Y1

Research Master Neuroscience Programme

Course Outline

Course Code	RMNS-1.6
Course Name	Complex brain functions
Teaching Methods	Lectures, problem-based-learning sessions (PBLs), self-study, group discussion, online assignment
Aims of the Course	To introduce students to the field of cognitive neuroscience, emotions and language. To illustrate several experimental approaches used to study complex brain functions in animal models and humans including computational methods. To show examples of maladaptive behaviours and thought processes that lie at the core of neuropsychiatric disorders such as schizophrenia, psychosis, depression and addiction.
Learning Goals	This module aims to achieve the following learning goals: 1) Students can explain the concepts of various complex brain functions, such as attention, planning, consciousness, circadian rhythms, language etc. (10 main concepts divided over 5 weeks – see syllabus for details); 2) Students can explain, interact and use the computational model of the "perceptron"; 3) Students can link complex brain functions to neuroscientific knowledge on a genetic, molecular, anatomical, neurophysiological and computational level; 4) Students can describe and elaborate on experimental approaches to study complex brain functions in animals (both vertebrate and invertebrate) and humans; 5) Students can explain how abnormalities in specific domains of complex brain functions are linked to neuropsychiatric diseases, specifically to schizophrenia, psychosis and depression; 6) Students can explain how stress, emotions, sleep and drugs interact with complex brain functions including the pathologies of drug abuse, PTSD and acute stress syndrome; 7) Students can describe the neuroscientific basis of language.
Target Group	MSc Neuroscience students
Organisation	Erasmus MC – Department of Neuroscience
Level Credits Study load	2 (Master) 6 ECs 168 hrs
Testing:	Written exam + Presentation of the assignment (experimental design)
Language	English
Number of Participants	1st year students MSc Neuroscience curriculum
Location	Erasmus MC – Education Center
Date	May / June
Registration	This course is part of the MSc Neuroscience curriculum. Separate registration is not necessary for admitted students.

Absent	If you are unable to attend class, you are kindly requested to report your absence in advance, via masterneuroscience@erasmusmc.nl.
Responsibility	Erasmus MC – Department of Neuroscience
Coordination	Dr. A. Badura and Dr. J. N. van der Geest
Contact	E. Buitenhuis-Linssen E-mail: masterneuroscience@erasmusmc.nl
Alumni	LinkedIn Group RM Neuroscience, Erasmus MC https://www.linkedin.com/groups/8133912

Information	
	Summary of the Course Building on the knowledge of all past modules (particularly 1.2, 1.4 and 1.5) students will learn how complex brain functions arise in the nervous system, from fairly simple decision making processes to complex perceptions of oneself and others. They will also learn what happens when these processes are malfunctioning leading to neuropsychiatric disorders (such as schizophrenia or depression) and maladaptive behaviors (such as addiction).
	Teaching Methods Lectures, problem-based-learning sessions, self-study, group discussion, student presentations, online assignment
Programme	
	Content In this course we will introduce students to the neuroscience of complex brain functions. Each week we will cover different aspects and topics. We will approach this topic from several angles, including animal and human studies, and from both fundamental and clinical, i.e., both neurological and psychiatric perspectives. We will start with introducing the concept of cognitive and complex brain functions. We will go over the definitions and historical perspective and study the anatomical regions involved in those functions. We will discuss tests used for probing of cognitive functions in humans and animals. We will elaborate on the advantages and limitations of the animal models in cognitive research. We will also discuss how genes influence our complex behaviors – both on a genetic and epigenetic level. Here we will also expose the students to the basic computational models of “learning”. To this end we will utilize the perceptron model. We will familiarize the students with this algorithm and set assignments for them to explore and use it on their own. In the second week we will study the cortical states and how they change with circadian rhythms. The focus will be put on brain regions and genetic and molecular pathways regulating these processes. Students will learn how to measure and differentiate different levels of consciousness using EEG and default network measurements. We will discuss how sleep deprivation impairs function and, on the other hand, how sleep improves cognition. Here we will also discuss what non-cortical brain areas are involved in sleep and to what extent they regulate it. In week three we will familiarize the students with the concept of emotions and their processing in the brain. Emphasis will be put on both cortical and sub-cortical regions. We will study how those circuits work in a healthy brain and how they can be high jacked by addictive substances in drug addiction. We will go into research on stress and mirror

	neurons, what brain areas cause us to act prosaically, how we can explain emotional contagion. In addition, we will deal with disorders such as Post-Traumatic Stress Disorder (PTSD) and acute postpartum psychosis. In the fourth week we will focus on language and speech. We will first emphasize brain regions involved in language and discuss two leading theories in how language forms. We will discuss research on the relevance of foxp2 gene in language development. We will also learn about the etiology of dyslexia and aphasia and their diagnostic criteria. In week five we will familiarize the students with the concept of endogenous and exogenous attention and discuss what brain areas are involved in different types of attention and how we can study it in animal models. Students will also learn what clinical syndromes lead to attention impairments. We will focus specifically on schizophrenia. We will discuss experiments showing how reward drives the decision making process, how prediction error is generated and how it is integrated in the decision making process, elucidating the ways the cerebellum and neocortex work together to plan actions. And if we allow ourselves to do so, we might also discuss the concept of "free will". In this week students will hear and learn how computational models at the level of population coding can help us to understand how working memory operates and what are the neural substrates of decision making. In the sixth and last week, students will present to their peers their assignment ("an experimental design to study a specific hypothesis on complex brain functions") and make the exam. By the end of the course students should be capable to critically appraise experimental en theoretical approaches to study complex brain functions from a neuroscientific point of view. Where possible, we will have students meet patients with (past) complex brain disorders, such as coma, depression, and schizophrenia.
	Duration of the Course 6 weeks
	Expected Resources for Students ▪ Purves (Unit V) ▪ Handouts provided by coordinator ▪ Scientific Articles:
	Teachers Dr. A Badura & Dr. J. N. van der Geest
	Graduate Attributes Upon completion of this course, if you have attended and actively participated in the classes, and when you passed the written exam with sufficient results, you are awarded 6 ECs.
Testing and Assessments	
	Testing (1) Written exam with multiple choice and essay questions (worth 70% of the final grade). The exam will cover all learning goals, This will include multiple choice questions and open questions. (2) Oral presentation of the assignment + 500 word summary of the presentation (worth 30% of the final grade). The presentation will be conducted in groups of 2. Assignment will entail designing an experiment for testing a specific hypothesis related to higher brain functions or a computational project on a model of a higher brain function. For every component of the exam, written exam and assignments, a 5,5 or higher must be scored.

	Testing Procedure The test will be assessed by a MSc faculty member. You will receive a grade on a scale from 1 (worst) to 10 (best). Grade appeal is subject to the rules laid out in the Teaching and Examinations Regulations of Erasmus MC.
Quality Management	
	Course evaluation and development The MSc programme co-ordinators are open for suggestions from course participants on possible improvements. Course adjustments can be made on the basis of your direct feedback. Additionally, at the end of the course, you will receive an invitation for an online survey on the contents and setup of the course. Course contents and setup are re-evaluated periodically, at least once a year, by the course directors and MSc programme chair members.