First year courses

Ba Brain Science Y1 courses

Faculty of Psychology and Neuroscience

Introduction to Brain Science

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.

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

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. Be able to summarize the historical events relevant to brain research within the three core fields underlying Brain Science: mathematics, psychology, and biology.
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 and good experimental design
4. understand basic principles of philosophy of science, including the relationship between theory and data, and scientific progress through falsification of hypotheses
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.

BRAIN1001
Period 1
2 Sep 2024
25 Oct 2024
Print course description
ECTS credits:
3.0
Coordinator:

- P.H.M. de Weerd

Teaching methods:
Lecture(s), PBL
Assessment methods:
Final paper
Faculty of Psychology and Neuroscience

Genes, Proteins and Evolution

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.
8. Perform basic procedures in a biochemical laboratory, understand and solve problems, and report honestly about observations and possible problems with procedures or observations resulting from these procedures.
9. 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).
10. Reflect on strengths and weaknesses based on your practical experience in the biochemical lab, and to identify interests and learning goals.

BRAIN1002
Period 1
2 Sep 2024
25 Oct 2024
Print course description
ECTS credits:
4.0
Coordinator:

- M. Gerards

Teaching methods:
PBL, Lecture(s), Skills
Assessment methods:
Written exam, Attendance, Assignment
Faculty of Psychology and Neuroscience

Linear Algebra and Calculus I and II

Full course description

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.

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

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.

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

Brain Science

Course objectives

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

BRAIN1003
Period 1
1 Sep 2024
20 Dec 2024
Print course description
ECTS credits:
6.0
Coordinators:

- F. de Martino
- G. Valente

Teaching methods:
Lecture(s), Skills, Assignment(s)
Assessment methods:
Attendance, Assignment, Written exam
Faculty of Psychology and Neuroscience

Pract. Genes, Proteins & Evolution

Full course description

This practical entails skills trainings wherein students learn basic lab skills. The practical is part of the main course Genes, Proteins and Evolution. The course description and objectives can be found in the description of the main course.

BRAIN1004
Period 1
2 Sep 2024
25 Oct 2024
Print course description
ECTS credits:
0.5
Coordinator:

- E. Nelissen

Teaching methods:
Assignment(s), Skills
Assessment methods:
Attendance, Assignment
Faculty of Psychology and Neuroscience

Introduction to Cognitive Neuroscience

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 experimental cycle 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 experimental cycle 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. explain the scientific method as used in the fields of cognitive psychology and neuroscience, and apply this method to new research questions
2. discuss experimental designs used in cognitive psychology and neuroscience to answer research questions
3. describe the cognitive and brain mechanisms underlying core cognitive constructs, including attention, memory, and action
4. 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
5. work together as a team in discussing topics in the domain of cognitive neuroscience

BRAIN1021
Period 2
28 Oct 2024
20 Dec 2024
Print course description
ECTS credits:
4.0

Brain Science

Coordinators:

- J.C. Peters
- S.J.G. ten Oever
- M.M.L. Moerel

Teaching methods:
PBL, Lecture(s), Presentations
Assessment methods:
Attendance, Presentation, Written exam
Faculty of Psychology and Neuroscience

Cellular Interactions and Metabolism

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;
8. Perform protein assays and PCR, understand and solve problems, and report honestly about observations and possible problems with procedures or observations resulting from these procedures;
9. 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).
10. Reflect on strengths and weaknesses based on your practical experience in the biochemical lab, and to identify interests and learning goals.

BRAIN1022
Period 2
28 Oct 2024
20 Dec 2024
Print course description
ECTS credits:
4.0
Coordinators:

- J.W. Renes
- G.R.L. Kenis

Teaching methods:
PBL, Lecture(s), Skills, Work in subgroups, Presentations, Paper(s)
Assessment methods:
Written exam, Assignment, Observation, Presentation, Attendance
Faculty of Psychology and Neuroscience

Pract. Cel. Interactions & Metabolism

BRAIN1024
Period 2
28 Oct 2024
20 Dec 2024
Print course description
ECTS credits:
0.5
Coordinators:

- J.W. Renes
- E. Nelissen

Faculty of Psychology and Neuroscience

Project Year 1

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 (in Years 1 and 2) integrate the knowledge and skills acquired in the courses into a real-life case that resembles what graduates face in a work environment, while benefitting from support of professionals and fellow students. 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 in Year 1 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 (or 2).

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

BRAIN1041
Period 3
6 Jan 2025
31 Jan 2025
Print course description
ECTS credits:
5.0
Coordinators:

- L. Hausfeld
- S.J.G. ten Oever
- M. Mané Damas

Teaching methods:
Research, Work in subgroups
Assessment methods:
Attendance, Final paper, Presentation, Participation
Faculty of Psychology and Neuroscience

Neuroanatomy

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.

BRAIN1042
Period 3
6 Jan 2025
31 Jan 2025
Print course description
ECTS credits:
2.5
Coordinator:

- U. von Rango - Hilmes

Teaching methods:
Skills, Work in subgroups, Lecture(s), Assignment(s)
Assessment methods:
Attendance, Assignment, Written exam
Faculty of Psychology and Neuroscience

Principles of Perception

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.

Brain Science

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

BRAIN1061
Period 4
3 Feb 2025
4 Apr 2025
Print course description
ECTS credits:
4.0
Coordinators:

- M.J. Roberts
- L. Hausfeld

Brain Science

Teaching methods:
Lecture(s), PBL, Presentation(s)
Assessment methods:
Attendance, Presentation, Written exam
Faculty of Psychology and Neuroscience

Brain Cells

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 bio-inspired 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.

BRAIN1062
Period 4
3 Feb 2025
4 Apr 2025
[Print course description]
ECTS credits:
4.0

Brain Science

Coordinators:

- J.J. Briedé
- A.F. Roebroeck
- S. Hildebrand

Teaching methods:
Lecture(s), PBL, Paper(s), Presentations, Work in subgroups
Assessment methods:
Attendance, Written exam, Presentation
Faculty of Psychology and Neuroscience

Advanced Calculus and Dynamical Systems

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 both analytically and numerically.
2. Classify and interpret ordinary differential equations (ODEs) and partial differential equations (PDEs).
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.

BRAIN1063
Period 4
3 Feb 2025

Brain Science

4 Apr 2025
Print course description
ECTS credits:
3.0
Coordinators:

- J. Huys
- O. D'Huys

Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Attendance, Written exam, Assignment
Faculty of Psychology and Neuroscience

The Motor System

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

BRAIN1081
Period 5
7 Apr 2025
6 Jun 2025
Print course description
ECTS credits:
4.0
Coordinators:

- J. Reithler
- K. Meijer

Teaching methods:
PBL, Lecture(s), Assignment(s), Work in subgroups
Assessment methods:
Attendance, Written exam, Presentation
Faculty of Psychology and Neuroscience

Learning and Memory

Full course description

The goal of the present course is to offer a broad, basic introduction into human memory. In particular, this course will introduce the cognitive main stages in learning and memory, I.e., encoding, storage, and retrieval, and related processes of consolidation and forgetting. We will also learn discuss different kinds of memory, and about the different brain areas and structures that contribute to the different types of memory. In addition, we will study the different ways in which individual neurons and neural populations can maintain memory traces for shorter or longer durations. We 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!

While covering these various fundamental insights, the course will take a partly historical perspective, and discussing some of the original, corner-stone studies that transformed the field of learning and memory.

Insights into how memory works may help enhancing memory and learning in many daily activities, in educational contexts, and in clinical contexts that involve revalidation after physical or emotional trauma, or neurological disease, brain lesions or ageing. The course will stimulate students to make the link between theoretical insights and applications.

Overall, the course will have a 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

BRAIN1082
Period 5
7 Apr 2025
6 Jun 2025
Print course description
ECTS credits:

Brain Science

4.0
Coordinator:

- V.G. van de Ven

Teaching methods:
Assignment(s), Lecture(s), PBL, Presentations, Work in subgroups
Assessment methods:
Attendance, Written exam, Presentation
Faculty of Psychology and Neuroscience

Probability Theory

Full course description

A brain scientist needs to be able to analyse and model high-dimensional data. These abilities rest on a solid understanding of probability theory and statistics. In this course you will learn the foundations of probabilistic modelling and learn how to use random variables to model and interpret brain science experiments. You will learn useful discrete and continuous probability distributions, and examine the concepts of expectation, moments and statistical independence. After completing this course, you will have obtained an overview of commonly seen probability distributions, as well as several statistical procedures. Additionally, you will be able to deal with problems that involve probabilities and measure their outcome. 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 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

BRAIN1083
Period 5
7 Apr 2025
6 Jun 2025
Print course description
ECTS credits:
3.0
Coordinators:

- J. Huys
- A. Wodeyar

Teaching methods:

Brain Science

Lecture(s), PBL, Assignment(s)
Assessment methods:
Attendance, Assignment, Written exam
Faculty of Psychology and Neuroscience

Programming I

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

BRAIN1005
Period 1
2 Sep 2024
6 Jun 2025
Print course description
ECTS credits:
5.0
Coordinators:

- R. Auksztulewicz
- A. Lage Castellanos

Teaching methods:
Lecture(s), Skills, Assignment(s)
Assessment methods:
Attendance, Assignment
Faculty of Psychology and Neuroscience

Writing and Presenting I

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. Notably, most of the training in academic communication occurs within the main content courses, through the use of written or oral assessment formats, such as writing a paper or doing a presentation, which is followed by feedback from examiners, tutors or peers. This means that there is ample attention to academic communication throughout the curriculum, to which the present course adds an extra credit 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 where this becomes relevant for the students. For example, around the time students will need to write down a project proposal and do 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.

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 (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 (presentation & paper/report)
5. Design effective visual text structure (paper/report)
6. Design effective slides (presentation)
7. Deliver with enthusiasm/confidence (presentations)
8. Exchange opinions of what constitutes good writing and presenting, and to learn from each other on these topics.

BRAIN1122
Period 1
2 Sep 2024
11 Jul 2025
Print course description
ECTS credits:
1.5
Coordinator:

- H.C.A. Woodruff

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

Brain Science

Attendance, Portfolio
Faculty of Psychology and Neuroscience

Mentor-guided Portfolio-building

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, will 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, 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 elective, 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 (Appendix 8), 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.

BRAIN1123
Period 1
2 Sep 2024
11 Jul 2025
Print course description
ECTS credits:
2.0

Brain Science

Coordinator:

- G.A.M. Blokland

Teaching methods:
Assignment(s)
Assessment methods:
Attendance, Portfolio