitssingel East, Room 4.750, E-mail: a.sack@maastrichtuniversity.nl

Objective(s)
This workshop focuses on the different possibilities of combining non-invasive functional brain imaging techniques, in this case fMRI, with non-invasive functional brain interference techniques, in this case TMS, for the study of human cognition in healthy volunteers.

Key words
Non-invasive brain stimulation; functional magnetic brain interference; multi-modal imaging

Description of the Course
The simultaneous combination of fMRI and TMS within the same experimental session promises to provide new insights into the functional neural network accounts of cognition. This workshop will provide some knowledge regarding the methodological and technical challenges posed by such simultaneous multi-modal imaging approaches, discuss selected examples of concrete application in Cognitive Neuroscience, and ends with a practical demonstration of an experimental simultaneous TMS & fMRI set-up at the Maastricht Brain Imaging Centre.

Literature
Journal articles

Instructional Approach
One overview lecture given by the coordinator, followed by a group discussion. Demonstration of experimental set-up and some hands-on experience.

W4: Consciousness and coma
Date: 3rd week January, 2011
Location: ULG
Coordinator: Steven Laureys, Coma Science Group, Cyclotron Research Centre and Neurology Dept, Sart Tilman B30, 4000 Liège steven.laureys@ulg.ac.be

Objective(s)
This workshop focuses on the study of conscious perception and residual cognition in altered states of consciousness such as sleep, hypnosis, anaesthesia, coma and the vegetative state by means of PET, fMRI, and EEG.

Key words
Consciousness; coma; sleep; vegetative state; multi-modal imaging

Description of the Course
While philosophers have for centuries pondered upon the relation between mind and brain, neuroscientists have only recently been able to explore the connection analytically. This ability stems from recent advances in technology and emerging neuroimaging modalities.
We will here present the possibilities and pitfalls of the search for the neural correlate of consciousness by means of functional neuroimaging (mainly focusing on PET and fMRI) in health and physiological (sleep), pharmacological (general anaesthesia) and pathological (coma, brain death and the vegetative state) alterations of consciousness.
Consciousness is a multifaceted concept that has two major components: awareness of environment and of self (i.e., content of consciousness) and wakefulness (i.e., level of consciousness). You need to be awake in order to be aware (REM-sleep being a notorious exception). The contrastive approach (comparing brain activation in circumstances that do or do not give rise to consciousness in either of its two main senses of awareness and wakefulness) is now widely applied in functional neuroimaging. Next, we will focus on situations where wakefulness and awareness are dissociated. The most tragic example is the vegetative state. Here, patients 'awaken' from their coma but show no 'voluntary' interaction with their environment. We will discuss recent neuroimaging studies revealing the functional neuro-anatomy of arousal and awareness illuminating the relationships between conscious perception and: (i) global brain function; (ii) regional brain function; (iii) changes in functional connectivity; and (iv) primary versus associative cortical activation to external stimuli.

Literature
Journal articles and reviews

Instructional Approach
One overview lecture given by the coordinator and collaborators, followed by a group discussion. Demonstration of coma assessment teaching video and hospital and lab visit.

Form of Assessment
Attendance and questionnaire evaluation.

W5: Advanced real-time functional magnetic resonance imaging (rt-fMRI) and brain-computer interfacing
Date: 3rd week February, 2011
Location: UM
Coordinator: Bettina Sorger, Cognitive Neuroscience (FPN), Phone 38 82177, 40 Universiteitssingel East, Room 4.771, E-mail: b.sorger@maastrichtuniversity.nl

Objective(s)
This workshop will introduce the participants to the methodology and application possibilities of real-time fMRI and brain-computer interfacing.

Keywords
Real-time functional magnetic resonance imaging, online data analysis, brain-computer interface, neurofeedback

Description of the Course
Analysing fMRI data *online* allows for direct brain-computer interfacing and therewith opens up novel research possibilities in fundamental and clinical neuroscience. Following the theoretical introduction of the technical and methodological requirements/challenges of real-time fMRI, the workshop will critically review already realised real-time fMRI projects (*e.g.*, neurofeedback training studies and brain-based communication experiments) as well as discuss further potential applications. Finally, participants will be given a demonstration of a real-time fMRI experiment at the Maastricht Brain Imaging Centre. In this way, the course participants can get some practical experience (maybe also as a subject).

Literature
Journal articles

Instructional Approach
The students will read some basic papers as preparation of the course. The workshop starts with an overview lecture given by the coordinator. Then, recent and potential real-time fMRI projects will be discussed and an example real-time experiment will be planned (day 1), set-up and performed (day 2).

Form of Assessment
Short writing assignment (report about the performed real-time fMRI experiment or proposal about another reasonable real-time fMRI project)

W6: Machine Learning
Date: 3rd week March, 2011
Location: UM
Coordinator: Federico De Martino, Cognitive Neuroscience (FPN), Phone 38 84532, 40 Universiteitssingel East, Room 4.735, E-mail: f.demartino@maastrichtuniversity.nl

Objective(s)
This workshop focuses on the use of machine learning techniques in neuroimaging (fMRI and EEG). Applications for the localisation of spatially (temporally) distributed patterns of activity, brain reading and model-based fMRI analysis will be introduced and discussed.

Key words
Machine Learning; pattern recognition; EEG; fMRI; distributed patterns; brain reading.

Description of the Course
Machine learning algorithms (classification and regression) are being increasingly used for the analysis of neuroimaging (fMRI and EEG) data. Such methods have been shown to be more sensitive than conventional statistical techniques for the detection of functionally specialised patterns of activity. Furthermore pattern recognition algorithms have received increasing interest for their ability to "predict" presented stimuli and/or subjects' behaviour from the neuroimaging activity ("brain reading"). In the basic part of the workshop the students will be introduced to the concepts of machine learning. Different applications to the analysis of fMRI and EEG data will be illustrated. The advanced part of the workshop will illustrate some of the main differences between different machine learning algorithms; will present the use of machine learning based regression as an application for model-based fMRI data analysis. The advanced part will conclude with a small practical session where fMRI data will be analysed using pattern recognition algorithms.

Literature
Journal articles, book(s) chapter(s).

Instructional Approach
Both days will start with an overview lecture given by the coordinator, followed by a group discussion. The second day will also include a demonstration/hands-on on the analysis of fMRI data.

W7: Brain connectivity
Date: 3rd week April, 2011
Location: UM
Coordinator: Dr. Alard Roebroeck, Cognitive Neuroscience (FPN), Phone 38 84309, 40 Universiteitssingel East, Room 4.749, E-mail: a.roebroeck@maastrichtuniversity.nl

Objective
This workshop aims to give an overview of methods for modelling and measuring brain connectivity and their applications. After attending the workshop, the participant should be familiar with the different ways in which 'brain connectivity' can be defined, the different methods by which it can be measured or modeled and how each could be used in answering neuroscientific questions.

Key words
Functional connectivity; effective connectivity; diffusion tensor imaging; fiber tracking; independent component analysis; Granger causality; dynamic causal modelling; EEG/MEG coherence; Connectivity by TMS interference

Description
This workshop will give an overview of commonly used methods for modelling and measuring brain connectivity. Both the structural aspect (i.e. white matter pathways) and the functional and processing aspects (i.e. communication or interaction between brain structures) will be discussed. The course will touch upon theoretical considerations of inferring causality, interference and information transfer. It will focus, in turn, on a few of the most used methods investigate connectivity and communication in the brain: fMRI functional connectivity approaches; fMRI effective connectivity modelling; DTI, crossing fiber models and fiber tracking; EEG/MEG coherence measurement; and connectivity inference by TMS interference. For each of the methods the basic principles, strengths and shortcomings, and likely applications are discussed.

Instructional approach
Lectures and literature suggestions

W8: Sequence development: basics and advanced design for brain imaging
Date: first week November, 2011
Location: Ulg
Coordinator: Evelyne Balteau, ULg, Tel. +32 4366 2366, Fax +32 4366 2946, e-mail e.balteau@ulg.ac.be

Objective(s)
The course will focus on the data acquisition aspect of the MRI processing pipeline, covering pulse sequence strategies to generate MRI raw data, image reconstruction strategies and early-stage data processing and artifact corrections. The course aims to provide an overview of the existing methods and known issues in sequence design and image reconstruction, encompassing the mechanisms that affect data and image quality, and providing a general knowledge framework for a critical and innovative perspective in research.

Key words
MRI; data acquisition; data processing; artifact corrections

Description of the course
Magnetic Resonance Imaging has developed along with the implementation of increasingly complex acquisition techniques. Sequence development must take into account the evolution of hardware capabilities and adapt to the new challenges offered by e.g. multichannel RF coils and ultra-high field environments. Developments are also application-driven, in answer to the experimental and clinical requests, for research or diagnostic purposes. Sequence development is therefore essential in the evolution of MRI, just as are improvements in hardware design and data processing and analysis.

The following overview describes the topics the course aims to cover and provides a non-exhaustive description of the general guidelines.

Part I – Pulse sequence design and implementation. This section will introduce the basics principles of image encoding and k-space sampling, relaxation time-based contrasts and diffusion weighting. It will describe the most common acquisition techniques and carry on towards more advanced features like eddy current correction, gradient design and gradient imperfections, non-Cartesian k-space sampling, RF pulse design, B_0 and B_1 heterogeneities...

Part II – Image reconstruction. The different strategies for image reconstruction will be reviewed and discussed. Reconstruction from (full or partial) Cartesian k-space sampling will be first introduced, reviewing Fourier transform techniques and filtering. K-space encoding errors will be discussed via the description of k-space trajectory measurements, phase correction and navigators, as well as reconstruction techniques taking these effects into account such as algebraic reconstruction methods. Strategies to reconstruct images from non-Cartesian sampling patterns will be reviewed, including gridding, conjugate phase reconstruction, algebraic methods and generalised fast FT amongst others. Parallel imaging reconstruction techniques will also be described, for Cartesian and non-Cartesian k-space coverage.

Literature
Journal articles

Instructional approach
Series of lectures given by the coordinator and invited speakers, acquisition of brain images on a 3T scanner for demonstration of the effects of the contrast strategies and k-space sampling schemes.

W9: Pharmacological MR
Date: first week December, 2011
Location: UM?
Coordinator: Rexford Newbould, Head of MR Physics, GSK Clinical Imaging Centre, Hammersmith Hospital, Du Cane Road, London W12 0HS, United Kingdom. Email: rexford.d.newbould@gsk.com

Objective(s)
This workshop focuses on the different methods currently being used in magnetic resonance imaging and spectroscopy for the non-invasive assessment of drug effects in human subjects.

Keywords
Clinical magnetic resonance research, drug discovery, magnetic resonance imaging, magnetic resonance spectroscopy.

Description of the Course
The approach for the use of MRI and MRS for clinical diagnosis differs from that used in pharmacological research. A much greater emphasis on quantisation and repeatability, as well as innovative "downstream" mapping of drug effects are required. This workshop will introduce methods in MRI and MRS which have been shown useful for drug discovery, with an emphasis on clinical, rather than preclinical, magnetic resonance imaging. Students will have the opportunity to witness current studies in drug discovery with MR, as well as learn about cutting edge techniques being employed.

Literature
Journal articles

Instructional Approach
Overview and in-depth lecture on the same day, followed by a group discussion. Hands-on experience with clinical MR in a drug study.

Form of Assessment
Attendance

LONG WORKSHOPS LW1-LW4
Format: 10 * 2h sessions + Self-study (6 credits)

LW1: Mathematical Methods
Date: Sept/Oct, 2010
Location: UM
Coordinator: Giancarlo Valente, Cognitive Neuroscience (FPN), Phone 38 82469, 40 Universiteitssingel East, Room 4.747, E-mail: giancarlo.valente@maastrichtuniversity.nl

Objective(s)
Mathematical methods are an important tool for conducting research in Cognitive Neuroscience. This course aims at providing the basic concepts and instruments to deal with Matrix Algebra and Calculus.

Key words
Basic algebra; vectors and matrix operations; calculus

Description of the Course
The course will deal with Matrix Algebra and Calculus. It will cover the topics of matrix modelling and matrix operations, of linear transformations and of solution of linear systems. Concepts of calculus, such as limits, derivative and integrals, together with complex numbers will be discussed in detail. Exercises on these topics (both pencil-and-paper and computer based) will be an important part of this course.

Literature
Books, Material provided during the course.

Instructional Approach
Lectures provided by the coordinator. Exercises and solutions, together with computer assignment, will be provided.

LW2: Advanced Modelling of Neuroimaging Data

Date: last 2 weeks Oct, 2010
Location: UM
Coordinator: Rainer Goebel, Cognitive Neuroscience (FPN), Phone 38 84014, 40 Universiteitssingel East, Room 4.753, E-mail: r.goebel@maastrichtuniversity.nl

Objective(s)
This core course provides an overview of important approaches to model multi-modal neuroimaging data at different levels of description, ranging from structural equation models to detailed neural network models. The course focuses on how to develop and evaluate large-scale neural networks that relate columnar level modelling to high-resolution fMRI data.

Key words
Effective connectivity; structural equation modelling (SEM); dynamic causal modelling (DCM); neural network modelling; columnar organisation; high-resolution fMRI; multi-modal brain imaging

Description of the Course
Computational modelling is an important tool to relate observed brain imaging data to its potential neuronal substrate that can greatly aid the development of theories about brain function. This core course starts with the principles of structural equation models (SEM) and dynamic causal models (DCM) that treat selected brain regions as nodes in a directed graph. The arrows connecting the nodes express hypotheses about effective directed influences between the modelled areas. Created candidate models may then be evaluated by fitting weights to the specified directed connections based on time courses extracted from included brain areas. The advantages and disadvantages of such hypothesis-driven approaches are then compared with more exploratory approaches, such as Granger Causality Mapping (GCM) that attempt to estimate directed influences directly from the data and that are not limited to a small set of pre-selected brain regions. In the second half of the course, the principles of large-scale neural network models are presented. These models allow a more detailed level of modelling since they not only investigate the spatio-temporal dynamics between brain regions, but also attempt to specify how information is represented *within* brain areas and how representations are processed and transformed over time on the basis of bottom-up, lateral and top-down influences. It will be further argued that columnar-level neuronal network models are particularly well suited to model high-resolution fMRI data. In practical sessions, it will be shown how such columnar-level neural network models can be created and linked to cortex meshes in order to explain and predict fMRI and EEG/MEG data.

Literature
Journal articles

Instructional Approach
Ten lectures given by the coordinator, followed by group discussions. Practical

sessions/Demonstrations of neural network modelling (with Neurolator 3D software package).

LW3: Advanced MR imaging and spectroscopy

Date: Sept/Oct, 2011
Location: UM
Coordinator: Francesco Di Salle, Cognitive Neuroscience (FPN), Phone 38 84038, 40 Universiteitssingel East, Room 4.759, E-mail: francesco.disalle@maastrichtuniversity.nl

Objective(s)
This course focuses on the advanced techniques suitable to obtain detailed information on the "in vivo" brain milieu through the use of Magnetic Resonance. Two main chapters of knowledge will be analysed, both orbiting around Magnetic Resonance as the basic instrument to produce information about the brain, the neuronal tissue constituents, and the intracranial metabolic and biochemical environment. On the one side, methods and techniques will be targeted, to "enrich" brain *images* with special information able to unveil specific elements of brain physiology and pathology. On the other side, it will be shown how the analysis of Magnetic Resonance spectra can produce extremely valuable information on brain biochemistry.

Key words
Advanced MR imaging methods; MR spectroscopy

Description of the Course
Advanced MR imaging methods have been pivotal in the development of new tools that have recently permitted to achieve crucial understandings of the brain, to explore brain functions through MRI, to delineate anatomical connectivity through white matter imaging dissection, to analyse regional brain perfusion, the abundance in macromolecules, or the extent of regional microcirculation. Likewise, modern MR spectroscopy promises to reveal the intimate dynamics of brain metabolites, including precious information regarding many classes of neurotransmitters. The course will provide with the necessary theoretical framework to explore these possibilities of MR in detail, and, in the same time, with an individual training to derive multi-parametric information from MR images, to understand the value of single information in a multidimensional space of MR parameters, and to conveniently combine MR imaging and MR spectroscopy information. The most relevant information will be provided regarding the main developments in MR spectroscopy of neurotransmitters and the main concepts of molecular imaging.

Literature
Journal articles

Instructional Approach

One full week of teaching, given by the coordinator, with simultaneous hands on section of practise on MR images and spectra from normal and diseased human brains.

LW4: Advanced MR neurovascular coupling

Date: Last 2 weeks Oct, 2011

Location: UM

Coordinator: Kamil Uludag, Cognitive Neuroscience (FPN), Phone (xxx), 40 Universiteitssingel East, Room 4.759, E-mail: (xxx)

Course objective

The objective of this course is to introduce physiological and physical mechanisms underlying different functional imaging modalities and to explore the possibilities and limitations of each of these methods.

Key words

Functional magnetic resonance imaging (fMRI); Positron emission tomography (PET); electroencephalography (EEG); magneto-encephalography (MEG); near infrared spectroscopy (NIRS); multi-modal Imaging; physiology; physics

Description of the course

Recent functional imaging techniques provide a non-invasive window to probe the human brain function while it is performing a task or experiencing a sensory stimulation. To understand the capabilities and limitations of each of the techniques, it is important to review the chain of physiological and physical events leading to the imaging signals. The purpose of this course is to enable the students to decide which imaging methods are appropriate for the neuro-scientific questions asked.

The physiological and physical basis of the following imaging methods will be covered: a) Functional magnetic resonance imaging (fMRI), b) Positron emission tomography (PET), c) Electroencephalography (EEG), d) Magneto-encephalography (MEG), and e) Near infrared spectroscopy (NIRS).

In addition, recent developments combining different imaging modalities via simultaneous acquisition or via post-processing will be discussed. At the end of the course, there will be an open discussion about the capabilities and limitations of each imaging method.

Instructional approach

Lectures

Assessment

Attendance

ELECTIVES

The purpose of an elective is that students receive individualised one-on-one training by a supervisor. Electives are organised on an ad hoc basis, and students are supposed to take initiative in approaching a supervisor to receive a particular type of training. Precise contents and credits on Ad hoc basis (1 credit/day; max = 20 credits)

Potential options:

E1: training in animal electrophysiology	Mark Roberts
E2: writing skills (joint writing on papers or grants)	
E3: Brainvoyager segmentation training	Bettina Sorger
Etc.	

PROFESSIONAL ACTIVITIES

Offered by UM:

P1: Five lectures from M-BIC series (1 credit)
P2: Five project proposal meetings (1 credit)
P3: Five Vision Group meetings (1 credit)
P3: Conferences (0,5 credit/day)
P4: Five Brainvoyager Cafés (1 credit)
P5: Certified user training for fMRI (0,5 credits)
P6: Certified user training for TMS (0,5 credits)
P7: Red Cross training (0,5 credit)

Offered by ULG:

P8: 5 seminars from the CRC-Seminars series (1 credit)
P9: 5 seminars from the CRC-Methods Meetings series (1 credit)
P10: certified user for the 256-channels EEG system (1 credit)
P11: certified user for fMRI-EEG (1 credit)

RECOMMENDED CONFERENCES

European Society for Magnetic Resonance in Medicine and Biology (ESMRMB)
Date: 10-12 DEC 2010
Location: Maastricht
Organised by K. Uludag
Weblink: http://www.esmrmb.org

Human Brain Mapping (HBM)
Date: 6-10 June 2010
Location: Barcelona, Spain
Weblink: http://www.humanbrainmapping.org

Society for Neuroscience (SfN)
Date:13-17 November 2010
Location: San Diego, CA
Weblink: http://www.sfn.org

European Conference on Visual Perception (ECVP)
Date: 22-26 August 2010
Location: Lausanne, Switzerland
Weblink: http://www.ecvp.org

Vision Sciences Society (VSS)
Date: 7-12 May 2010
Location: Naples, Florida
Weblink: http://www.visionsciences.org