Introduction to Brain Science

Faculty of Psychology and Neuroscience

BRAIN1001

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
3.0

Coordinator:
P.H.M. de Weerd

Teaching methods:
PBL, Lecture(s)

Assessment methods:
Assessment

Full course description

This course has three main purposes. A first goal is to make students feel welcome in the course and in the BSc Brain Science. The tutorials in this course will make ample room for students to get to know each other, and for getting familiar with the teaching system (PBL) as implemented in the BSc Brain Science. The materials to be read and discussed in the tutorials will be limited, in order to allow for this.
A second goal is to provide students with a bird's eye overview of the curriculum, insight into the principles that underlie its construction, and information about the role of different courses, the projects, electives, and internship/thesis. In this way, students will know why they have to undertake specific learning activities at any given moment in the curriculum. Students will be informed about their (excellent) perspectives for master choices, and excellent job prospects. Some practical information will also be provided in this course (e.g., on mentorship, social media etiquette in lectures and tutorials, choice of projects, etc.). A third goals is to introduce students to the transdisciplinary field of Brain Science at a content level. The scientific method and its historical/philosophical antecedents will be covered, leading to the concept of the theoretical-experimental cycle. In an introductory and conceptual manner, through the use of examples, the course will also anticipate on the application of the mathematical training in brain research. Finally, the course will highlight cutting-edge methodological developments in this transdisciplinary field, such that students learn not only about the history of their chosen academic discipline, but also about its exciting future.
“Please note: the final assessment for this course is pass or fail - and not a grade.”

Course objectives

1. Understand the relevance of some ancient findings and philosophies for current brain science.
2. Understand the roots of the transdisciplinary field of Brain Science in its constituting research traditions.
3. Understand the core ideas of the scientific method
4. Understand basic concepts of philosophy of science
5. Understand the basics of some of the current findings, theories and computational models that emerged from different research traditions, and understand their interrelations.
6. Develop a beginning understanding of the current and future directions for the transdisciplinary field of Brain Science, with awareness of potential ethical concerns
7. Develop skill in writing about various topics in brain science (e.g., describing, explaining and contrasting theories), with a sense of critical thinking.
8. Learn how to explain important concepts and theories in brain science to each other, thus working as a team to collectively increase understanding of the topics covered in each task.
9. Apply good, respectful communication in the group, and write in professional English.

Genes, Proteins and Evolution

Faculty of Psychology and Neuroscience

BRAIN1002

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
4.0

Coordinator:
M. Gerards

Teaching methods:
PBL, Lecture(s), Skills

Assessment methods:
Written exam, Attendance

Full course description

In this course, students will be introduced to the anatomy and function of the eukaryotic cell. The course will further focus on the structure, function, and dynamics of several key molecules, including DNA, RNA, and proteins, as well as their interrelations and interactions. An important aspect of this is how environmental factors affect gene expression and hence cell functioning and thus, ultimately, behaviour. In this way, the course provides an important perspective on links between cell biology and psychology (behaviour). In addition, the topic of epigenetics will be related to the concepts of genetics and genomics. Furthermore, the course will introduce students to the key principles of evolution, such as random mutation and non-random selection, inheritance, and the relation between phenotype and genotype. This gives students a basic understanding not only of how biological but also psychological/cognitive traits of an individual may emerge. Some concepts of selection in evolution also foreshadow concepts of probability theory taught later in the curriculum. This course, furthermore, entails skills trainings wherein students learn basic lab skills.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Describe and explain the anatomy of eukaryotic cells.
2. Understand the structure, function and dynamics of DNA and DNA replication.
3. Understand the structure, function and dynamics of genes and proteins.
4. Describe the processes involved in translating genetic information into proteins
5. Understand the core principles and mechanisms of evolution.

6. Understand the principles of genetic variation in populations and explain the relationship between genetic variation, phenotypic differences and evolution.
7. Describe the role of epigenetic processes and how environmental factors affect phenotypic traits.

Linear Algebra and Calculus I and II

Faculty of Psychology and Neuroscience

BRAIN1003

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
6.0

Coordinator:
G. ValenteF. de Martino

Teaching methods:
Lecture(s), Skills, Assignment(s)

Assessment methods:
Written exam, Attendance, Assignment

Full course description

Linear Algebra and Calculus I

Brain science rests on a solid basis in mathematics. In fact, the empirical study of brain mechanisms relies on the observation and interpretation of multidimensional data together with the use of complex mathematical models, which requires tools of Linear Algebra. In this foundational course we will introduce the concepts of vectors, spaces, matrices and their operations, including sums, products, inversion, eigenvalue decomposition and linear systems of equations.

Each week consists of one or two lectures, together with homework, both pen and paper and computer assignments. Furthermore, a weekly debriefing session will take place to discuss the homework and assignments, under the guidance of a tutor.

The course links broadly through selected applications with concepts (e.g. Hebbian learning, mental rotations, spatial filtering) that are described in parallel and future courses such as Introduction to Cognitive Neuroscience and Learning and Memory.

Linear Algebra and Calculus II

A problem that occurs ubiquitously, when modelling real world phenomena (e.g., brain processes such as perception, or neural computations), is how to deal with instantaneous changes, and infinitely small quantities. This second part of the course will provide foundations of infinitesimal calculus, which are needed for the analysis as well as computational modelling of brain data and related behavioural data and serves as a substrate for more specific mathematical and modelling

topics. The course will introduce the concepts of functions and their inverses, complex numbers as well the concepts of infinite series, limits, integration, differentiation, and multivariable calculus. Each week consists of one or two lectures, together with homework, both pen and paper and computer assignments. Furthermore, a weekly debriefing session will take place to discuss the homework and assignments, under the guidance of a tutor.
The course links broadly through selected applications with concepts (e.g. retinotopy, tonotopy, memory decay, action potential) that are described in parallel and future such as Introduction to Cognitive Neuroscience, Learning and Memory and Brain Cells.

“Please note: the final assessment for this course is a grade between 1-10."

Course objectives

Linear Algebra and Calculus I

1. understand matrix notation and matrix operations
2. solve a linear system of equations by Gaussian Elimination
3. understand vector spaces and subspaces – the idea of basis
4. understand orthogonality and projections
5. understand eigenvalues, singular values and principal components
6. help each other in solving various mathematical exercises

Linear Algebra and Calculus II

- understand functions and inverse functions of a single variable
- understand and manipulating complex numbers
- understand the decomposition of a function into an infinite series
- understand the concepts of limits, derivatives and integration and their relation
- know how to perform differentiation and integration
- understand the concept of differential equation and its solution
- help each other and exchange background and skill in addressing the challenges posed by the mathematical problems discussed in the exercise (debriefing) sessions.

Pract. Genes, Proteins & Evolution

Faculty of Psychology and Neuroscience

BRAIN1004

Period 1:

1 Sep 2025 **24 Oct 2025**

Credits:

0.5

Coordinator:

A. TianeR.J.M. Riemens

Teaching methods:

Skills

Assessment methods:

Attendance, Assignment

Full course description

Practical for module BRAIN1002 Genes, Proteins and Evolution

Programming I

Faculty of Psychology and Neuroscience

BRAIN1005

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
5.0

Coordinator:
D. TrübutschekR. Auksztulewicz

Teaching methods:
Lecture(s), Skills, Assignment(s)

Assessment methods:
Attendance, Assignment

Full course description

This course introduces students to the world of programming. Programming is a core tool of a Brain Scientist, as it allows for manipulating and visualizing neural processes and neural data as well as to translate theoretical ideas into practical applications. Students learn about the principles of programming and basic programming tools, which involves knowledge of data structures and skill in object-oriented programming. Students will also be taught the principles of proper housekeeping of their software, including appropriate commenting of scripts and the implementation of proper version control. Students meet in groups where an instructor explains a set of programming principles, and sends the students home with a task to accomplish by the next meeting. Specifically, students must translate specific tasks into computer code. These tasks will be chosen to link with the content and mathematical insights of other courses. Throughout this programming course, an emphasis will be placed on visualizations of data and algorithms, and on the implementation of basic aspects of specific types of computational models. Hence, in addition to exercises in the mathematics courses, the programming course is the place where the coding of specific models or the simulation of these models will be practiced in coordination with the content courses where these models are introduced. After completing the Programming I, students will be familiar with the core elements of programming and can implement learned mathematical functions or computational principles into programs and (simplified) computational models.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. understand core elements of programming
2. implement programs in Python

Writing and Presenting I

Faculty of Psychology and Neuroscience

BRAIN1122

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
1.5

Coordinator:
H.C.A. Woodruff

Teaching methods:
PBL, Lecture(s), Assignment(s), Presentation(s)

Assessment methods:
Portfolio, Attendance

Full course description

Throughout Year 1 and 2, students will receive training to improve their written and oral communication. This training encompasses a range of writing formats and skills (e.g., from keeping lab books and records of procedures to writing the different parts of a scientific paper), as well as presentation formats (e.g., from project proposals to presenting results). In addition, although the focus of teaching communication skills lies on scientific communication, some attention is also given to communication tailored to lay audiences.

Recognising the evolving landscape of communication technologies, the curriculum incorporates instruction on the responsible and ethical use of generative AI (genAI) tools to enhance writing and presenting skills. Students will learn how and when to effectively utilize genAI platforms to improve clarity, organization, and style in their work. This includes understanding the limitations of AI assistance, ensuring originality, learning good prompting skills, and maintaining academic integrity. Notably, most of the training in academic communication occurs within the main content courses, through the use of written or oral assessment formats. These will include crafting the structure of a paper to be used as a starting point for the use of Large Language Models (LLMs, such as chatGPT), writing short descriptions of what was learned during a part of a course, or doing a presentation, which is followed by reflection on the use of GenAI, as well a feedback from examiners, tutors, peers, or AI writing coaches. Furthermore, students will be encouraged o use LLMs to generate different versions of their drafts for different audiences and applications, and will reflect on the varied outputs.

All this means that there is ample attention to academic communication throughout the curriculum, to which the present course adds an extra 1.5 credits in the first two years of the programme. The purpose of the extra formalized teaching in the present course is to give timely, standardized instruction and guidelines to students with respect to the different communication formats used in the curriculum. Hence, specific communication styles (e.g., a specific format of presentation or writing) will be covered at the time in the academic year when this becomes relevant for the students.

For example, around the time students will need to write a project proposal and deliver a project presentation for their Project in Period 3, the principles and points of attention for these written and oral forms of communication will be highlighted. Simultaneously, guidance on leveraging genAI tools for brainstorming, drafting, and refining their proposals and presentations will be provided. Emphasis will be placed on critical thinking and the ability to assess AI-generated suggestions, ensuring students can discern valuable input while avoiding potential pitfalls such as misinformation or lack of originality.

By integrating genAI education into the curriculum, we aim to equip students with modern communication skills that are essential in todays technologically advanced academic and professional environments. This holistic approach ensures that students are not only proficient in traditional communication methods but are also adept at responsibly utilizing emerging technologies to enhance their work.

The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

1. Relay content correctly and accurately (presentation & paper/report)
2. Provide a transdisciplinary perspective by linking the work with other courses (presentation & paper/report)
3. Use a clear structure and convey the interrelations among parts (presentation & paper/report)
4. Use the English language properly, enhancing language proficiency with appropriate GenAI tools and feedback (presentation & paper/report)
5. Design effective visual text structure, potentially utilizing GenAI for visual aids (paper/report)
6. Design effective slides, considering GenAI suggestions for layout and content (presentation)
7. Deliver presentations with enthusiasm and confidence, understanding the role of GenAI in preparation (presentations)
8. Utilize GenAI tools responsibly and ethically to enhance writing and presenting skills (presentation & paper/report)
9. Critically assess and integrate AI-generated content while maintaining academic integrity (presentation & paper/report)
10. Understand the limitations and potential biases of GenAI tools, ensuring originality in work (presentation & paper/report)

11. Exchange opinions on what constitutes good writing and presenting, including the impact of GenAI, and learn from each other on these topics.

Mentor-guided Portfolio-building

Faculty of Psychology and Neuroscience

BRAIN1123

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
2.0

Coordinator:
G.A.M. Blokland

Teaching methods:
Assignment(s)

Assessment methods:
Portfolio, Attendance

Full course description

In Year 1, and throughout the programme, students will be mentored, and mentorship will be organized around portfolio building and individualized follow-up. All aspects of the programme, incl. all forms of assessment, as well as relevant extracurricular activities, may be used as material for feedback in a process by which students set specific goals, define strategies to reach their goals, and then analyse their progress. These goals can be in different competency domains (i.e., brain scientist, science communicator, professional, and/or lifelong learner competencies), including exam results on courses and skills, but may also focus on personal growth in various modes of communication and cultural sensitivity, organisational skills, providing and receiving feedback, etc. Because of the construction of the programme, stated goals in the portfolio in Year 1 and 2 most likely will be focused on content and skills required to master the curriculum. Towards the end of Year 2 and in Year 3, additional goals related to electives, thesis topic, and future study choices, as well as related to personal growth and life-long learning, will feature more prominently in the students' portfolio. Embedded in the mentorship offered to the students are also alumni, networking, and entrepreneurial events where staff from a range of academic, research, and governmental institutions as well as from various industries will interact with the Brain Science Bachelor students to provide perspectives on employability. These events will also invite students from relevant masters, with whom Brain Science bachelor students can interact to make informed master choices. The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

1. To perform self-analysis based on comprehensive information and self-observations to identify points for improvement in one or more competencies that need to be developed further, and to translate this analysis in goal setting.
2. To make choices of strategies towards reaching the identified goal, and plan implementation.
3. To translate strategies and implementation plans into action.
4. To monitor the outcomes of the actions against stated learning goals.
5. To conclude after a set time whether a goal has been reached or not, after which a new cycle of portfolio building is set in motion.
6. To perform all steps in the portfolio-building cycle with a realistic and balanced view towards oneself.
7. To create a written portfolio in good English, based on a well-organized set of honest notes collected through the academic year.
8. To elaborate verbally on the portfolio and to interact constructively with the input given by the mentor

Introduction to Cognitive Neuroscience

Faculty of Psychology and Neuroscience

BRAIN1021

Period 2:
27 Oct 2025 **19 Dec 2025**

Credits:
4.0

Coordinator:
J.C. PetersM.M.L. Moerel

Teaching methods:
PBL, Lecture(s), Presentation(s)

Assessment methods:
Written exam, Presentation, Attendance

Full course description

Cognitive psychology came to the forefront of psychology in the last fifty years, as it became clear that mental constructs can be meaningfully described in mechanistic terms. In this course, students will gain an overview of cognitive science through an introduction to several core topics including attention, memory, and action. Importantly, these cognitive functions are immediately linked to biological mechanisms in the brain. This introduces the field of cognitive neuroscience, the discipline that bridges cognitive science, psychology and neuroscience. Students will become acquainted with the most important theories and models in the domains of cognitive neuroscience. Moreover, a global overview of the various tools in the cognitive neuroscientist' arsenal, including neuroimaging tools like fMRI and EEG, and brain stimulation tools like TMS will be provided. The introduction to the most important cognitive domains and how they are studied will be illustrated by widely used, renowned cognitive tests (e.g., perception thresholds, memory 15-word list, Eriksen flanker task). In the course, there will be a focus on the scientific method and students will get hands-on experience on how cognitive phenomena can be measured by performing small "lab" experiments themselves.
With the overview of cognitive neuroscience gained in this course, students get the groundwork for four learning lines in the curriculum, including a set of three courses on perception, a set of three courses on learning & memory, a set of three courses focused on the motor system, and two courses on brain cells and networks. Additionally, the present course foreshadows separate year 2 courses in which students will receive background and training in the various data acquisition tools in the cognitive psychology arsenal, including behavioural experiments but also neuroimaging and brain

stimulation (Behavioural Research Methods, and Methods for Measuring and Manipulating Brain Activity). The focus on the scientific method is an optimal preparation for empirically-oriented projects in the subsequent project periods
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. describe the multi-disciplinary field of cognitive neuroscience, placing it in its historical context
2. explain the scientific method as used in the fields of cognitive psychology and neuroscience, and apply this method to new research questions
3. discuss experimental designs used in cognitive psychology and neuroscience to answer research questions
4. describe the various cognitive functions and link them to functional organization in the brain
5. describe the cognitive neuroscience techniques available to study the brain mechanisms underlying human cognition, analyse their relative advantages and disadvantages, and evaluate which technique is best suited for a particular purpose

Cellular Interactions and Metabolism

Faculty of Psychology and Neuroscience

BRAIN1022

Period 2:

27 Oct 2025 **19 Dec 2025**

Credits:

4.0

Coordinator:

K.R. Kampen

Teaching methods:

PBL, Lecture(s), Work in subgroups

Assessment methods:

Written exam, Attendance

Full course description

This cellular biology course focuses primarily on the important properties of individual cells such as cellular respiration and metabolism as well as on intercellular interactions and intracellular signalling. Cellular structural and functional knowledge obtained from the course Genes, Proteins and Evolution will be integrated. Students will first review the basic principles of chemistry, biochemical reactions and the role of enzymes herein, and will further explore how cells acquire, store and use energy to sustain cellular metabolic processes by using their pre-knowledge on cellular functioning. In addition, systemic homeostasis and how this is orchestrated by the brain is discussed. Next, students are introduced into the concepts of intracellular signalling and intercellular communication pathways, building upon their pre-knowledge on cellular structures. The important functions of specific molecules and proteins for specific cognitive capacities (such as the role of specific second messengers and proteins in visual perception, or in learning and memory) will be highlighted thereby demonstrating the important biological aspects of Brain Science, and providing links to the parallel course 'Introduction to Cognitive Neuroscience' in this period. This course, furthermore, entails hands-on lab exercises on Proteins & Enzymes, Immunocytochemistry and Nucleic Acids, part of which extend into Period 3. The present course builds upon the course Genes, Proteins and Evolution regarding cellular structures and functioning. In addition, concepts of brain functioning are introduced which are fundamental for most other parts of the curriculum. Specifically, it links to the course Brain Cells in period 4, which is focussed on action potentials, chemical neurotransmission and energy supply to neurons. Further, knowledge on cellular signalling cascades is required to understand how

extra- and/or intracellular alterations can lead to disturbed brain processes related to perception, learning and memory, covered in follow-up courses in the curriculum.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Understand and recall basic chemical principles;
2. Identify and explain the properties of the major biomolecules;
3. Describe the structure and constituents of the cell membrane and how those relates to its specific properties;
4. Explain the function and kinetics of enzymes, and how their activity is regulated;
5. Understand the mechanisms of intra- and intercellular signalling, in particular the signalling modalities of neurotransmitter receptors;
6. Explain how energy is produced in the cell, what the role of mitochondria is herein;
7. Understand and explain how cellular energy metabolism is linked to system level energy homeostasis via the neuroendocrine and autonomic nervous system;

Pract. Cel. Interactions & Metabolism

Faculty of Psychology and Neuroscience

BRAIN1024

Period 2:
27 Oct 2025 **19 Dec 2025**

Credits:
0.5

Coordinator:
K.R. Kampen

Teaching methods:
Skills, Work in subgroups

Assessment methods:
Final paper, Attendance, Observation

Full course description

In this practical training students will expand their laboratory skills while performing more complex procedures, such as enzymatic assays and SDS-PAGE. The module links to course BRAIN1022 'Cellular Interactions and Metabolism' where protein chemistry and enzyme reactions are discussed. During the first practical, the theoretical concepts of enzyme kinetics will be experimentally verified by determining the Michaelis-Menten constant of alkalic phosphatase. Hereto, students will process and plot the obtained data using appropriate software, and will programme and simulate the Michaelis-Menten equation in Python. The second practical involves the procedure of SDS-PAGE where students will do qualitative analysis of proteins samples. While preparing and performing these experiments, students work in pairs, thereby learning to cooperate in planning and execution of laboratory procedures.

Finally, the students write a lab report discussing the background, assay principles and results, in addition to evaluating the process.

The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

1. Perform enzymatic and protein assays, understand and solve problems, and report honestly about observations and possible problems with procedures or observations resulting from these procedures.
2. Work together in a small group to operate equipment and perform procedures in a biochemical laboratory, while positively receiving the feedback from the supervisor (and from

peers).

3. Reflect on strengths and weaknesses based on your practical experience in the biochemical lab, and to identify interests and learning goals.

Project Year 1

Faculty of Psychology and Neuroscience

BRAIN1041

Period 3:
5 Jan 2026 **30 Jan 2026**

Credits:
5.0

Coordinator:
S.J.G. ten OeverS.E. Pishva

Teaching methods:
Research, Work in subgroups

Assessment methods:
Final paper, Participation, Presentation, Attendance

Full course description

The projects will span a period of 8 weeks split into two blocks of 4 weeks; one block in Period 3 and one in Period 6. Projects give the students an opportunity in the curriculum to collect professional experiences while focussing on (parts of) the empirical cycle. They will work on chosen projects in a small team under the supervision of a UM staff member. Projects provide experience with making choices, teamwork, interacting with a supervisor, goal-setting, and working in a professional environment. Within an academic year, students will focus on a single project over a time period divided over periods 3 and 6. The work will be shared among a few students and will involve diverse activities. The core idea of the Project period is that students experience the various stages in the empirical cycle (or at least a subset of these stages).
Students can opt for a variety of projects that may be more or less focused on specific subdomains of Brain Science. For example, students may perform observational exercises, do simple procedures in the molecular lab (limited availability), do psychophysical experiments, do simple EEG measurements (e.g., alpha measurements under specific conditions), etc. In these various situations, students will get exposed to software use, creation or modification, and simple aspects of data analysis. Students will report on the projects in oral and written form. Projects are prepared by project coaches and adapted to the background level of students in Year 1.
The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

1. to gain experience with the different phases of the empirical cycle (finding the basis for a good question or hypothesis in literature; experimental design, data collection, analysis, data interpretation)
2. to learn to report on a project ideas and outcomes
3. to perform effective teamwork in a professional environment, including fair division of work and addressing of any problems in work or team functioning
4. to identify personal weaknesses and address them by learning new background and skills

Neuroanatomy

Faculty of Psychology and Neuroscience

BRAIN1042

Period 3:
5 Jan 2026 **30 Jan 2026**

Credits:
2.5

Coordinator:
U. von Rango - Hilmes

Teaching methods:
Lecture(s), Skills, Assignment(s), Work in subgroups

Assessment methods:
Written exam, Attendance, Assignment

Full course description

In this skill course, students will be introduced to the anatomy of the central and peripheral nervous systems. Students will learn about both the macro- and the microanatomy of the brain through a series of practical meetings. While the focus is on the human brain, students will also make comparisons with the anatomy of the sheep and rodent brain and other species, since these serve as important models in contemporary neuroscience. In these practical meetings, students will literally put their hands on the brain. They will get the chance to acquire hands-on experience in making sheep brain preparations. During a virtual microscopy training students will study the histology of different parts of the human and rodent brain. Furthermore, students will study real human and/or rodent brain sections performing an immunohistochemical staining. This will be a unique experience in which students will study and compare brain cells in different brain structures.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. describe the structural organization of the central nervous system
2. localize the different subcortical structures, ventricles and main fibre tracts in 3D models and in 2D images or sections
3. explain the cellular organization of the cerebral cortex and of the diffuse modulatory system
4. specify the neuroanatomic differences between the human, sheep and rodent brain
5. understand the principles of the different staining methods for microscopic analysis of brain sections, and specifically describe the procedure of an immunohistochemical staining

6. understand and solve problems with equipment or procedures, report observations, and honestly report on possible problems with equipment, procedures or observations;
7. work together in a small group to operate equipment and perform procedures in the anatomy laboratory, while addressing feedback from the supervisor (and from peers) constructively.

Principles of Perception

Faculty of Psychology and Neuroscience

BRAIN1061

Period 4:
2 Feb 2026 **2 Apr 2026**

Credits:
4.0

Coordinator:
L. HausfeldM.J. Roberts

Teaching methods:
PBL, Lecture(s), Presentation(s)

Assessment methods:
Written exam, Presentation, Attendance

Full course description

How does our brain give rise to our inner experience of the world around us? The ease with which we see, hear, feel and smell makes perception seem effortless. However, this ability is astounding when one considers the complexity and diversity of our senses and how the millions of neurons in our brain work together to process the various and constantly changing sensory stimuli.
This course will provide an introduction into basic principles of perception using examples from vision and audition. Students will learn how the visual system converts pixel intensities into visual object perception. Similarly, students will learn how the auditory system converts sound waves into auditory perception of objects. Treatment of both the visual and auditory systems will involve discussions of relevant sensory, subcortical, and cortical structures and provide a basic overview of biophysical, biochemical, and physiological principles underlying perception. In this sense, this course is placed on the intersection between biology (with a focus on neural mechanisms), and psychology (with a focus on visual, auditory, and multisensory perception).
Additionally, in several tasks, the neural mechanisms discussed will also be linked to the mathematics courses and will be used as a basis for mathematical and programming exercises or demonstrations. For example, the topic of psychophysical measures in this task will be linked to the concept of functions and their inverses in calculus. Signal detection foreshadows what students will learn in Probability and Statistics courses. The important concept of a receptive field will be linked to spatial (or temporal) filtering, and is related to matrices and matrix multiplications, as well as to Fourier principles as treated in Calculus.

Building on the understanding of the early sensory processes, students will discuss how constructive brain processes lead to perceptual grouping principles and illusions in both the visual and auditory domain, and ultimately the perception of objects. Students will study how statistical co-occurrence of features during development shapes the neural architecture and function of perception.

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. identify and understand different aspects of auditory and visual perception, such as object recognition, sound perception, Gestalt psychology, and auditory/visual illusions;
2. explain physiological principles of auditory and visual perception, such as the structure and function of the ear and eye, image and sound perception, subcortical and cortical auditory and visual pathways, and structural and functional principles of perception;
3. recognize and clarify anomalies in auditory and visual perception, such as hearing loss and retinal dysfunctions, and can relate these anomalies to underlying physiological mechanisms and/or brain damage;
4. understand, analyse and evaluate basic approaches and research methods central to the study of perception.
5. achieve understanding of theories and data covered in the tutorials through discussion in the group, and prepare group assignments
6. communicate scientific insights to your peers via a formal presentation

Brain Cells

Faculty of Psychology and Neuroscience

BRAIN1062

Period 4:
2 Feb 2026 **2 Apr 2026**

Credits:
4.0

Coordinator:
S. HildebrandA.F. Roebroeck

Teaching methods:
PBL, Lecture(s), Presentation(s)

Assessment methods:
Written exam, Presentation, Attendance

Keywords:
Neurons; Glia Cells; Neurogenesis; Resting Potential; Action Potential; Post-synaptic potential; Synapse; Neurotransmitter; Receptor; Local neural circuits

Full course description

In this course, students will learn about the function of cells in the brain from an anatomical and developmental perspective. Neurons are the basic unit of brain function, while non-neuronal cells perform important supporting functions. Students will learn how the development and structure of these cells, at a micro- and mesoscopic level, allow them to perform their specific function. Whereas the course has a strong cellular inclination, the course also covers how the function of individual cells can be linked to perception and other cognitive abilities. Hence, the course draws intricate biological mechanisms determining the functioning of individual cells into the area of psychology. In a subset of tasks, specific cellular functions are also described mathematically. For example, students' knowledge of differential equations acquired in the preceding Calculus course will permit students to study mathematical models of the action potential. At the same time, these mathematical models foreshadow what the students will learn about multidimensional dynamical systems in the Advanced Calculus & Dynamical Systems course that runs in parallel with the present Brain Cells course, as well as the Biophysical Modelling course in Year 2. Furthermore, students will study examples of neuroscientific techniques available to record and study brain cells. Thus, this course provides students with a solid foundation for all future neuroscientific courses in the program. This includes especially the computational courses in which understanding the assembly and functioning of bioinspired artificial neural networks depends on a firm grasp on how real neurons operate and communicate.

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Develop a background in cellular neurobiology, neurophysiology, and neuronal functioning from the micro- to mesoscale.
2. Gain an overview of the types of brain cells, their functions and how neurons constitute functional neural circuits.
3. Understand neural signalling within and between brain cells.
4. Develop a basic knowledge of the neuroscientific techniques available to study brain cells and their functioning at the micro- and mesoscale.
5. Work together on understanding complex questions about brain structure and function at various levels of inquiry.

Advanced Calculus and Dynamical Systems

Faculty of Psychology and Neuroscience

BRAIN1063

Period 4:
2 Feb 2026 **2 Apr 2026**

Credits:
3.0

Coordinator:
J. HuysO. D'Huys

Teaching methods:
PBL, Lecture(s), Assignment(s)

Assessment methods:
Written exam, Attendance, Assignment

Full course description

A brain scientist is able to develop mathematical descriptions of phenomena that evolve in space and time, and can interpret and model high-dimensional data. These abilities rest on a solid understanding of advanced calculus and dynamical systems theory. In this course, the students gain the foundations required to build sophisticated, biophysical models of neural phenomena, and the tools needed for the analysis and the computational modelling of brain and behavioural data.

This course builds on the Calculus and Linear Algebra Courses in periods 1-2. It provides the foundations of multivariate calculus, ordinary and partial differential equations, and the analytical and numerical methods to perform computations in one, two and three dimensions.

The students are subsequently introduced to the basics of dynamical systems theory: the course covers linear systems, stability of equilibria, bifurcation analysis and oscillatory systems, using relevant examples of neuronal systems whenever possible.

The course discusses several models that appear in different courses from a mathematical point of view: it links to Brain Cells, which runs in parallel, and provides the foundations for Biophysical Models.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Perform multivariable differentiation and integration
2. Classify, interpret and numerically solve ordinary differential equations (ODEs).
3. Understand a dynamical systems model comprised of coupled ODEs.
4. Find and classify the equilibrium point of dynamical system.
5. Perform a bifurcation analysis of dynamical systems.
6. Collaborate with your peers to solve mathematical problems.

The Motor System

Faculty of Psychology and Neuroscience

BRAIN1081

Period 5:
7 Apr 2026 **5 Jun 2026**

Credits:
4.0

Coordinator:
K. MeijerJ. Reithler

Teaching methods:
PBL, Lecture(s), Assignment(s), Work in subgroups

Assessment methods:
Written exam, Presentation, Attendance

Full course description

This course introduces students to the motor system and how it generates motor output. Students will learn that the hardware for generating action is hierarchically organized, with interconnected neuronal circuits of increasing complexity at the level of the spinal cord, the brain stem, and the cerebral cortex. The course also covers the ancient anatomical structures underlying motivational drive (hypothalamus), action selection (basal ganglia) and online optimization of ongoing movements (cerebellum). Students will learn about current theories on how these systems function and contribute to action generation. The course emphasizes the various levels of neural movement representation as well as the reciprocity between perception and action: action oftentimes emerges as a direct or indirect response to sensory input and in turn influences perceptual processes. Consequently, the interplay between perception and action is a guiding principle at all levels of the motor system, from the low-level reflex arcs in the spinal cord, to the skilled execution of a complex action.

The present course joins concepts from biology and psychology by investigating how actors effectively plan, select and execute context-appropriate actions. Additionally, understanding concepts underlying 'central pattern generators', movement-related 'neural state space trajectories', and computational models of cerebellar functioning will build on the knowledge and skills acquired in the 'Advanced Calculus and Dynamical Systems' course in Period 4. Moreover, principles such as population coding and receptive fields covered in earlier courses will be extended to the motor

domain, while several of the discussed neural structures (e.g., basal ganglia, cerebellum) will also prominently feature in the parallel ‘Learning & Memory’ course.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Characterize and localize the main components of the motor system in terms of their input, output and functional role
2. Specify the influence of the hypothalamus on the brain stem, and explain its role in arousal and its relation to innate behaviours
3. Explain current views of cortical motor control as trajectories through neural state space, and explain the advantages compared to single-neuron descriptions
4. Describe current models of the basal ganglia, and explain the role of dopamine modulation
5. Characterize the repeated canonical circuit architecture in the cerebellum, and explain its role in models of cerebellar function in relation to online motor control
6. Explain and illustrate the hierarchical relation of the motor control subsystems in the context of real-life movements (e.g., reaching for a cup, balancing posture), and give examples of sensorimotor integration at different levels
7. Understand computational or mathematical aspects of models of the motor system studied in the course
8. Work together in your tutorial groups to increase your understanding of motor mechanisms

Learning and Memory

Faculty of Psychology and Neuroscience

BRAIN1082

Period 5:

7 Apr 2026 **5 Jun 2026**

Credits:

4.0

Coordinator:

V.G. van de VenJ. Reithler

Teaching methods:

PBL, Lecture(s), Assignment(s), Work in subgroups, Presentation(s)

Assessment methods:

Written exam, Presentation, Attendance

Full course description

The goal of the present course is to offer a basic introduction into human memory. This course will introduce the main cognitive stages in learning and memory, i.e., encoding, storage, and retrieval, and related processes of consolidation and forgetting, different types of memory, and different brain areas and neural/molecular mechanisms that contribute to memory functions. We will also study the different ways in which individual neurons and neural populations form and maintain memory traces for shorter or longer durations. You will learn that memories are often not as robust as we think. Memories can be forgotten, altered or otherwise interfered with by many factors, and what we remember may not even be “true”!

In discussing these matters, the course will take a partly historical perspective and introduce some of the original, corner-stone studies that transformed the field of learning and memory.

Insights into how the brain forms and maintains memory may help enhancing memory and learning in many daily activities, in educational contexts, and in clinical contexts, such as revalidation after physical or emotional trauma, memory problems in neurological disease, brain lesions or healthy and pathological ageing. The course will stimulate students to find links between theoretical insights and applications.

The course will have a strong neurobiological orientation and will use insights from behavioural and neurophysiological research in animals to better understand human learning and memory. In addition, we will also discuss relevant computational models that explain theoretical or biological mechanisms underlying learning and memory.

The course builds on concepts and skills offered in previous courses. For example, understanding neural plasticity underlying learning and memory requires information about the action potential that was discussed in “Brain Cells”, as well as cellular processes covered in “Genes, Proteins and Evolution” and “Cellular Interactions and Metabolism”. Discussion of cerebellar and basal ganglia pathways in the parallel course “The Motor System” will be relevant when discussing conditioning and procedural skill learning. In addition, computational models describing hippocampal memory (e.g., the Hopfield model), Hebbian plasticity and learning based on error reduction require matrix and vector algebra that was discussed in “Linear Algebra” and “Calculus”, as well as concepts of network dynamics covered in “Advanced Calculus and Dynamical Systems”. By the end of this course, the students will have a good basic understanding of the cognitive, neurobiological and computational mechanisms of learning and memory, which provides a solid basis for the two additional courses in Year 2 in the Learning & Memory learning line

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. identify and understand different forms of learning and memory, including working memory and various types of long-term memory (episodic memory, classical and operant conditioning, skill learning)
2. understand cognitive theories of memory and explain these theories making use of the supporting behavioural experiments
3. understand at a detailed conceptual level computational models of learning and memory, with an emphasis on neural networks of associative memory (e.g., Hopfield auto-associative networks) and error reduction algorithms for (non-) associative learning (e.g., Rescorla-Wagner model)
4. understand neural plasticity at the level of cellular signalling
5. use computational insights to link neurophysiological and cellular mechanisms with cognitive representations and behavioral outcomes
6. Explore the socio-economic relevance of behavioural/cognitive theories as well as brain mechanisms of memory (e.g., in educational contexts, or for understanding and/or treatment of clinical conditions)
7. understand basic principles of different methodological approaches to the study of neural plasticity and memory
8. present scientific content related to the present course to your peers and use prepared materials to trigger discussion in the tutorial group
9. Work together in your tutorial group to gain insight into challenging topics related to learning and memory

Probability Theory

Faculty of Psychology and Neuroscience

BRAIN1083

Period 5:
7 Apr 2026 **5 Jun 2026**

Credits:
3.0

Coordinator:
M. Pietrasik

Teaching methods:
PBL, Lecture(s), Assignment(s)

Assessment methods:
Written exam, Attendance, Assignment

Full course description

A brain scientist needs to be able to analyse and model data from experiments and from the brain, data for which we do not usually know the generative model. Probability theory forms the basis of such analyses. In this course you will learn the foundations of probability. You will understand how random variables, an extension of classical variables that endows them with probabilistic interpretation, allow us to model and interpret outcomes from brain science experiments. We will examine the functional form of commonly used discrete and continuous probability distributions, summarize them using the concept of expectation and understand types of data for which they are most applicable. After completing this course, you will have an intuition for working with probability, as well as how probability theory is applied in a small set of statistical procedures to do the all-important process of inference, or, how can we actually come to conclusions about data coming from a random process? We will examine the point process-like statistics of neuronal firing, as well as the gaussian distribution of fMRI blood oxygenation level dependent signals among other brain science inspired datasets. Critically, we will examine the times when our assumptions about the probability structure of signals from the brain and from experiments in brain science break down and how to navigate those uncharted territories to ensure we know where we are.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. understand the concept of event space and probability of an event using set theory

2. understand the concept of random variable, its probabilistic characterization both in discrete and continuous settings with density and mass functions
3. understand statistical independence, conditional probability and Bayes theorem
4. identify commonly used discrete and continuous distributions
5. understand the concept of a random draw from a population and its probabilistic characterization
6. understand the concepts of parameter estimation and of hypothesis testing
7. work together or assist each other while solving exercises

Computational Science of Networks

Faculty of Psychology and Neuroscience

BRAIN2001

Period 1:

1 Sep 2025 **24 Oct 2025**

Credits:

4.5

Coordinator:

M. SendenA.F. Roebroeck

Teaching methods:

PBL, Lecture(s), Assignment(s)

Assessment methods:

Written exam, Attendance, Assignment

Keywords:

Network science; Neural networks; Functional connectivity; effective connectivity; Connectomics; Graph theory; Integration and segregation in networks

Full course description

The human brain is one of the largest and most complex biological networks known to exist. It contains ~85 billion neurons each making on average ten thousand connections with other neurons. The computational science of networks (also known as Network science, or Network neuroscience as applied to the brain) studies the structure and function of neural circuits and systems as connected networks. It focuses on how neural elements, such as proteins, brain cells, or brain areas interact with each other both within as well as across scales. Network neuroscientists typically employ techniques for measuring and characterizing structural, functional and effective connectivity between neural elements together forming a complex network. To measure structural and functional networks, empirical techniques such as tract tracing, single-cell recording, diffusion-weighted MRI and functional MRI are frequently employed. Inferring effective connectivity often additionally involves computational modeling techniques such as Granger causality, dynamic causal modeling or noise diffusion models. Mathematical tools also play an important role in characterizing networks. This includes graph theory which is used to characterize the structure of networks. This course also introduces the scientific field of connectomics. Today, the map or annotated graph of all connections in the brain (at a given scale) is called the connectome and the emerging field of connectomics aims to measure and understand the connectome. This course first introduces students to the empirical

and computational methods used to study neural systems. Subsequently, the course takes a closer look at neural systems operating at separate spatial and temporal scales. Lastly, the course explores multi-scale systems and how systems at different scales interact. Learning how to look at the brain from a network perspective will greatly aid the understanding how brain structure and function interact to produce high-level mental functions such as memory.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

After following this course, students should be able to:

1. Understand the concept of a network, consisting of nodes and edges, and how it applies to the brain
2. Describe structural, functional and effective connectivity as well as how these concepts relate to each other
3. Describe the empirical methods utilized to measure brain networks or connectomes, manifesting at different scales
4. Utilize graph theory to characterize the structure of complex networks
5. Utilize computational techniques to characterize the functional processes that unfold in complex structural networks
6. Describe key examples of neural networks or connectomes at the micro-, meso-, and macro-scale

Prerequisites

Linear Algebra and Calculus I (BRAIN1003); Programming I (BRAIN1005); Brain Cells (BRAIN10xx)

Ethics in Brain Science

Faculty of Psychology and Neuroscience

BRAIN2002

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
4.0

Coordinator:
D. Horstkötter

Teaching methods:
PBL, Lecture(s)

Assessment methods:
Written exam, Participation, Attendance

Keywords:
Ethics, autonomy, identity, sense of self, critical reflection,

Full course description

This course provides an introduction into ethical and philosophical discourses on pertinent issues in the context of Brain Science. Ethical questions target the realm of 'doing good'. Ethics concerns our systems of values and the ultimate reasons that motivate, or should motivate, us to engage in, or refrain from, particular actions or modes of behavior.

From an ethical perspective, the brain has a special status that distinguishes it from other organs and its healthy functioning plays a central role in the operation of our bodies, our capacities for autonomous agency, our conceptions of ourselves, our relationships with others, etc. Therefore, scientific research into the brain trigger and raise particular ethical questions. To put it differently, knowledge gained from Brain Science will not stay with brains as such but have a direct (positive or negative) impact on issues like autonomy, identity or social relationships.

Conditions that can be linked to brain functioning, such as movement disorders, memory disturbances or perceptional difficulties pose also particular challenges. On the one hand, they are likely to directly and aversively affect, also our personal identities and sense of selves; a situation which emphasizes the need for effective remedies and puts particular pressure on the search for rehabilitative and therapeutic applications. On the other hand, however, special caution is needed as well, because for brain interventions it is often particularly unclear what the effects and possible

side-effects are, and how they do affect not only target conditions, but also other traits, the identity or personality of patients as a whole.
The course ‘Ethics in Brain Science’ will provide students with an overview of ongoing ethical debates and point towards ethical arguments that link scientific insights to the domain of human values and raise awareness on the need to also tackle questions of desirability and justifiability of (upcoming) scientific possibilities.
This course will start with an introduction into pertinent questions of the philosophy of the mind, that actually build the ground for the very assumption that the brain indeed does have a special status in human life. Next, the course provides for an exploration on the requirements of doing ethically good research, and corresponding regulations focusing on research that makes use of brain banks and of living animals. Upon this fundament, the course explores ethical questions related to and resulting from the four main learning lines of the curriculum. It explores and discusses ethical questions that arise in the contexts of i) brain stimulation for movement disorders ii) prothesis for sensory perception, iii) pharmacological modification of memory function. Moreover, it discusses ethical issues in iv) computational brain simulation and regarding v) brain stem cells/organoids and chimeras.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Students have knowledge and insight on pertinent ethical discussion and arguments regarding brain stimulation, sensory protheses, memory modification, brain simulation, and brain organoids/stem cells/chimeras
2. Students have insight into basic topics of the philosophy of agency and mind that relate to the four learning lines of their curriculum
3. Students know research ethical regulations on biobank research and research with animals and have insight in the normative background of these regulations
4. Students are able to relate ethical questions, aspects, or concerns they have encountered in one area of application also to other brain science topics
5. Students are able to actively engage in ethical discussions on the implications of scientific brain research, to exchange arguments with fellow students and to form a personal point of view on contested topics.

Machine Learning

Faculty of Psychology and Neuroscience

BRAIN2003

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
3.0

Coordinator:
Y.C. Semerci

Teaching methods:
Lecture(s), Skills, Assignment(s)

Assessment methods:
Written exam, Assignment

Keywords:
Artificial Intelligence, Data Analysis, Machine Learning, Modelling

Full course description

In this course, students will be familiarized with numerous core principles that guide learning in machines. We will cover the difference between supervised, unsupervised and reinforcement learning. Each of these will be discussed in greater detail by looking at several algorithms such as regression (the prediction of a continuous outcome variable), classification, clustering or the mapping of reward values over a state-space. We will also get a glimpse of artificial neural networks that can approximate any mathematical function to desired accuracy, given sufficient data and computational resources. We will take the multi-layered perceptron and convolution as examples. The course will use case studies such as Eigengrasps and visual receptive fields to show how machine learning applies to brain science.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

Students should be able to

1. Understand the difference between supervised, unsupervised and reinforcement learning.
2. Have a conceptual understanding of their most important algorithms.
3. Know how to use these algorithms by working with Python software packages to analyze data.
4. Know how machine learning principles of this course apply to brain science.

Prerequisites

Linear Algebra and Calculus I and II (BRAIN1003); Programming I (BRAIN1005)

Programming II

Faculty of Psychology and Neuroscience

BRAIN2121

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
5.0

Coordinator:
J. HaarsmaL.J. Edwards

Teaching methods:
Lecture(s), Skills, Assignment(s)

Assessment methods:
Attendance, Assignment

Full course description

This course builds on Programming I and continues familiarizing students to the world of programming. Students continue learning about the principles of programming including proper housekeeping of their software (commenting of scripts and version control). Students meet in groups where an instructor explains a set of programming principles, and sends the students home with a task to accomplish by the next meeting. Specifically, students must translate specific tasks into computer code. These tasks will be chosen to link with the content and mathematical insights of other core courses. Throughout Programming II, following the content of coure and mathematical courses in year 2, students will be familiarized with conducting proper statistical analyses and introduced to basic principles of machine learning and bioinformatics as well as the implementation of basic biophysical models.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. understand core elements of programming
2. implement programs in Python

Writing and Presenting II

Faculty of Psychology and Neuroscience

BRAIN2122

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
1.0

Coordinator:
J. HaarsmaL.J. Edwards

Teaching methods:
PBL, Lecture(s), Assignment(s), Presentation(s)

Assessment methods:
Portfolio, Attendance

Full course description

Throughout Year 1 and 2, students will receive training to improve their written and oral communication. This training encompasses a range of writing formats and skills (e.g., from keeping lab books and records of procedures to writing the different parts of a scientific paper), as well as presentation formats (e.g., from project proposals to presenting results). In addition, although the focus of teaching communication skills lies on scientific communication, some attention is also given to communication tailored to lay audiences.
Recognising the evolving landscape of communication technologies, the curriculum incorporates instruction on the responsible and ethical use of generative AI (genAI) tools to enhance writing and presenting skills. Students will learn how and when to effectively utilize genAI platforms to improve clarity, organization, and style in their work. This includes understanding the limitations of AI assistance, ensuring originality, learning good prompting skills, and maintaining academic integrity. Notably, most of the training in academic communication occurs within the main content courses, through the use of written or oral assessment formats. These will include crafting the structure of a paper to be used as a starting point for the use of Large Language Models (LLMs, such as chatGPT), writing short descriptions of what was learned during a part of a course, or doing a presentation, which is followed by reflection on the use of GenAI, as well a feedback from examiners, tutors, peers, or AI writing coaches. Furthermore, students will be encouraged o use LLMs to generate different versions of their drafts for different audiences and applications, and will reflect on the varied outputs.

All this means that there is ample attention to academic communication throughout the curriculum, to which the present course adds an extra 1.5 credits in the first two years of the programme. The purpose of the extra formalized teaching in the present course is to give timely, standardized instruction and guidelines to students with respect to the different communication formats used in the curriculum. Hence, specific communication styles (e.g., a specific format of presentation or writing) will be covered at the time in the academic year when this becomes relevant for the students.
For example, around the time students will need to write a project proposal and deliver a project presentation for their Project in Period 3, the principles and points of attention for these written and oral forms of communication will be highlighted. Simultaneously, guidance on leveraging genAI tools for brainstorming, drafting, and refining their proposals and presentations will be provided. Emphasis will be placed on critical thinking and the ability to assess AI-generated suggestions, ensuring students can discern valuable input while avoiding potential pitfalls such as misinformation or lack of originality.
By integrating genAI education into the curriculum, we aim to equip students with modern communication skills that are essential in today's technologically advanced academic and professional environments. This holistic approach ensures that students are not only proficient in traditional communication methods but are also adept at responsibly utilizing emerging technologies to enhance their work.
The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

1. Relay content correctly and accurately (presentation & paper/report)
2. Provide a transdisciplinary perspective by linking the work with other courses (presentation & paper/report)
3. Use a clear structure and convey the interrelations among parts (presentation & paper/report)
4. Use the English language properly, enhancing language proficiency with appropriate GenAI tools and feedback (presentation & paper/report)
5. Design effective visual text structure, potentially utilizing GenAI for visual aids (paper/report)
6. Design effective slides, considering GenAI suggestions for layout and content (presentation)
7. Deliver presentations with enthusiasm and confidence, understanding the role of GenAI in preparation (presentations)
8. Utilize GenAI tools responsibly and ethically to enhance writing and presenting skills (presentation & paper/report)
9. Critically assess and integrate AI-generated content while maintaining academic integrity (presentation & paper/report)

10. Understand the limitations and potential biases of GenAI tools, ensuring originality in work (presentation & paper/report)
11. Exchange opinions on what constitutes good writing and presenting, including the impact of GenAI, and learn from each other on these topics.

Prerequisites

Writing and Presenting I BRAIN1122

Mentor-guided portfolio Building

Faculty of Psychology and Neuroscience

BRAIN2123

Year:
1 Sep 2025 **31 Aug 2026**

Credits:
2.0

Coordinator:
G.A.M. Blokland

Teaching methods:
Assignment(s)

Assessment methods:
Portfolio, Attendance

Keywords:
Portfolio; reflection; learning goals

Full course description

In Year 2, and throughout the programme, students will be mentored, and mentorship will be organized around portfolio building and individualized follow-up. All aspects of the programme, incl. all forms of assessment, as well as relevant extracurricular activities, may be used as material for feedback in a process by which students set specific goals, define strategies to reach their goals, and then analyse their progress. These goals can be in different competency domains (i.e., brain scientist, science communicator, professional, and/or lifelong learner competencies), including exam results on courses and skills, but may also focus on personal growth in various modes of communication and cultural sensitivity, organisational skills, providing and receiving feedback, etc. Because of the construction of the programme, stated goals in the portfolio in Year 2 most likely will be focused on content and skills required to master the curriculum. Towards the end of Year 2 and in Year 3, additional goals related to electives, thesis topic, and future study choices, as well as related to personal growth and life-long learning, will feature more prominently in the students' portfolio.

Course objectives

1. To perform self-analysis based on comprehensive information and self-observations to identify points for improvement in one or more competencies that need to be developed further, and to translate this analysis in goal setting.

2. To make choices of strategies towards reaching the identified goal, and plan implementation.
3. To translate strategies and implementation plans into action.
4. To monitor the outcomes of the actions against stated learning goals.
5. To conclude after a set time whether a goal has been reached or not, after which a new cycle of portfolio building is set in motion.
6. To perform all steps in the portfolio-building cycle with a realistic and balanced view towards oneself.
7. To create a written portfolio in good English, based on a well-organized set of honest notes collected through the academic year.
8. To elaborate verbally on the portfolio and to interact constructively with the input given by the mentor

Prerequisites

BRAIN1123

Research Participation

Faculty of Psychology and Neuroscience

BRAIN4001

Period 1:
1 Sep 2025 **24 Oct 2025**

Credits:
0.0

Coordinator:

Assessment methods:
Attendance

Full course description

As part of the curriculum, Brain Science students are required to participate in experimental research as volunteers. This participation allows students to gain the perspective of volunteers in Brian Science experimental approaches and familiarises students with classical methods used in brain science.
If you started in 2024 or later, you must act as a test subject for a total of 6 hours. The corresponding ECTS credit will only be awarded in year 2 and are coupled to BRAIN2101 Project-Year 2, Although participation can start in year 1. Furthermore, the sign-off Research Participation hours must have been obtained if you want to continue the program abroad at the start of the 3rd academic year. Students can only participate in studies offered in SONA for research participation hours. Students are only allowed to participate in experimental studies, with the following research methods: behavior, fMRI, TMS, TACS, TDCS, EEG. Online studies are not allowed.

Course objectives

1. To gain perspective on the voluntary participation in research experiments.
2. To familiarize with typical research approaches used in brain science.

Neuro-modulators of Perception & Psychopathology

Faculty of Psychology and Neuroscience

BRAIN2021

Period 2:

27 Oct 2025 **19 Dec 2025**

Credits:

4.0

Coordinator:

L. Goossens

Teaching methods:

PBL, Lecture(s), Presentation(s)

Assessment methods:

Written exam, Presentation, Attendance

Keywords:

Neuromodulation, psychopathology, dopamine, serotonin, glutamate, cortisol

Full course description

The chemical substances in the brain have a direct and long-lasting influence on communication at the neural cleft but also at the systems scale. This course explores how key neurochemical modulators—such as neurotransmitters, neuromodulators, and neurohormones—shape brain function and influence perception, cognition, and emotional processes. Students will learn about the role of these chemical messengers in maintaining healthy brain activity and examine how their dysregulation can lead to psychiatric and neurological disorders. Bridging biological, computational, and psychological perspectives, the course provides a transdisciplinary approach to understanding brain modulation.

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

After following this course, students should be able to:

1. Identify the main neuromodulators and their brain targets
2. Understand how the main neuromodulators affect fundamental processes such as perceptual, cognitive, and emotional processing
3. Compare the categorical DSM-5 definition of psychiatric disorders to a dimensional, symptomatology-based characterization

4. Explain how computational modeling can aid the understanding of the biological mechanisms underlying neurological/psychiatric disorders

Prerequisites

Cellular interactions & metabolism (year 1, period 2, BRAIN 1022)

Computational Science of networks (year 2, period 1, BRAIN2001)

Cellular and Systems Mechanisms of Memory

Faculty of Psychology and Neuroscience

BRAIN2022

Period 2:
27 Oct 2025 **19 Dec 2025**

Credits:
4.5

Coordinator:
S.E. Pishva

Teaching methods:
PBL, Lecture(s), Work in subgroups, Presentation(s)

Assessment methods:
Written exam, Participation, Presentation, Attendance

Full course description

The goal of the present course is to offer an advanced and integrated view on neuronal plasticity and how this translates into learning and memory in an organism. In particular, the course offers in an integrated fashion:

1. Detailed insights into the cellular pre- and postsynaptic pathways governing synaptic plasticity
2. Adaptive myelination and myelin plasticity
3.Whole brain perspective on (hippocampal) learning
4.Computational perspectives on biochemical models of postsynaptic signaling

After having been exposed to the main forms of learning (Learning and Memory year I), the present course focuses on the basic biological and computational mechanisms of learning and memory. The course starts at the synapse between two neurons, and ends with a brain-wide systems perspective of learning and memory. In the first few tasks of the course, students get a deeper understanding in the dynamics of pre- and postsynaptic cellular pathways involved in neural plasticity (i.e., the various forms of LTP/LTD).

The courses BRAIN1002 Genes, Proteins and Evolution and BRAIN1022 Cellular Interactions and Metabolism and associated practical sessions in the preceding year will be instrumental in understanding the anatomy as well as cellular processes discussed in the present course. Background on the action potential offered in Brain Cells (as well as biological insight in cellular processes offered in BRAIN1002 Genes, Proteins and Evolution and BRAIN1022 Cellular Interactions and Metabolism) will be important in understanding LTP. The concepts of structural and functional connectivity in the

Systems Neuroscience course - linking micro, and macro-levels of brain circuitry - provide important background for the zooming-out from cellular to systems-level processes of learning and memory offered in the present course. Computational models discussed in the present course will link with several exercises and demonstrations. The reading material will consist of strategically chosen papers and reviews, explanatory documents written by the course coordinators, and various sources of material on the internet. By the end of this course, the student will have a solid basis for the transdisciplinary follow-up course Learning & Memory III, which will zoom in on the transdisciplinary aspects of learning and memory, and in particular MCI and Alzheimer's disease.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

Students will be able to:
1: recall the primary forms of synaptic plasticity (i.e., LTP, LTD) and their biological mechanisms, including the role of protein kinases, CREB, and signaling pathways.
2: explain the cellular pre- and postsynaptic mechanisms governing synaptic plasticity, including neurogenesis and its relationship with learning and memory.
3: describe how different neuromodulators (dopamine, acetylcholine, noradrenaline) influence learning processes in neural networks
4: apply computational models to simulate synaptic plasticity, using biochemical models of postsynaptic signaling pathways
5: demonstrate an understanding of the mechanisms underlying adaptive myelination by explaining the role of oligodendrocytes and neuronal activity in response to experience and learning
6: distinguish between different phases of memory (encoding, consolidation, retrieval) at the systems level and analyze the roles of hippocampal and cortical circuits in each phase.
7: evaluate the mechanisms and efficacy of repair-inducing cognition enhancers by analyzing case studies on pharmacological agents, neurotrophic factors, and lifestyle interventions that promote cognitive repair and enhancement
8: integrate knowledge of cellular plasticity mechanisms, neuromodulatory processes, and systems-level memory consolidation to design novel hypotheses about the interplay between synaptic plasticity and memory formation.
9: collaborate in small groups to present their understanding of assigned tasks, providing a comprehensive overview of key concepts, mechanisms, and models of neuronal plasticity, learning, and memory to their peers.

Prerequisites

Passed the course Learning & Memory Year I

Advanced Statistics

Faculty of Psychology and Neuroscience

BRAIN2023

Period 2:
27 Oct 2025 **19 Dec 2025**

Credits:
3.0

Coordinator:
P. NaseriG. Valente

Teaching methods:
Lecture(s), Skills

Assessment methods:
Written exam, Attendance

Full course description

Every scientist is faced with the task of correctly analyzing their data and interpret the results. This skill course will equip students with some of the most commonly used modeling techniques for a correct statistical analysis. The course will mainly cover Analysis Of Variance and regression in their multiple facets. The course will also introduce students to the principles of Bayesian analysis, which has become progressively more popular with the advent of modern computers.
Each week consists of one or two lectures, together with homework, both pen and paper and computer assignments. Furthermore, a weekly debriefing session will take place to discuss the homework and assignments, under the guidance of a tutor.
Furthermore, a selected range of applications of the illustrated concepts in the field of brain science are provided throughout the course.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Understand the concept of statistical testing
2. Understand the principles behind Analysis Of Variance (ANOVA)
3. Understand within and between designs
4. Understand modeling data with linear regression
5. Understand fixed and random effects in linear regression
6. Understand the principles and assumptions behind both Frequentist and Bayesian statistics
7. Help each other in formalizing statistical models and apply them to real world examples

Project Year 2

Faculty of Psychology and Neuroscience

BRAIN2041

Period 3:
5 Jan 2026 **30 Jan 2026**

Credits:
5.0

Coordinator:
S.J.G. ten Oever

Teaching methods:
Research, Work in subgroups

Assessment methods:
Final paper, Participation, Presentation, Attendance

Full course description

The projects will span a period of 8 weeks split into two blocks of 4 weeks; one block in Period 3 and one in Period 6. Projects give the students an opportunity in the curriculum to collect professional experiences while focussing on (parts of) the empirical cycle. They will work on chosen projects in a small team under the supervision of a UM staff member. Projects provide experience with making choices, teamwork, interacting with a supervisor, goal-setting, and working in a professional environment. Within an academic year, students will focus on a single project over a time period divided over periods 3 and 6. The work will be shared among a few students and will involve diverse activities. The core idea of the Project period is that students experience the various stages in the empirical cycle (or at least a subset of these stages).
Students can opt for a variety of projects that may be more or less focused on specific subdomains of Brain Science. For example, students may perform observational exercises, do simple procedures in the molecular lab (limited availability), do psychophysical experiments, do simple EEG measurements (e.g., alpha measurements under specific conditions), etc. In these various situations, students will get exposed to software use, creation or modification, and simple aspects of data analysis. Students will report on the projects in oral and written form. Projects are prepared by project coaches and adapted to the background level of students in Year 2.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. to gain experience with the different phases of the empirical cycle (finding the basis for a good question or hypothesis in literature; experimental design, data collection, analysis, data interpretation)
2. to learn to report on a project ideas and outcomes
3. to perform effective teamwork in a professional environment, including fair division of work and addressing of any problems in work or team functioning
4. to identify personal weaknesses and address them by learning new background and skills

Behavioral Research Methods

Faculty of Psychology and Neuroscience

BRAIN2042

Period 3:
5 Jan 2026 **30 Jan 2026**

Credits:
2.0

Coordinator:
F.T.Y. Smulders

Teaching methods:
Lecture(s), Skills, Paper(s)

Assessment methods:
Attendance, Assignment

Keywords:
psychophysics; signal detection; behavioral measures; experimental design; data analysis

Full course description

Students will learn about psychophysical methods. Psychophysics is about the relation between the outer (physical) world and the inner world of our perceptions. It seeks to provide a formal description of that relation. A daunting challenge, you might think, because how can we quantify our experience? It will be shown that behavioural measures can be helpful in measuring our experience. A good example is the detection of signals that are so faint that we are not certain about whether they are there. Signal Detection Theory provides a strong model of our sensation in this case and also of the decision whether the signal is there or not. Of course, our sense organs and brain are ultimately responsible for all this. Therefore, psychophysical measures are an indispensable part of cognitive neuroscience. Students will learn about various psychophysical methods, the design of experiments, data processing and modelling, and do some experiments on themselves. Based on the results of these experiments and background literature, they write a scientific report.
The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

1. understand various psychophysical methods
2. understand experimental design in psychophysical methods

3. understand the role of psychophysical experimentation in brain science
4. programming: tweaking existing Matlab scripts
5. develop ability in data processing and visualization of psychophysical data
6. developing scientific writing ability based on a theoretical background

Computational Neurobiology of Movement and Reinforcement

Faculty of Psychology and Neuroscience

BRAIN2061

Period 4:
2 Feb 2026 **2 Apr 2026**

Credits:
4.0

Coordinator:
J.C. StapelH.P. Leunissen

Teaching methods:
PBL, Lecture(s), Assignment(s)

Assessment methods:
Written exam, Attendance, Assignment

Keywords:
Motor system, robotics, decision making, prefrontal cortex, basal ganglia, reinforcement learning

Full course description

In the first-year course "The Motor System," you were introduced to the basic parts of the motor system and how they work. In this course, we'll explore how these parts work together in real-world situations.

We will start by focusing on how the brain controls a simple action, like reaching out to grasp an object. We will look at this from a few angles: the biology of the nervous system, the neural state space concept (which you learned about last year), and how robots are programmed to perform similar movements.

Next, we will shift to the thought process behind grasping—how do we decide what to pick up, and how? Voluntary actions not only involve physical movement but also require motivation, cognitive processes, attention, and motor choices. For each of these components, decisions must be made. You will learn how different parts of the brain contribute to these decisions, working closely with subcortical structures like the basal ganglia to coordinate and execute voluntary actions. In addition, we will also look at the role of certain neurotransmitters in this process and computational models to understand how the brain makes decisions related to movement.

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Explain how the different parts of the nervous system work together to produce a simple reaching and grasping movement.
2. Gain insight into how grasping movements can be modelled and executed by robotic systems, and be able to draw parallels to biological motor control.
3. Describe the cognitive processes involved in deciding what to grasp, and how decisions are made based on sensory input, values and goals.
4. Understand how cortico-striatal circuits contribute to decision making and action selection in the brain, particularly in goal-directed grasping.
5. Specify how neurotransmitter systems can influence decision making.
6. Explain neurobiological basis of reinforcement learning and its role in goal directed action.
7. Apply mathematical theories and models of reinforcement learning, and be able to draw parallels to neurobiology of decision making.

Memory Disorders and Treatment

Faculty of Psychology and Neuroscience

BRAIN2062

Period 4:
2 Feb 2026 **2 Apr 2026**

Credits:
4.0

Coordinator:
S.E. PishvaD.L.A. van den Hove

Teaching methods:
PBL, Lecture(s), Presentation(s)

Assessment methods:
Written exam, Presentation, Attendance

Full course description

Throughout Year 1 and 2, in advance of this course, students have studied the principles behind learning and memory. The aim of the present course is to offer a more in-depth multidisciplinary view into memory disorders and their treatment, with a particular focus on Alzheimer's disease (AD). The course will stimulate students to make the link between theoretical insights and applications. Overall, the course will have both a neurobiological and computational orientation and will use insights from both epidemiological, cellular, molecular and multi-omics research to better understand the pathophysiology of AD. In addition, we will also discuss relevant computational models that explain theoretical or biological frameworks underlying e.g. AD heterogeneity. The course builds on concepts and skills offered in previous courses. For example, understanding neuronal plasticity underlying learning and memory requires information about the action potential that was discussed in "Brain Cells", as well as cellular processes covered in "Genes, Proteins and Evolution" and "Cellular Interactions and Metabolism"., Furthermore, the course will predominantly build upon the knowledge obtained in "Learning and Memory". By the end of this course, the students will have a good understanding of the development and course of AD, as well as on the concept of AD heterogeneity, how to study these principles and how knowledge on these domains may aid in the development of novel biomarkers and treatment strategies.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. understand the concept of AD dementia, in view of its symptoms, demographics, epidemiology
2. identify and understand what happens within the brain in AD - AD development and progression; cholinergic hypothesis, amyloid & tau hypotheses
3. understand the immune hypothesis in AD - role of microglia, oligodendrocytes
4. understand the role of genetics and epigenetics in AD - GWAS/EWAS, familial AD, sporadic AD.
5. understand the concept of AD heterogeneity and how to study this using disease modelling, multi-omics analyses and computational modelling.
6. explore the options of treatment & prevention of disorders like AD
7. understand the link between memory and stress
8. understand the concept of diffusion neuroimaging
9. understand the concept of gamma oscillation entrainment treatment
10. work together in your tutorial group to gain insight into challenging topics related to memory disorders and their treatment
11. present scientific content related to the present course to your peers and use prepared materials to trigger discussion in the tutorial group

Biophysical Modelling

Faculty of Psychology and Neuroscience

BRAIN2063

Period 4:

2 Feb 2026 **2 Apr 2026**

Credits:

3.0

Coordinator:

M. SendenA.F. Roebroeck

Teaching methods:

PBL, Lecture(s), Assignment(s)

Assessment methods:

Written exam, Attendance, Assignment

Full course description

How do microscopic molecular interactions shape the functional properties of neurons? How do individual neurons process information, and how do networks of neurons interact to produce cognition and behavior? Biophysical Modeling offers a computational framework to explore these fundamental questions, bridging scales from molecular dynamics to large-scale neural networks.

In this course, students will engage with the mathematical representations of neural systems, focusing on how the physical processes unfolding within neural components contribute to overall brain activity. By simulating and predicting the behavior of complex biological phenomena, biophysical modeling provides insights that are often unattainable through experimental means alone. It enables brain scientists to test hypotheses about neural mechanisms, predict how neural systems respond under various conditions and integrate diverse, multi-scale, experimental data. This enables biophysical modeling to identify knowledge gaps and to bridge basic research with clinical applications.

The course moves across spatial scales and levels of abstraction, starting at the subcellular level with the modeling of ion channel dynamics and intracellular signaling pathways. The course then progresses to single-neuron models, including the Hodgkin-Huxley model and several simplified neuron models. For the latter, students will incorporate stochastic elements, perform parameter fitting, and apply dynamical systems theory to analyze neuronal behavior.

Building upon single-neuron dynamics, the course will then transition to networks of neurons with fixed and changing connectivity. This introduces concepts of synaptic plasticity and learning

mechanisms, drawing connections to machine learning. The course culminates with population-level models, such as neural mass models.
By constructing, simulating, and analyzing biophysical models, students gain deeper appreciation of how complex brain functions emerge from fundamental physical principles while simultaneously enhancing their computational and mathematical proficiency.

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Understand subcellular models, such as Markov chain models of ion channel dynamics
2. Understand neuron models, including Hodgkin-Huxley and integrate-and-fire type models
3. Understand the collective behaviour of networks of interconnected neurons, including both excitatory and inhibitory neurons
4. Understand neural mass models, including Wilson-Cowan type neurons and the fundamentals of mean field models
5. Apply mathematical techniques, including concepts from dynamical systems theory, to analyse neuron and neural population models
6. Utilize computational tools and simulation software, such as the Brian simulator and the NEST Neural Simulation Tool, to implement and run simulations of neural models at various scales

Measuring and Manipulating Brain Activity

Faculty of Psychology and Neuroscience

BRAIN2081

Period 5:
7 Apr 2026 **5 Jun 2026**

Credits:
3.0

Coordinator:
F. Duecker

Teaching methods:
PBL, Lecture(s), Assignment(s), Presentation(s)

Assessment methods:
Assignment

Full course description

This course offers an exploration of research methods foundational to cognitive neuroscience, focusing on how brain activity can be measured and manipulated using state-of-the-art technologies. Students will examine electro- and magnetoencephalography (EEG/MEG), functional magnetic resonance imaging (fMRI), and non-invasive brain stimulation techniques, including transcranial magnetic stimulation (TMS) and transcranial electrical stimulation (tDCS/tACS). Emphasis is placed on the scientific principles and echnological foundations behind these methods, from the generation and measurement of brain signals to the physiological responses they capture or modulate, such as blood-oxygen-level-dependent (BOLD) signals in fMRI or induced neural activity through TMS.

Through this course, students will learn how these methods function individually and how they can be integrated to address complex questions in cognitive neuroscience. A focus on experimental design will guide students in understanding the types of research questions each method is suited to answer, whether in isolation or combination, and the methodological considerations involved in study planning and interpretation.

To foster hands-on learning, the course includes structured lab visits where students can observe and interact with these technologies. Exercises and practical demonstrations provide opportunities to work with real data and understand the implementation of these techniques. By the end of the course, students will have a solid grasp of the strengths, limitations, and applications of each method, preparing them to critically evaluate and use these tools in neuroscience research.

The final assessment for this course is pass or fail - and not a numerical grade between 0,0 and 10,0.

Course objectives

By the end of this course, students will be able to:

1. Describe the primary research methods in cognitive neuroscience
2. Explain the scientific and technological principles underlying these methods, including how they measure or influence brain activity.
3. Evaluate the strengths, limitations, and applications of each technique, both individually and in combination, for addressing cognitive neuroscience questions.
4. Apply foundational experimental design principles to create basic study proposals utilizing one or more of these methods.
5. Engage with practical lab activities to gain familiarity with implementing these techniques and handling the data they produce.

From Neurons and Networks to Perception

Faculty of Psychology and Neuroscience

BRAIN2082

Period 5:

7 Apr 2026 **5 Jun 2026**

Credits:

4.0

Coordinator:

L.T. DowdleF. de Martino

Teaching methods:

PBL, Lecture(s), Work in subgroups

Assessment methods:

Written exam, Presentation

Full course description

Building on Perception I, this course discusses the brain processes that underlie human perception of images and sounds. After covering the elementary aspects of how incoming images and sounds are processed in the sensory periphery in the course Principles of Perception (BRAIN1061), this course teaches how sensory features are put together to lead to the coherent percepts that we experience. We will take a computational perspective of visual and auditory perception. Specifically, we will delve into supervised (e.g., encoding and decoding approaches) and unsupervised learning models (e.g., deep learning), as well as biophysical modelling (e.g., Wilson Cowan Cortical model) and will relate these modelling approaches to neuroscientific findings. Crucially, students will learn to evaluate the neuroscientific significance of computational modelling results, and in doing so experience the relative advantages and disadvantages of each modelling approach for advancing our understanding of the human brain.

The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Describe how visual and auditory perception arises from hierarchical brain processing.
2. Describe key aspects of higher-level perception: object recognition, object invariance, perception-for-identification & perception-for-action (what-where pathway)
3. Provide examples of how visual and auditory processing can be studied through the use of (1) supervised learning models, (2) unsupervised learning models, and (3) biophysical modelling

4. Critically discuss computational modelling results in terms of their significance for answering neuroscientific research questions
5. Compare advantages and disadvantages of the various computational modelling approaches covered in this course

Drug and BCI Treatment of Movement Disorders

Faculty of Psychology and Neuroscience

BRAIN2083

Period 5:
7 Apr 2026 **5 Jun 2026**

Credits:
4.0

Coordinator:
R.J. VermeulenC.E. Herff

Teaching methods:
PBL, Lecture(s), Paper(s)

Assessment methods:
Written exam

Keywords:
Brain-Computer Interfaces, Movement Disorders, Parkinson's Disease, Cerebral Palsy

Full course description

Medical conditions, such as a spinal cord injury, Parkinson's disease, a stroke or Cerebral Palsy can result in damage to the complex motor system. In this course, students will be exposed to treatments based on Brain-Computer Interfaces (BCIs) or drugs that can help alleviate motor deficits.
In particular, the working principles of drugs such as Dopamine-based medication will be discussed and current research in advanced cellular mechanisms to create the next generation of advanced treatments will be highlighted.
Alternatively, neurotechnology, such as BCIs and Deep Brain Stimulation will be studied by the students. The entire pipeline from signal acquisition in motor related areas in the brain to decoding of movement related information will be covered to provide students with a holistic overview of motor neuroprostheses. Advanced approaches, in which the extracted control signals are then used to stimulate the spinal cord or control exoskeletons will wrap-up the course.
Reversing the direction of information processing, the students will learn about Deep Brain Stimulation approaches in which deep areas of the brain are stimulated to reduce symptoms.
The final assessment for this course is a numerical grade between 0,0 and 10,0.

Course objectives

1. Describe at which points the motor system can be damaged and how drug and BCI treatments could help.
2. Understand the hypo- and hyper-kinetic pathways and how drugs interfere with them.
3. Describe the building blocks of Brain-Computer Interfaces.
4. Develop a realistic understanding of what is possible with Brain-Computer Interfaces
5. Understand how stimulation of deeper brain structures can help in movement disorders.
6. Recommend stimulation targets for different movement disorders based on motor pathways.

Prerequisites

BRAIN1081 The Motor System, BRAIN2003 Machine Learning