

EBERHARD KARLS
**UNIVERSITÄT
TÜBINGEN**



Module Handbook

Neural and Behavioural Sciences Master of Science

Academic Year 2019-20

Faculty of Science and Medical Faculty
Graduate School of Neural and Behavioural Sciences



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1. Qualification goals of the master course 'Neural and Behavioural Sciences'

This research oriented course of study aims at German and international students with a first academic degree (BSc) in biology, psychology, cognitive science, medical sciences, computer science or in another relevant field of natural or engineering sciences. The theoretical and practical education comprises topics of systems and cognitive neuroscience, theoretical neuroscience, neurophysiology, neuropsychology and, furthermore, state-of-the-art neuroscience methods, particularly brain imaging methods. Moreover, an emphasis is set on scientific writing and communication skills. The overall goal of the course is to impart solid knowledge and competences to qualify students to independently plan and carry out neuroscientific experiments, to choose appropriate methodological approaches, and to critically evaluate their findings in comparison with published data. The qualification goals in more detail:

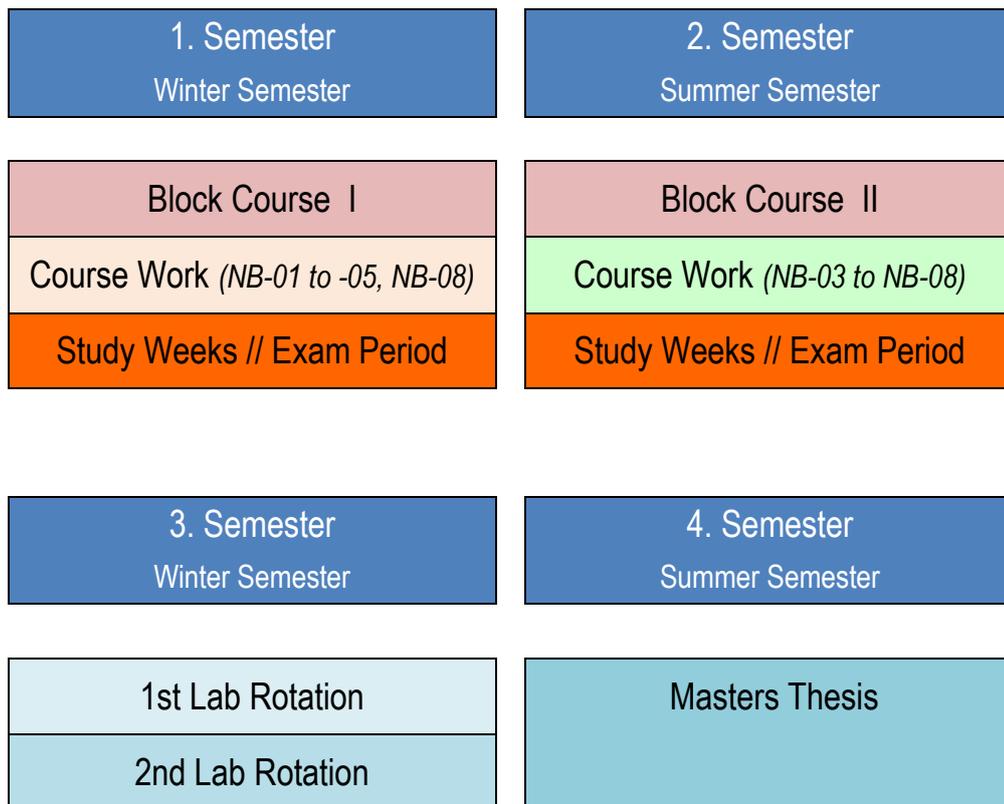
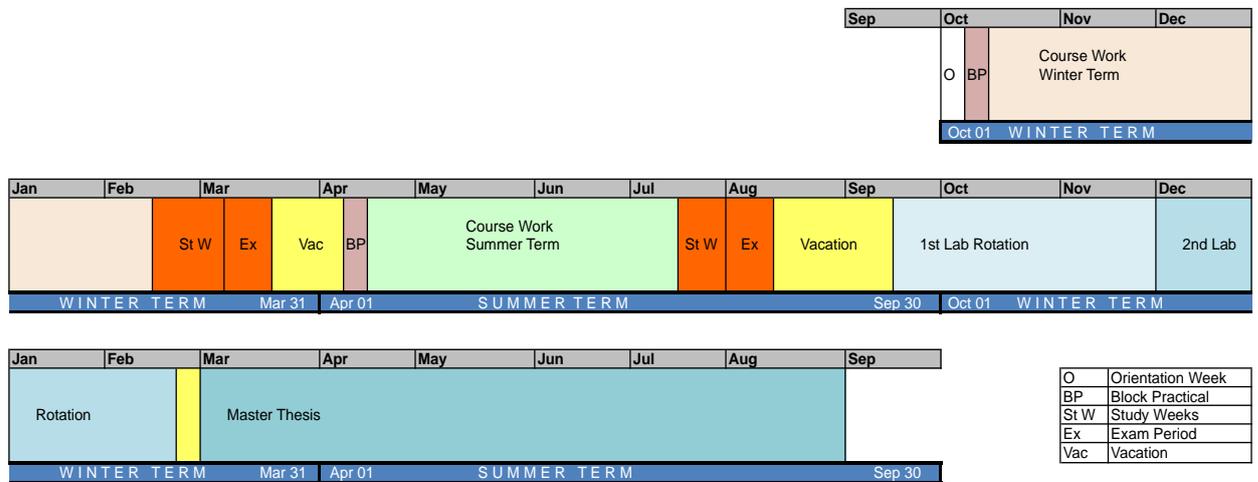
- Our graduates have a sound standing in the interdisciplinary field of neuroscience, extending from molecular, cellular and physiological neuroscience, to sensory and motor systems neuroscience, up to cognitive neuroscience and basic computational approaches.
- They have profound skills in mathematics, statistics and Matlab-programming, which provides them with the 'toolboxes' to collect, analyze and statistically evaluate data and to illustrate the results appropriately as graphs and/or diagrams.
- Graduates have a solid theoretical and – to some extent – hands-on expertise in a wide range of state-of-the-art neuroscientific methods, including brain imaging methods (fMRI, EEG, MEG, TMS), neurophysiological recording techniques (*in vivo* and *in vitro*), but also non-invasive psychophysical approaches.
- They are capable of critically scrutinizing the suitability of specific experimental approaches for studying various neuroscientific questions (*can I answer my scientific questions with the method at hand?*). Also, they will be able to combine techniques in a meaningful way to also make rather complex scientific problems accessible.
- Graduates have required English language competency at least equivalent to C1-level. They can present scientific findings of their research orally and in writing. Moreover, in discussions they are skilled to answer scientific questions in a proficient manner. At scientific meetings, they can communicate – in English – with experts in the field and contribute to discussions on current neuroscientific topics.
- During their studies and laboratory rotations, graduates have also gained general competencies such as time and conflict management, coping with stressful situations, as well as social skills and the capacity for teamwork. Furthermore, as members of an international course-of-study and by working in internationally composed research groups they also gain cross-cultural competence to some extent.

In conclusion, after successful graduation from the master course students are well prepared to engage, eventually, in a demanding doctoral research project and pursue a career in science.

2. Modules overview

Module Code	Module Title	Semester	Credits
NB-01	Theoretical Neuroscience and Data Handling	1 st	11
NB-02	Physiological and Cellular Mechanisms of Neurons	1 st	6
NB-03	Systems Neuroscience	1 st and 2 nd	10
NB-04	Methods in Neuroscience	1 st and 2 nd	9
NB-05	Introduction to Current Research Topics	1 st and 2 nd	3
NB-06	Cognitive Neuroscience	2 nd	6
NB-07	Clinical Cognitive Neuroscience	2 nd	6
NB-08	Electives	1 st and 2 nd	11
NB-09	Laboratory Rotations	3 rd	28
NB-10	Master Thesis	4 th	30
			Sum 120

3. Timeline of the master course



4. Semester / Courses / Credits

1. Semester // Winter Semester	Credits	
Functional Neuroanatomy (<i>1 week block</i>)	2	
Introduction to Computational Neuroscience	3	
Essential Mathematics for Neuroscience	3	
Essential Statistics for Neuroscience	3	
Molecular and Cellular Neuroscience	3	
Neurophysiology	3	
Sensory Systems I – Visual	2	
Sensory Systems II – Auditory and remaining	3	
Methods in Neuropsychology	3	
Physiological and Physical Basis of Brain Imaging Methods	3	
Elective course	3	
NeuroColloquium	0,5	Σ 31,5

2. Semester // Summer Term	Credits	
Introduction to MatLab Programming (<i>1 week block</i>)	2	
Motor Systems	3	
Perception, Cognition and Behavior	3	
Evolutionary Cognitive Neuroscience	3	
Methodological Frontiers in Cognitive Neuroscience	3	
Social and Affective Disorders in Psychiatry	3	
Neuropsychology	3	
Retreat	2	
NeuroColloquium	0,5	
Elective Courses	8	Σ 30,5

3. Semester // Winter Semester	Credits	
Laboratory Rotations incl. Seminars	28	Σ 28

4. Semester // Summer Term	Credits	
Master Thesis	30	Σ 30
		Σ 120

5. Modules and examinations

Module	Module Element // Course	Course Requirements	Exam Period		
			Midterm WS/SS	Ex. Per. Spring	Ex. Per. Summer
NB-01	Introduction to MatLab Programming	programming project	X		
	Introduction to Computational Neuroscience	written exam (2 h)		X	
NB-02	Molecular and Cellular Neuroscience	written exam (4 h)		X	
	Neurophysiology				
NB-03	Functional Neuroanatomy	written exam (1,5 h)	X		
	Sensory Systems I	written exam (4 h)		X	
	Sensory Systems II				
	Motor Systems	written exam (2 h)			X
NB-04	Methods in Neuropsychology	written exam (4 h)		X	
	Physiological and Physical Basis of Brain Imaging Methods				
NB-05	Retreat	oral presentation	X		
NB-06	Perception, Cognition and Behavior	written exam (4 h)			X
	Evolutionary Cognitive Neuroscience				
NB-07	Neuropsychology	written exam (2 h)			X
	Social and Affective Disorders in Psychiatry				

This examinations overview shows:

- all examinations in the first year of study (1st and 2nd semester),
- the modules / module elements that are concluded with an examination,
- the type and the duration of an examination,
- the time points of the examinations (midterm, spring or summer examination period),
- and the number of exams in a given exam period (*please note the colour coding*).

6. Modules and courses

Code	Module	Module Coordinator	Term	Courses	CPs	Σ CPs
NB-01	Theoretical Neuroscience and Data Handling	Berens	1 st	<ul style="list-style-type: none"> • Introduction to MatLab Programming • Introduction to Computational Neuroscience • Essential Mathematics for Neuroscience • Essential Statistics for Neuroscience 	2 3 3 3	11
NB-02	Physiological and Cellular Mechanisms of Neurons	Schwarz	1 st	<ul style="list-style-type: none"> • Molecular and Cellular Neuroscience • Neurophysiology 	3 3	6
NB-03	Systems Neuroscience	Himmelbach	1 st + 2 nd	<ul style="list-style-type: none"> • Functional Neuroanatomy • Sensory Systems I – Visual • Sensory Systems II – Auditory and Remaining • Motor Systems 	2 2 3 3	10
NB-04	Methods in Neuroscience	Himmelbach	1 st + 2 nd	<ul style="list-style-type: none"> • Physiological and Physical Basis of Brain Imaging Methods • Methods in Neuropsychology • Methodological Frontiers in Cognitive Neuroscience 	3 3 3	9
NB-05	Introduction to Current Research	Himmelbach	1 st + 2 nd	<ul style="list-style-type: none"> • NeuroColloquium (WS + SS) • Retreat 	1 2	3
NB-06	Cognitive Neuroscience	Nieder	2 nd	<ul style="list-style-type: none"> • Perception, Cognition and Behaviour • Evolutionary Cognitive Neuroscience 	3 3	6
NB-07	Clinical Cognitive Neuroscience	Derntl	2 nd	<ul style="list-style-type: none"> • Neuropsychology • Social and Affective Disorders in Psychiatry 	3 3	6
NB-08	Electives	Himmelbach	1 st + 2 nd	<ul style="list-style-type: none"> • Elective Courses 1 – 4 		11
NB-09	Laboratory Rotation	Himmelbach	3 rd	<ul style="list-style-type: none"> • Laboratory Work + Lab Report • Student Seminar - Presentation of Lab Projects 		28
NB-10	Master Thesis	Himmelbach	4 th	<ul style="list-style-type: none"> • Laboratory Work + Thesis 		30
					Sum	120

7. Descriptions of the individual modules (NB-01 to NB-10)

Module 01		Code: NB-	ECTS Credit points 11
Theoretical Neuroscience and Data Handling			
Module coordinator Prof. Dr. Philip Berens , Institute for Ophthalmic Research			
Duration of module 1 Semester	Cycle Annually	Language of instruction English	

Module elements			
Course title	SWS	Course type	Semester*
Introduction to Computational Neuroscience	2	Lecture	WS
Essential Mathematics for Neuroscience	2	Lecture with exercises	WS
Essential Statistics for Neuroscience	2	Lecture with exercises	WS
Introduction to MatLab Programming	1 week block	Lecture with exercises	WS

* WS = winter semester

<p>Module content</p> <p>The module provides a first overview of the field of theoretical neuroscience including the necessary mathematical, statistical and computational skills. The topics covered include (1) <i>Excitable membranes</i> - Hodgkin-Huxley theory of the action potential; cable theory of passive conduction; examples of ordinary differential equations. (2) <i>Receptive fields</i> - Linear, spatio-temporal systems theory and the convolution integral; special functions used for modelling receptive fields in the visual system; relation to neurophysiological measurement protocols; nonlinear receptive fields (stereo, motion). (3) <i>Artificial neural networks</i> - Activation functions, topologies, learning rules; perceptron (pattern recognition); associative memory and self-organizing feature maps; covariance matrices and principal component analysis. (4) <i>Coding and representation</i> - The notion of statistical information (entropy); population coding; topographic maps in the visual cortex.</p> <p>The mathematics course will consist of (i) <i>Calculus</i> (differentiation, integration and Taylor approximations, multivariate calculus, basics of differential equations); (ii) <i>Linear algebra</i> (vector- and matrix manipulations, linear systems of equations as well as Eigen-values); and (iii) <i>Advanced topics</i> (principle component analysis - PCA). The statistics topics include a-priori and post-hoc tests, factorial / two-way ANOVA, repeated measures design, mixed and higher factorial designs, multiple / stepwise regression, general linear model, and finally non-parametric ANOVA.</p> <p>The programming course will introduce elements common to all programming languages (e.g. variables and operators, data types, control flow, file input/output) and point to techniques and concepts specific to Matlab, including scalar expansion, logical subscripting, reshaping and other high-level manipulation of arrays, high-level graphics commands, scripts vs. functions, speed and memory issues, and graphical user interfaces. Lectures will be interspersed with practice periods for which exercises are provided.</p>
<p>Qualification goals / learning targets</p> <p>After successful completion of the module, students will have knowledge of key concepts of computational neuroscience, understand how neuroscientific concepts can be formalized mathematically and developed into quantitative measurement protocols, and have basic understanding of the mathematical concepts required for reading journal papers in neurophysiology and systems neuroscience.</p>

Students will also have a basic tool-set of mathematical and statistical methods at their disposal that allows for applying them to data-analysis problems, for basic statistical analyses of scientific data and for correct interpretation of statistics in scientific papers. Furthermore, the programming course will enable students to collect, import, analyse and visualize experimental and modelled data of widely varying formats.

Teaching methods

The computational neuroscience class is taught in lecture-style and will provide an overview of the field. Students are expected to review topics after class by using their class notes and textbooks, which are available in the Graduate Schools library. Additional readings will be recommended.

The maths and statistics courses consist of lecture-style presentations and weekly or bi-weekly assignments that cover mathematical and statistical exercises related to the topics covered in class. The assignments will also be presented and reviewed in class. Statistical methods will also be trained by means of computer-based tutorials. Both, the maths and the statistics courses are accompanied by a tutorial (participation voluntarily).

The programming class (1 week block) consists of lecture-style teaching combined with supervised programming exercises at the computer (in teams of two or singly) by which the previously taught course content will be applied to specific questions.

Prerequisites for participation

Basic physical, mathematical and statistical skills are required.

Usability of the module

This compulsory module is to be completed in the 1st semester of the masters program and provides working knowledge and competences required for the more advanced courses in the 2nd semester and, most importantly, for data handling and analysis in the laboratory rotations and the masters thesis.

Module requirements, exams and grading scheme

The Computational Neuroscience course is concluded with a 2 hour written examination in the spring exam period (graded).

For the maths and statistics courses, 60% of the homework assignments (problem sheets) have to be achieved (not graded, pass/fail).

For the Matlab course, students are required to develop and present a programming project (midterm, shortly after conclusion of the course, graded).

The final module grade will be calculated from the grades achieved in the written exam and the programming project, weighted according to the credit points allocated (3:2). The maths and statistics courses will not contribute to the module grade.

Workload assessment and credit points		
Module element	Workload	CPs**
Introduction to Computational Neuroscience	Co: 30h + Re: 40h + Ex: 20h = 90h	3
Essential Mathematics for Neuroscience	Co: 30h + As:60h = 90h	3
Essential Statistics for Neuroscience	Co: 30h + As:60h = 90h	3
Introduction to MatLab Programming	Co: 35h + As:25h = 60h	2
Total		11

* Co=Contact time in class, Re=review after class, As=assignments/homework, Ex=exam preparation/exam

** 30 hours workload = 1 ECTS credit point

Module 02	Code: NB-	ECTS credit points 6
Physiological and Cellular Mechanisms of Neurons		
Module coordinator Prof. Dr. Cornelius Schwarz , CIN, Systems Neurophysiology		
Duration of module 1 Semester	Cycle Annually	Language of instruction English

Module elements			
Course title	SWS	Course type	Semester*
Molecular and Cellular Neuroscience	3	Lecture	WS
Neurophysiology	3	Lecture	WS

* WS = winter semester

<p>Module content</p> <p>This module will deal with the function of the basic computational units within the brain, the nerve cells and their synaptic interaction. The lecture on cellular and molecular neuroscience will provide an introduction to the lower levels of neural function, genes, proteins and sub-cellular compartments. Topics include gene expression and protein transport, ion channels, neurotransmitters and their respective ionotropic and metabotropic receptors and neurotransmitter transporters, intracellular signalling cascades and calcium functions as well as axonal transport mechanisms. Finally, the different types of glial cells are addressed and their roles in various brain functions. The cell types, processes and molecules discussed are the key players that determine the proper functioning of neural networks.</p> <p>The functional hallmark of neurons on a higher level is their ability to generate electrical and chemical signals with which they encode, transfer, and compute information. The neurophysiology lecture focuses on these signals, their nature, their mechanisms of generation, and their transmission and processing at the intra- and intercellular levels. Basic concepts, key experiments and methodological tools to study these issues are presented. The topics covered include basic electro-chemical properties (resting, action and synaptic potentials), as well as basic characteristics of neural coding using spikes and computation using dendritic potentials. State of the art electrophysiological tools (intracellular current and voltage recordings of soma and dendrites; extracellular spike and local field potential recordings; micro stimulation) as well as novel experimental techniques probing neural function using light rather than electricity (calcium/voltage imaging, and optogenetic stimulation) will be introduced.</p>
<p>Qualification goals / learning targets</p> <p>The aim of the module is to provide students with profound knowledge and basic competences on the physiology of neurons at the genetic, molecular, cellular and network level, and the methods used for its study. By the end of the module, students will have a solid understanding of electrical signal generation, processing and integration in neurons, transmission of the neuronal signal at the chemical synapse, as well as the underlying molecular building blocks. They will also be familiar with the basics of the techniques used to study neuronal processing at the single cell and small neuronal network level.</p> <p>In summary, after successful completion of this module students will be able to apply their theoretical expertise in demanding laboratory projects or, eventually, a master thesis. Furthermore, they are well prepared to read and critically evaluate publications dealing with neurophysiological topics.</p>
<p>Teaching methods</p> <p>The module is taught in lecture-style with interposed tutorials. Students are expected to review topics after class by using their class notes, the hand-outs provided and the lecture slides. Also, additional readings, such as textbooks and articles will be recommended. For the tutorials, short assignments have to be prepared and presented in class.</p>

Prerequisites for participation

Basic notions of cell biology, physiology and brain organisation are needed.

Usability of the module

Compulsory module in the 1st semester of the master program Neural and Behavioural Sciences.

Module requirements, exams and grading scheme

The module will be concluded with a 4 hour written examination (graded), which takes place in the spring exam period.

Workload assessment and credit points

Module element	Workload*	CPs**
Molecular and Cellular Neuroscience	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
Neurophysiology	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
		Total 6

* **Co**=Contact time in class + **Re**=review after class + **As**=assignments/homework + **Ex**=exam preparation and exam
 ** 30 hours workload = 1 ECTS credit point

Module 03		Code: NB-	ECTS credit points 10
Systems Neuroscience			
Module coordinator PD Dr. Marc Himmelbach, Graduate Training Centre of Neuroscience			
Duration of module 2 Semesters	Cycle Annually	Language of instruction English	

Module elements			
Course title	SWS	Course type	Semester*
Functional Neuroanatomy	1 week block	Lecture + Practical + Tutorial	WS
Sensory Systems I – Visual	1	Lecture	WS
Sensory Systems II – Auditory and remaining	2	Lecture	WS
Motor Systems	2	Lecture	SS

* WS = winter semester, SS = summer semester

<p>Module content</p> <p>The aim of this module is to provide students - coming from diverse scientific backgrounds - with a common platform of theoretical and practical knowledge about the functional organisation of the main sensory and motor systems of the mammalian brain and its structural basis. The functional organisation of the mammalian brain is introduced on the microscopic and macroscopic level from the spinal cord to the neocortex. Based on this general knowledge various sensory systems will be covered – from signal transduction at the sensory receptors to higher order processing and psychophysics. The topics include retina and visual system, cochlea and central auditory system, somatosensory system, nociception and pain, and the chemical senses olfaction and gustation. The common principles of information processing, such as signal transduction processes, coding of sensory information and neuronal representation, will be emphasized comparing these systems. The motor system part will introduce students to motor behaviour and sensorimotor integration and to the architecture and functions of the underlying neuronal substrate. The discussion of the intact systems is complemented by excursions into the consequences of disease, affecting the structures at issue.</p>
<p>Qualification goals / learning targets</p> <p>After successful completion of the module, students will be able to name and identify the major parts of the brain and their connectivity comprising the different sensory and motor systems pathways. They can compare the different types of sensory receptor cells and receptor proteins and their signal transduction cascades and explain principles of sensory transduction. Furthermore, students will be able to differentiate common and special features of information processing and coding of sensory information in the different systems. Students will be able to name and identify major brain nuclei and their connectivity comprising the motor systems pathways and circuits involved in sensorimotor integration and explain the concepts of information processing in the motor system. Students will be able to offer possible solutions to some theoretical issues in motor control. Also, students will have developed a basic understanding of some major dysfunctions and diseases of sensory and motor systems afflicting human patients</p> <p>Students will be able to compare typical examples of sensorimotor integration in humans and animals and combine knowledge on sensory and motor systems and on behavioural neurobiology to explain more complex behaviours and their underlying neuronal substrates and processes, such as the re-afference principles, learning-related modifications of behaviour, and attention-dependent changes in perception.</p>
<p>Teaching methods</p>

The functional neuroanatomy will be taught in a one-week block course consisting of lectures in the morning and tutorials and supervised practical parts in the afternoon. Students will be provided with plastinated human brain sections and with histological slides of different kinds of brain tissue for macroscopic and microscopic inspection.

The remaining courses in this module are taught in lecture-style with interposed tutorials. Students are expected to review topics after class by using their class notes, the hand-outs provided and recommended additional readings, such as textbooks and journal articles. The required textbooks are present in the Graduate Schools library. For the tutorials, short assignments have to be prepared and presented in class.

Prerequisites for participation

Basic notions of cell biology, physiology and on brain organisation are needed.

Usability of the module

Compulsory module in the 1st year of the master program Neural and Behavioural Sciences.

Module requirements, exams and grading scheme

The final module grade will be compiled from three separate examinations. The written exam covering the functional neuroanatomy course will be held shortly after conclusion of the course (midterm). A second written exam covers the sensory systems lectures and takes place in the spring exam period. A third written exam covers the motor systems lecture and is scheduled for the summer exam period. The final module grade will be calculated from the three exams weighted according to the credit points allocated (2:5:3).

Workload assessment and credit points

Module element	Workload*	CPs**
Functional Neuroanatomy	Co: 30h + Re: 10h + Ex: 20h = 60h	2
Sensory Systems I – Visual	Co: 15h + Re: 20h + As: 10h + Ex: 15h = 60h	2
Sensory Systems II – Auditory and remaining	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
Motor Systems	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
Total		10

* Co=Contact time in class, Re=review after class, As=assignments/homework, Ex=exam preparation/exam
 ** 30 hours workload = 1 ECTS credit point

Module 04	Code: NB-	ECTS Credit points 9
Methods in Neuroscience		
Module coordinator PD Dr. Marc Himmelbach , Graduate Training Centre of Neuroscience		
Duration of module 2 Semesters	Cycle Annually	Language of instruction English

Module elements			
Course title	SWS	Course type	Semester*
Physiological and Physical Basis of Brain Imaging Methods	2	Lecture	WS
Methods in Neuropsychology	2	Lecture + Practical	WS
Methodological Frontiers in Cognitive Neuroscience	2	Student Seminar	SS

* WS = winter semester, SS = summer semester

<p>Module content</p> <p>Functional imaging techniques, i.e. functional magnetic resonance imaging (fMRI), positron emission tomography (PET), electro-encephalography (EEG), magneto-encephalography (MEG) and near infrared spectroscopy (NIRS) provide a non-invasive window to probe human brain functions while subjects perform a task or experience a sensory stimulation. These correlative neuroimaging techniques are complemented by methods that allow for causal conclusions between interference with brain functions and behavioral changes: lesion-behavior mapping in neuropsychological patients and transcranial magnetic stimulation. The physiological and physical fundamentals of these techniques, practical constraints and conditions of their use, as well as ethical implications, are covered in this module. In addition, combinations of different methods via simultaneous acquisition or via post-processing will be covered. The lectures are corroborated by a seminar that introduces advanced methods and combinations of established methods presented in the lectures. Students read and discuss outstanding studies that demonstrate the impact of new methodological developments in the abovementioned technological fields.</p>
<p>Qualification goals / learning targets</p> <p>After successful completion of this module, students will have a solid understanding of the physiological and physical mechanisms underlying different functional imaging modalities used in humans. They will be able to choose the imaging methods appropriate for the specific neuroscientific questions at hand. They will get insight in the strength and limitations of each of the methods and their pitfalls and know which techniques are suitable to be combined in order to potentiate the scientific outcome. Finally, the module enables the students to read and critically discuss published neuroimaging and TMS and neuropsychological studies. The expertise gained in this module is an asset for students who plan on doing lab rotations where functional brain imaging techniques or TMS is employed.</p> <p>In the seminar, the students will be requested to summarize each paper, discuss the content, and to moderate the discussion. Despite of an advanced methodological knowledge, the key goal of the seminar is to develop students' skills in structured reading of scientific articles, presentation, moderation, and critical scientific discussion based on their knowledge about methods in neuroscience.</p>
<p>Teaching methods</p> <p>The courses in this module are taught in lecture-style with additional tutorials, supplementary exercises and supervised hands-on practical sessions. Students are expected to review topics after class by using their class notes and recommended additional readings. For the tutorials, short assignments have to be prepared and discussed in class. The seminar requires students to deal with cognitive neuroscience topics and methods in</p>

more depth. Students present seminal papers on selected topics. The core findings and conclusions of the studies will be discussed in class. Students have to read all papers before they are presented in class.

Prerequisites for participation

Basic knowledge in neurophysiology, physics and inferential statistics.

Usability of the module

Compulsory module in the 1st year of the master program Neural and Behavioural Sciences.

Module requirements, exams and grading scheme

The module examination consists of a 4 hour written exam (graded) in the spring exam period.

For the seminar, students have to give a presentation on a selected topic. In addition, they are required to hand in one-page summaries/discussions of the papers before each session. The seminar is not graded (pass/fail).

Workload assessment and credit points		
Module element	Hours*	CPs**
Physiological and Physical Basis of Brain Imaging Methods	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
Methods in Neuropsychology	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90 h	3
Methodological Frontiers in Cognitive Neuroscience	Co: 30h + Re: 20h + As: 40h = 90h	3
		Total 9

* **Co**=Contact time in class, **Re**=review after class, **Se**=preparation of seminar presentation, **As**=assignments/homework, **Ex**=exam preparation/exam
 ** 30 hours workload = 1 ECTS credit point

Module 05	Code: NB-	ECTS Credit points 3
Introduction to Current Research		
Module coordinator PD Dr. Marc Himmelbach , Graduate Training Centre of Neuroscience		
Duration of module 2 Semesters	Cycle Annually	Language of instruction English

Module elements		
Course title	Course type	Semester*
NeuroColloquium	Talks (<i>invited speakers</i>)	WS + SS
Weekend Seminar / Retreat (<i>changing topics</i>)	Student Seminar	SS

* WS = winter semester, SS = summer semester

<p>Module content</p> <p>The NeuroColloquium is a long-standing, fortnightly seminar series organized by the Tübingen neuroscience community. The seminar presents internationally renowned researchers from various fields of neuroscience. The talks have a review-like character providing an overview on state-of-the-art neuroscience topics, from genes to behaviour and new methodologies. Students will get the opportunity to choose speakers of their interest and meet with them before and after the talk.</p> <p>Once a year, the master students of the two Graduate Schools will jointly attend a retreat where they present and discuss topics that are generally not part of their regular curricular course program. Past topics included: Sex Differences in the Brain, Neuropharmacology: From Basic Science to Marketable Drugs, Neuroprosthetics, Executive Functions, Philosophy of Mind, Ethics in Neuroscience, and Animals in Neuroscience Research. The seminar topics are usually proposed and cooperatively chosen by students and lecturer and change every year.</p>
<p>Qualification goals / learning targets</p> <p>The intention of this module is to introduce students to a wide spectrum of current neuroscientific topics. The talks in the NeuroColloquium and the retreat complement one another to achieve this goal and provide insights in state-of-the-art neuroscience research questions and methodologies.</p> <p>Particularly in NeuroColloquium students will get to know a wide range of neuroscience research topics and methods and makes them 'look beyond their own noses'. Of the 8 speakers visiting per semester, 2 speakers will be selected, invited and hosted by students of the Graduate Schools. By doing so, students actively participate in organizing a seminar series and will thereby gain organizational skills and social competence.</p> <p>After successful completion of the retreat, students will have achieved skills that are required for scientific work in general, including literature search and preparation and presentation of a seminar talk on an unfamiliar topic. In addition to discussing and reflecting scientific topics, these retreats are also meant as social events where students from the three master programs meet with scientists and lecturers in a beautiful setting and a relaxed ambiance to get to know each other and to potentially initiate local co-operations.</p>
<p>Teaching methods</p> <p>The retreat requires students to deal with new, as yet unfamiliar neuroscience topics in depth. The students present talks on general neuroscience topics. The core findings and conclusions will be discussed after the talk.</p> <p>The NeuroColloquium is a bi-weekly seminar series with invited speakers.</p>

Prerequisites for participation
None

Usability of the module

Compulsory module in the 1st and 2nd semester of the master program Neural and Behavioural Science.

Module requirements, exams and grading scheme

For the NeuroColloquium, regular attendance is required. Successful participation of the Retreat requires complete attendance and presentation of a 30 minutes talk on a selected topic, including the preparation of a hand out. This module is not graded (pass/fail).

Workload assessment and credit points

Module element	Workload*	CPs**
NeuroColloquium (16 talks in total in WS and SS)	Co: 30h	1
Weekend Seminar / Retreat (2 days)	Co: 30h + Se: 30h = 60h	2
		Total 3

* **Co**=Contact time in class, **Re**=review after class, **As**=assignments/homework, **Se**=preparation of seminar presentation
 ** 30 hours workload = 1 ECTS credit point

Module 06		Code: NB-	ECTS Credit points 6
Cognitive Neuroscience			
Module coordinator Prof. Dr. Andreas Nieder , Dept. Biology, Inst. Neurobiology – Animal Physiology			
Duration of module 1 Semester	Cycle Annually	Language of instruction English	

Module elements			
Course title	SWS	Course type	Semester*
Perception, Cognition and Behaviour	2	Lecture	SS
Evolutionary Cognitive Neuroscience	2	Lecture	SS

*SS = summer semester

<p>Module content</p> <p>This module will provide an introduction into the field of Cognitive Neuroscience. It will offer an overview on the perceptual, behavioural and physiological processes of human and animal cognition, including relevant methodological techniques and computational aspects.</p> <p>The lecture Perception, Cognition and Behaviour first teaches conceptual issues of learning and memory, how memories ontogenetically develop and can go wrong (false memories), and how humans and animals learn from others (social learning). Next, spatial cognition and navigation is addressed, how it can be implemented in the human brain and in robots. The lecture closes with a view on visual perception, its subjective and active components as emphasized by inferences and eye movements.</p> <p>The lecture Evolutionary Cognitive Neuroscience addresses the behavioural and neural foundations of cognition in the animal kingdom with a strong emphasis on evolutionary and comparative aspects. Topics comprise the theory of evolution, evolutionary neuroscience, phylogeny and ontogeny of communication and social cognition, neuroethological model systems of cognition, core knowledge of objects, actions, number, and space.</p>
<p>Qualification goals / learning targets</p> <ul style="list-style-type: none"> • To understand the psychological manifestations and core concepts of cognition, its unifying aspects and difference with respect to other brain functions. • To grasp the neurophysiological mechanisms and brain structures giving rise to animal and human cognition. • To assess the adaptive value of cognition in humans and animals. • To appreciate the phylogenetic diversity of cognitive phenomena found in the animal kingdom from a comparative point of view. • To become familiar with the different invasive and non-invasive techniques used to link brain and cognition. • To interpret the consequences of cognitive dysfunction in patients. • To learn to think critically and scientifically about the scopes and limits of experimental protocols, methods, data bases and derived conclusions in cognitive neuroscience.
<p>Teaching methods</p> <p>The courses of this module are taught in lecture-style with regular, interposed tutorials. Students are expected to review topics after class by using their class notes and the course hand-outs provided. Additional readings will be recommended. For the tutorials, short assignments have to be prepared and presented in class.</p>

<p>Prerequisites for participation</p> <p>Solid knowledge about fundamental neuroscience, behavior and physiology is required.</p>

Usability of the module

Compulsory module in the 2nd semester of the master program Neural and Behavioural Sciences.

Module requirements, exams and grading scheme

The final module examination consists of a written, graded exam in the summer examination period covering the topics of the courses taught in the module.

Workload assessment and credit points		
Module element	Hours*	CPs**
Perception, Cognition and Behaviour	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
Evolutionary Cognitive Neuroscience	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
		Total 6

* Co=Contact time in class, Re=review after class, As=assignments/homework, , Ex=exam preparation/exam

** 30 hours workload = 1 ECTS credit point

Module 07		Code: NB-	ECTS Credit points 6
Clinical Cognitive Neuroscience			
Module coordinator Prof. Dr. Birgit Derntl , Clinic for Psychiatry and Psychotherapy, Res. Group Innovative Neuroimaging			
Duration of module 1 Semester	Cycle Annually	Language of instruction English	

Module elements			
Course title	SWS	Course type	Semester*
Neuropsychology	2	Lecture	SS
Social and Affective Disorders in Psychiatry	2	Lecture / Seminar	SS

*SS = summer semester

<p>Module content</p> <p>This module will provide an introduction to the field of clinical cognitive neuroscience. It will offer an overview on the perceptual, behavioural and physiological processes of human cognition and emotion in healthy individuals and clinical samples, including relevant methodological techniques and computational aspects.</p> <p>Neuropsychology bridges the fields of neurology/psychiatry and psychology to unravel and understand the relationship between structure and function in the human brain. Investigating cognitive-emotional processes can inform theories about brain functions and offers knowledge about neuronal mechanisms underlying these mental capacities. One approach to understand processes such as language, attention, perception, action, sensory-motor integration, learning, consciousness etc. is to study neurological patients with brain damage. Other techniques used by neuropsychologists in this course are functional neuroimaging (fMRI, PET, MEG) and function interference methods (TMS) in healthy and in brain-damaged subjects. The course will present neuropsychological disorders as well as results obtained by the latter techniques, both with respect to their contribution for our understanding of cognitive functions in humans.</p> <p>The course on Social and Affective Disorders in Psychiatry focuses on highlighting state of the art research in the domain of social and affective neuroscience in healthy individuals and patients suffering from psychiatric disorder.</p> <p>Investigating social cognition and affective processes is getting more and more popular as paradigms have been developed, which (partly) capture these complex processes. In the last years, a lot of evidence has been gathered regarding the “social brain”, where scientists aimed to better understand the neural correlates of emotion recognition, emotion regulation, mood induction, stress response, empathy, motivational behavior, etc. In this regard, patients suffering from mental disorders show severe impairments in social cognition with far reaching consequences for diagnostics and therapeutic interventions. Furthermore, in a time when perceived work load and stress levels are rising, investigating mental disorders that are associated with stress (such as depression, anxiety or schizophrenia) and their dysfunctions have broad societal significance.</p> <p>In this seminar, major psychiatric disorders will be introduced with a focus on schizophrenia and affective disorders. Neuroimaging studies performed in these clinical samples that investigated social or affective processes will be highlighted and presented by students illustrating state of the art methods and current research directions. By doing so, we want to discuss the experimental methods, paradigms applied, methodological issues as well as clinical relevance. Moreover, future directions will be discussed.</p>
<p>Qualification goals / learning targets</p> <p>A central goal of this module is to introduce students to the functional organisation of the human brain in healthy individuals and different clinical samples. By the end of this module, students will be familiar with different invasive and non-invasive techniques used to link brain and cognition / emotion with a specific introduction to the ,social brain'. Students will know and characterize the hallmarks of major neurological and psychiatric disorders</p>

and their dysfunctions related to cognition and emotion. Moreover, they know classic and state of the art paradigms used to assess cognitive and socio-emotional processes.

Teaching methods

The Neuropsychology course is taught in lecture-style with regular, interposed tutorials. Students are expected to review topics after class by using their class notes and the course hand-outs provided. Additional readings / textbooks will be recommended. For the tutorials, short assignments have to be prepared and presented in class.

In the seminar, a general introduction to social and affective neuroscience and the different mental disorders will be given. Then, the students will be requested to orally present a published study of their choosing (although some criteria are determined before). All studies will investigate socio-emotional abilities with neuroimaging methods and will include a clinical sample. Thereby, students will be introduced to literature research, train their understanding of scientific texts and learn how to present a study in short time (15min). Additionally, students will be asked to write a scientific expose, where they have to design a study of their own focusing on socio-emotional competencies and mental disorders. By doing so, they will have to perform a literature research (in order to write the background), think of hypotheses and consider a realistic work plan. Students will receive feedback on their oral presentation as well as on their expose.

Prerequisites for participation

Solid knowledge of systems neuroscience and brain imaging methods.

Usability of the module

Compulsory module in the 2nd semester of the master program Neural and Behavioural Sciences.

Module requirements, exams and grading scheme

For the Neuropsychology lecture the final examination consists of a written exam (graded) covering the topics of the lectures taught. For the seminar, students have to present a study, write an expose and actively participate in the seminar. All students will receive feedback on their presentation, their participation in the seminar and their expose (graded). The module grade is obtained by a weighted average from the two course grades based on their allocated CPs.

Workload assessment and credit points		
Module element	Hours*	CPs**
Neuropsychology	Co: 30h + Re: 30h + As: 10h + Ex: 20h = 90h	3
Social and Affective Disorders in Psychiatry	Co: 30h + Re: 30h + As: 30h = 90h	3
		Total 6

* Co=Contact time in class, Re=review after class, As=assignments/homework, , Ex=exam preparation/exam

** 30 hours workload = 1 ECTS credit point

Module 08		Code: NB-	ECTS credit points 11
Electives			
Module coordinator PD Dr. Marc Himmelbach , Graduate Training Centre of Neuroscience			
Duration of module 2 Semester	Cycle Annually	Language of instruction English	

Module elements			
Course title	SWS	Course type	Semester*
Elective Courses	n.a.	n.a.	WS / SS

* WS = winter semester / SS = summer semester

<p>Module content</p> <p>Depending on the subjects of their previous training and/or their particular interests, students are free to choose courses from the masters programs Neural and Behavioural Sciences or Neural Information Processing or from any other masters program offered at Tübingen University. The electives may comprise advanced neuroscience or neuroscience methods courses, statistics or programming courses as well as courses on ethical, philosophical or related issues. Before the start of the term, students will be provided with a list of selected courses to choose from. Courses selected by a student have to be approved beforehand by the module coordinator.</p>
<p>Qualification goals / learning targets</p> <p>The electives will impart students with specific knowledge and competencies in subject areas of their choice and may either deepen their knowledge in fields of their specialization or complement the training already provided with the compulsory curricular courses. By doing so, students can pursue their broad interest and can understand contexts and co-relations beyond the limits of their major discipline and, depending of the topics chosen, students will be imparted to discuss research topics interdisciplinary.</p>
<p>Teaching methods</p> <p>Depends on the type of course selected.</p>

<p>Prerequisites for participation</p> <p>Depending on the type of course selected. The course coordinator must approve the subjects of choice.</p>
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<p>Usability of the module</p> <p>Compulsory module in the 1st and 2nd semester of the master program Neural and Behavioural Sciences.</p>

<p>Module requirements, exams and grading scheme</p> <p>According to the specifications provided in the module description of the respective masters program.</p>
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Workload assessment and credit points		
Module element	Hours*	CPs*
Elective Courses	330 h	11
		Total 11

• 30 hours workload = 1 ECTS credit point

Module 09		Code: NB-	ECTS Credit points 28
Laboratory Rotations			
Module coordinator PD Dr. Marc Himmelbach , Graduate Training Centre of Neuroscience			
Duration of module 1 Semester / 2 x 10 weeks	Cycle n.a.	Language of instruction English	

Module elements		
Course title	Course type	Semester*
1 st Laboratory Rotation	Practical	WS
+ Presentation of Laboratory Projects	Student Seminar	
2 nd Laboratory Rotation	Practical	WS
+ Presentation of Laboratory Projects	Student Seminar	

* WS = winter semester

<p>Module content</p> <p>Students are required to perform two laboratory rotations (10-weeks each, all day) where they work on small research projects in laboratories of their choice. In general, the assigned study is in line with currently on-going research in the respective laboratory and supervised at least by an advanced doctoral student or a postdoc. The lab projects have to be concluded with a written report (formatted like a scientific paper) and an oral presentation during a seminar at the end of the rotation, which provides a platform for the students to present their research projects.</p> <p>The curriculum requires students to perform <i>two</i> experimental lab rotations, which should ideally be performed in <i>two</i> different research groups with distinct scientific questions and different methods.</p>
<p>Qualification goals / learning targets</p> <p>During the lab rotations, students will acquire a wide range of practical skills in state-of-the-art methods and they get to know current scientific questions and research approaches. The skills trained during lab rotations include literature survey, planning of research project and design of experiments, documentation of data generated, critical evaluation and interpretation of results, compiling data for and writing of a report. In addition, social competences will be trained during collaboration with other members of the hosting research group. In the end, students have also learned to prepare and give an oral presentation on their research project.</p> <p>After successful performance of the two laboratory rotations students will have gained theoretical and practical competencies to tackle a demanding master thesis project: they can identify a scientific question, they can implement adequate experiments and combine methods in a meaningful manner, they can critically analyse their data collected, reflect their findings and relate them to relevant findings of others, hypothesize about the potential meaning of their findings and generate genuine ideas for future experiments.</p>
<p>Teaching methods</p> <p>Supervised practical training in the laboratory, including reading of research papers, writing of a report formatted like a scientific paper, oral presentation and discussion of the research findings. The student's progress is monitored through weekly meetings with her/his supervisor.</p>

Prerequisites for participation

Successful completion of the winter and summer semester modules and project-specific knowledge gained in the first year of study.

Usability of the module

Compulsory module in the 3rd semester of the master program Neural and Behavioural Sciences.

Module requirements, exams and grading scheme

The students' performance will be assessed and graded by the supervisor according to the following criteria: understanding of theoretical framework and literature overview (15%), practical work in the lab (30%), generation of own ideas (10%), oral presentation of the project and discussion in the seminar (15%), written lab report (30%). The evaluation will be done on a form provided by the Graduate School.

Workload assessment and credit points		
Module element	Workload *	CPs**
1 st Laboratory rotation	Co: 9w = 360 h	12
Writing of report, preparing presentation, seminar	LR/Se: 7d = 56 h	2
2 nd Laboratory rotation	Co: 9w = 360 h	12
Writing of report, preparing presentation, seminar	LR/Se: 7d = 56 h	2
	Total 832 h	28

* Co=contact time in laboratory, LR=writing of laboratory report, Se=preparation of seminar presentation, w=weeks, d=days, h=hours
 ** 30 hours workload = 1 ECTS credit point

Module 10		Code: NB-	ECTS Credit points 30
Master Thesis			
Module coordinator PD Dr. Marc Himmelbach , Graduate Training Centre of Neuroscience			
Duration of module 1 Semester / 6 months	Cycle n.a.	Language of instruction English	

Course title	Course type	Semester*
Experimental Master Thesis	Research Project	SS

*SS = summer semester

<p>Module content</p> <p>To complete their studies, students are required to prepare a master thesis in a laboratory of their choice. In general, the assigned project is in line with currently on-going research in the respective laboratory and supervised by the group leader or at least by an advanced postdoc. The experimental master thesis will require students to perform research more or less independently within a given period of time. The master's project will be concluded with a written thesis formatted like a scientific paper.</p>
<p>Qualification goals / learning targets</p> <p>After successful completion of the master thesis, students have acquired profound practical skills in state-of-the-art methods applied in neuroscience. They are acquainted with current neuroscientific questions and recent publications in this particular field. They are trained in compiling and analysing scientific data and writing a scientific report. In addition to scientific expertise, students will acquire soft skills, such as time and project management, working in international, interdisciplinary teams, English communication and writing skills, and rules of responsible conduct of research. Overall, with successful completion of the master thesis, students proof their scientific competence and demonstrate that they are well prepared to tackle demanding research projects such as, for example, a doctoral thesis (see also: 2nd paragraph of qualification goals of module NB-09).</p>
<p>Teaching methods</p> <p>Supervised practical training in a laboratory, including reading of research papers, presentation of progress reports, and writing of a master thesis.</p>

<p>Prerequisites for participation</p> <p>Successful completion of all theoretical and practical course requirements of the first 3 semesters (exams, lab rotations).</p>
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<p>Usability of the module</p> <p>Compulsory module in the 4th semester of the master course Neural and Behavioural Sciences.</p>

<p>Module requirements, exams and grading scheme</p> <p>Students are required to submit – after 6 months of work – three copies of their thesis to the office of the Graduate School. At the student's request and upon hearing the supervisor, the examination board may grant an extension of the submission deadline for up to 4 weeks, at most. Two readers, one of which is the supervisor, will evaluate the thesis. The examination board will appoint the readers.</p>

Workload assessment and credit points		
Module element	Workload	CPs*
Master Thesis	23 w x 5 d x 8 h = 920 h	30

* 30 hours workload = 1 ECTS credit point (w=weeks, d=days, h=hours)