Faculté des Sciences
Faculté ALLSH
Institute of Language, Communication and the Brain

Master

Mention
SCIENCES COGNITIVES

Année 2025-2026

Course Syllabus

amU Faculté des sciences Aix Marseille Université amU ALLSH Aix Marseille Université

Structure M1 Cognitive Sciences

Semester 1 Cognitive Sciences
Core Curriculum

HSCAK01 - Design a research project in Cognitive Science

Experimental methods	HC0AU20
Responsible : LEMAIRE Patrick	3 ECTS 10h CM, 16h TD, 4 TP Language : English

Description
This introductory Python course is tailored specifically for cognitive science and psychology students who have no prior experience in coding. It provides a gentle introduction to programming concepts using Python, a versatile and user-friendly language. Through practical examples and hands-on exercises, students will learn to write basic scripts, analyze data, and visualize results.

Skills to acquire
Experimental Design write-up; control of confound; design a sound experiment; c riticizing empirical findings; assessment of research contribution and inferences from data; understanding fundamental notions (variables; validity**)**

Pedagogy and class organization
CM + TD + TP

Bibliography

- •Breakwell, G., Wright, D. B., & Barnett, J. (Éds.). (2020). Research methods in psychology (5e éd.). SAGE Publications.
- Coolican, H. (2024). Research methods and statistics in Psychology. New York: S.J. Routledge.
- •Cooper, H. M., Coutanche, M. N., & McMullen, L. M. (2023). APA handbook of research methods in psychology (Second Edition). American Psychological Association.
- •Dempster, M., & Hanna, D. (2016). Research methods in psychology for dummies (UK edition). John Wiley and Sons.

Programming tools	SSCAU05

Responsible : FOURTASSI Abdellah — 3 ECTS
10h CM, 10h TD, 10 TP.
Language : English

Description
This course will teach solid culture in experimental methods, as used in cognitive sciences.
Following fundamentals (e.g., observation methods, basic experimental design, hypothesis, variables), students will learn a number of advanced notions and skills, such as experimental control of confounds, factorial design, notion of proof in experimental sciences, validity, how and which inferences can we make in sciences, and criteria for assessing contributive value of a research findings.
Skills to acquire:
This introductory Python course is tailored specifically for cognitive science and psychology students who have no prior experience in coding. It provides a gentle introduction to programming concepts using Python, a versatile and user-friendly language. Through practical examples and hands-on exercises, students will learn to write basic scripts, analyze data, and visualize results.
Pedagogy and class organization
CM + TD + TP

Mathematics for cognitive science — SSCAU06

Responsible : TORRESANI Bruno — 6 ECTS
Mathematics general: 10h CM, 20h TD, 0 TP
Mathematics statistics: 10h CM, 20h TD, 0 TP
Language : English

Description
Mathematics- general: The aim of this course is to revisit and deepen mathematical elements already covered by students in their previous studies, and to put them into perspective in several examples relevant to cognitive science.
In particular, elements of linear algebra important for data analysis (vector and matrix calculus, vector spaces, dimension and dimension reduction, linear discriminant analysis,) will be covered. Aspects of mathematical analysis (Fourier analysis, optimization) and simple models of dynamical systems will also be covered and illustrated on examples from cognitive science.

Mathematics-statistics: The aim of this course is to develop a conceptual understanding of inferential statistics, to learn which test to use depending on the type of experimental design and data, and to learn how to perform tests using JASP and G-power software. The course also covers the description of the results in American Psychological Association style and the interpretation of test results. We will cover t-tests for independent, matched samples, one-way ANOVA, factorial ANOVA, repeated measures ANOVA, mixed ANOVA, ANCOVA, post-hoc tests, simple effects analysis, correlations, and linear regressions. For the various tests, we will cover the notion of effect size, confidence interval around the effect size and power analysis.

Skills to acquire:

Mathematics-general: Perform elementary vector and matrix calculus; Apply simple data analysis methods (dimension reduction, classification, visualization) using the R language.
Mathematics-statistics: Perform power analysis and data analysis for the most common experimental designs; Interpret statistical test results; describe results in APA style.
Pedagogy and class organization
Mathematics-general: Theoretical courses will be complemented by practical sessions based on the R computing language.
Mathematics-statistics: Theoretical courses will be complemented by practical exercise.

Mandatory prerequisites
Mathematics: general: elements of linear algebra; elements of mathematical analysis (functions, derivatives...); elements of programming (with R, or another language).

Assessment methods
The course will be evaluated through Continuous Assessment (60%) and a Final Exam (40%). The Continuous Assessment component includes a written test and a report, while the Final Exam will be a written exam lasting 2 hours

Bibliography
Mathematics: general:
Mike Landy, Eero Simoncelli: Mathematical tools for neural and cognitive sciences. https://www.cns.nyu.edu/~eero/math-tools/
Ella Batty: Math tools for neurosciences. https://github.com/ebatty/MathToolsforNeuroscience
Gilbert Strang: Linear algebra (online videos). https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/video_galleries/video-lectures/

HSCAK02 - Integrate transdisciplinary fundamental knowledge

Introduction to cognitive science SSCAU07

Responsible : Nguyen Noël 6 ECTS
27h CM, 27h TD
Language : English

Description
The seminar will be divided into five main blocks. Block 1 (What is cognition?) will form a general introduction to the history of cognitive science, its present contours, and its philosophical ramifications. Block 2 (How to study cognition?) will cover experimental and computational approaches to cognition. Block 3 (Emergence of cognitive functions) will be concerned with the advent of cognitive functions at both the phylogenetic and ontogenetic scales. Block 4 (Disorders of cognitive functions) will offer an overview of pathological cognitive disorders. Block 5 will focus on one specific cognitive function, namely auditory perception.
Skills to Acquire
The students are expected to acquire a solid knowledge base on the history and present contours of cognitive science, its main experimental and computational

approaches, and its main domains of application. **Pedagogy and class organization** CM + TD
Mandatory prerequisites A good level of English proficiency is necessary.
Bibliography Miller, G. A. (2003). The cognitive revolution: a historical perspective. Trends in cognitive sciences, 7(3), 141-144.

HSCAK03 - Mobilize fundamental knowledge from different disciplines

Cognitive modeling	HCOAU21
Responsible : REY Arnaud	3 ECTS 18h CM, 8h TD, 0 TP Language : English

Description

This course aims to give students an active introduction to formalization in the field of cognitive science and cognitive psychology in particular. By formalizing the mechanisms that lie at the heart of our mental activity, we strive to give them a comprehensible and graspable form that enables us to describe the nature and dynamics of these mental mechanisms. Modeling and formalizing are inseparable from any empirical and experimental approach to scientific activity. In this course, divided into two parts (one taught by Arnaud Rey and the other by Noël Nguyen), we will endeavor to study theoretical proposals in the field of implicit learning and categorization. The models studied will belong to the register of computational modeling, which enables these formalisms to be implemented on a computer. Our aim will be to gain a clear understanding of how these theoretical proposals work, to identify their strengths and limitations, and to determine the way in which they can be fitted to experimental data.

Skills to acquire

The aim of this course is 1) to make students more agile and familiar with the field of cognitive modeling, 2) to train students in reading about and understanding these theoretical frameworks, so that students can more easily deal with these frameworks as part of their own research work, and 3) to demystify this type of approach and show students that it is not only essential, but also entirely within their reach.

Pedagogy and class organization

The course will be divided into 6 lectures in which different models of implicit learning and categorization will be presented. Two intermediate exams will link these theoretical proposals to experimental results. Students will also have to prepare an oral presentation in which they will present the main models proposed within different topics from the cognitive sciences.

Organization of the course:

Lesson 1 : A. Rey (3h) : General introduction and introduction to implicit learning
Lesson 2 : A. Rey (3h) : Study of the SRN model (Elman, 1990)
Lesson 3 : A. Rey (3h) : Study of the PARSER mode (Perruchet & Winter, 1998)

Lesson 4 : A. Rey (1h) : Intermediate exam
Lesson 5: A. Rey (3h) : Oral presentations by studens on theoretical frameworks in various fields of cognitive science
Lesson 6 : N. Nguyen (3h) : Introduction to the domain of categorization
Lesson 7 : N. Nguyen (3h) : Fundamentals of Bayesian models of categorization
Lesson 8 : N. Nguyen (3h) : From numerical simulations to fitting a model to experimental data
Lesson 9 : N. Nguyen (1h) : Intermediate exam
Lesson 10: N. Nguyen (3h TD) : Oral presentations by students on theoretical frameworks in various fields of cognitive science

Mandatory prerequisites
Students must have read the text related to each course prior to the course. For the first lecture by A. Rey, they should have read the introductory chapter of the book Rey (2012, Psychologie Cognitive Experimentale, PUF), which will be available on Ametice in pdf format.

Assessment methods
The assessment for this course is divided into two written exams and an oral presentation, all taking place throughout the semester. The two written exams each have a coefficient of 0.4 and cover the material from the three preceding lectures (CM). Additionally, students must deliver an oral presentation with a coefficient of 0.3. The combination of these assessments ensures a comprehensive evaluation of the students' understanding and ability to apply the course material.

Optional Disciplinary courses 1 — HSCAX20

6 ECTS
Language : English & French

Description
Students have to choose one or two of the courses listed to achieve the 6 ECTS required..

Lecture & Cognition.	3 ECTS
Psychologie de la décision	3 ECTS
Formes sonores du langage 1	3 ECTS
Signification et Interaction 1	3 ECTS
Statistics	6 ECTS

Mandatory prerequisites
A good level of French & English proficiency is necessary.

Neurobiologie pour les sciences cognitives — SSCAU08

Responsible : THIRION Sylvie

3 ECTS
18h CM, 3h TD, 9h TP
Language : English & French

Description
Cet enseignement vise à présenter les concepts fondamentaux de neurobiologie et de neurophysiologie. L'anatomie fonctionnelle du système nerveux, son organisation aux différentes échelles et les systèmes de neurotransmission

principaux seront abordés.
Les bases neurobiologiques du réseau cérébral « de la récompense », impliqué dans l'évaluation des objectifs, la motivation à agir, et les choix comportementaux seront présentées au travers de l'exemple de la prise de décision.
Des notions de méthodologie et d'analyses de données appliquées à la neurobiologie seront acquises à travers des travaux dirigés de rétroingénierie effectués en classe inversée. Les étudiants réinvestiront au travers de travaux collaboratifs les notions vues en cours les dérégulations des fonctions et comportements traités en cours, ainsi que les pathologies associées.
Skills to acquire:

- Réaliser des tâches collaboratives,
- Formuler, via une pensée critique, des arguments convaincants et apprendre à les étayer avec rigueur et clarté.

Pedagogy and class organization
L'UE sera organisée autour de cours magistraux, travaux dirigés et travaux pratiques. Les notions théoriques fondamentales seront présentées lors des CM, et ensuite développées et mises en pratique au cours des TD et des TP.

Assessment methods
Contrôle Continu Intégré

Semester 2 Cognitive Sciences Core Curriculum

HSCBK01 - Design a research project in cognitive science

Data in cognitive science	SSCBU04
Responsible : LONGCAMP Marieke.	3 ECTS 15h CM, 3h TD, 12h TP Language : English

Description
Even more so in the study of cognition than in any other field, the phenomena of interest are not directly observable. The aim of this course is to work on the properties of data in the cognitive science, considered as indexes of mental processes. We will also explore why and how data is “manipulated”, and represented, prior to statistical analysis.
Data in cognitive science: general presentation, validity and reliability; 1- chronometric data (reaction times, accuracy) ; 2- electrophysiological data; 3- MRI and fMRI data; 4- eye movement data or kinematics data; 5- corpus.
Skills to acquire:

- Understand the principles, value and limitations of empirical data in cognitive science.
- Understand the physical principles and physiological bases of brain imaging data.

- Use computational tools for data organization and analysis.
- Present orally elements of a research project.
- Identify and plan the various stages of a research project.

Pedagogy and class organization
Several data types will be presented, each time through a lecture followed by practicals. Practical work will take place in the form of workshops, with students from different disciplines working in pairs. Several datasets will be proposed. Students will have to set up a rigorous procedure to preprocess and visualize the data. The results of this evaluation will finally be presented and discussed with the other students and professors.

Mandatory prerequisites
Basic statistics & Methods in cognitive science.
Recommended prerequisites
Brain imaging techniques & Behavioral techniques.

Assessment methods
The UE will be assessed by a final test involving presentation of one type of data, and one "*contrôle continu*" with a written report of practicals. We will assess the following points: Planning and implementing an analysis, from measurement to data formatting. Use software adapted to each type of data. Identify the steps requiring choices. Motivate choices with theoretical arguments. Implement rigorous procedures to assess the consequences of choices, in compliance with ethical rules. Report on progress in a precise, structured manner.

Bibliography
Ward, J. (2020). The student's guide to cognitive neuroscience (4th ed.). Psychology Press. Chapters 2, 3, 4, 5
https://routledgetextbooks.com/textbooks/9781138490543/default.php

Machine Learning. SSCBU05

Responsible : NASR Alexis. . 3 ECTS
10h CM, 10h TD, 10h TP
Language : English/ French

Description
Ce cours est une introduction à l'apprentissage automatique avec un accent fort mis sur les réseaux de neurones. Le cours vise à introduire quelques concepts fondamentaux de l'apprentissage automatique et de les illustrer sur un type de modèles que sont les réseaux de neurones.
Afin de comprendre le fonctionnement des réseaux de neurones, un certain nombre de concepts mathématiques seront introduit, en particulier la notion de fonction, de dérivée, de fonctions à plusieurs variables et de gradient. Cela permet d'introduire l'algorithme de descente du gradient qui est au cœur de l'optimisation des réseaux de neurones.
Différentes architectures de réseaux de neurones seront décrites : le perceptron multicouche, les réseaux convolutionnels et les réseaux récurrents.
Afin de réaliser des réseaux de neurones, on utilisera la librairie tesorflow et keras dans le cadre de trois projets reposant sur chacune des trois architectures présentées.
Skills to acquire:

- Comprendre des notions de bases de l'apprentissage, en particulier la fonction de perte et l'optimisation de cette dernière sur des données étiquetées.
- Maîtriser une implémentation des réseaux de neurones, en particulier les librairies tensorflow et keras.
- Apprendre à réaliser des expériences mettant en jeu des réseaux de neurones sur des thèmes variés.

Pedagogy and class organization
Le cours se présente sous la forme de séances de cours/TP durant lesquelles les notions importantes sont introduites et illustrées sur des exercices ainsi que sous la forme de séances de TP durant lesquelles les étudiants travaillent sur les trois projets qui leur ont été proposés.

Mandatory prerequisites
Programmation en python, le niveau demandé correspond à celui du cours de python du premier semestre de master.

Bibliography

- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.
- Goldberg, Y. (2022). Neural network methods for natural language processing. Springer Nature.
- - Jurafsky, D., & Martin, J. H. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition.

Research Internship

SSCBU06

Responsible : CASINI Laurence .

6 ECTS

Language : English and/or French

Description
The research internship offers students the opportunity to engage in hands-on research within the field of cognitive science. Students will work under the supervision of experienced researchers in a research group, gaining practical experience in various cognitive science methodologies. The internship will involve participating in ongoing research projects, collecting and analyzing data, and contributing to the development of research findings.

Skills to acquire
- Understanding and applying various research methods in cognitive science (e.g., experimental design, observational studies, etc.).
- Gaining experience in collecting, managing, and analyzing data using appropriate statistical tools and software.
- Developing the ability to read scientific literature and formulate research question.
- Enhancing written and oral communication skills through the writing of a research report and the presentation of a scientific poster.
- Learning to work effectively in a team, collaborating with peers and supervisors to achieve common research goals.

Pedagogy and class organization
The M1 internship (120 hours) must be supervised by a statutory member (with a PhD). The internship will be assessed based on a written report and the presentation of a scientific poster evaluated by a jury.
Students may complete their internship in a research laboratory.

HSCBK02 - Integrate transdisciplinary fundamental knowledge

Writing : From Theory to Practice — SSCBU07

Responsible : ALARIO Xavier. — 3 ECTS
10h CM, 10h TD, 10h TP
Language : English/French

Description
Cette UE présentera des modèles développés en sciences cognitives pour rendre compte des processus d'écriture (surtout) et de la lecture de texte qui contraint l'écriture (un peu). Cet enseignement théorique sera prolongé par des travaux pratiques et travaux dirigés mettant en action les compétences d'écriture afin de les consolider au service de différentes formes d'écrits.
Skills to acquire:

- Connaissance des travaux théoriques et empiriques sur la production de l'écriture.
- Capacité à formuler un texte dans un style universitaure privilégiant la clarté d'exposition.
- Capacité à commenter la forme des écrits de ce type. Mise en page systématique pour une écriture scientifique robuste.

Pedagogy and class organization
Cours magistraux présentant des modèles de références ou des expériences classiques. TD et TP avec exercices d'écriture alliant le fond (contenu des CM) et la forme (capacités d'écriture).

Mandatory prerequisites
Expérience d'écriture universitaire en français ou en anglais.

Assessment methods
CC +CT: Le travail sera évalué à mis parcours et par un contrôle final sur table.

Bibliography
Pinker, S. (2015). The sense of style: The thinking person's guide to writing in the 21st century. Penguin Books.

Track preparation. — SSCBU08

Responsible : STRIJKERS Kristof and ABADIE Marlène — 3 ECTS
Language, Communication and the brain 1 15h CM, 15h TD, 0h TP
Typical and atypical cognitive functioning 1 25h CM, 5h TD, 0h TP
Language : English

Description

Typical and atypical cognitive functioning 1

Part 1. Memory (15h CM)

In the first part of the course, we will show how the field of memory has evolved from the time when Hermann Ebbinghaus, a 19th century German philosopher, memorized meaningless syllables to show that memory could be studied scientifically, to today, when we are able to create false memories in the hippocampus of mice. All of the material in the course will be presented from an interdisciplinary perspective, ranging from psychology to neurosciences. We shall begin with an introduction on what memory is and how it is studied in psychology and neurosciences. The second chapter will focus on the learning process, the factors that determine its success, and the different types of learning. Knowledge about memory is constantly evolving at all levels, from the cognitive to the cellular. It will not be long before we isolate cells specifically involved in individual memories of personal experiences and see how the brain stores them. Memories of personal experience – episodic memory - will be the topic of the third chapter of the course. The ability to remember our lives defines who we are, what we have done, and ultimately a sense of meaning and purpose. We shall see what science tells us about the cognitive and brain mechanisms that underlie the encoding and retrieval of episodic memory. This will help us understand how we transform memories, which are fleeting and fragile echoes of experience, into the enduring scaffolding of our autobiographies. Finally, we shall show how the understanding of memory has benefited the study of patients with memory deficits and, in turn, the assessment, diagnosis, and treatment of these patients.

Part 2. Emotions and Memory (10h CM)

The second part of the course is devoted to understanding how emotions affect memory for different types of stimuli and different paradigms. Again, following Part 1, this part will discuss the main phenomena, paradigms, and theories regarding the role of emotions on memory, also ranging from psychology to neuroscience. Previous findings reveal how we can experience déjà-vu phenomena, how emotions can either enhance or impair our memory, how emotions can change our memories or even lead to impressive false memories. The mechanisms responsible for such effects are now fairly well understood, and we will present them in this second part. Finally, we will examine how the effects of emotions change during adulthood and in the case of certain experiences, such as intense stress. This will enable us to understand how aging and certain pathologies, such as PTSD or depression, may modify emotion-memory interactions.

TD. Computational modeling in memory

TDs will introduce students to computational modeling of memory.

Language Communication and the Brain 1

Students will present and discuss recent articles related to the fields covered, published in international peer-reviewed journals. Lectures will focus on neuroanatomy and neural dynamics, and how they relate to psycholinguistic functions. Theoretical frameworks, empirical observations and methods used to evaluate them will also be discussed, as well as current controversies. In the journal club, students will give oral presentations of topical scientific articles published in international peer-reviewed journals on themes related to the course, and then debate these articles critically and constructively. Classes and debates will be held in English and moderated by the course leaders.

Skills to acquire:

Typical and atypical cognitive functioning 1

This course presents an overview of the latest research on memory and its interaction with emotions in psychology and neuroscience. Students will gain a solid understanding of the models and methods used to study memory, its neurobiological basis and the effect of emotions on memorization. They will also learn to use mathematical modeling to account for memory phenomena.

More broadly, they will learn to conceptualize memory from an interdisciplinary perspective, and will be expected to master the experimental methodology used in psychology and neuroscience.

Language Communication and the Brain 1. The aim of this UE is for students to acquire expert knowledge of the main models of the relationship between language and the brain, as well as their empirical testing. Students will benefit from advanced theoretical training, focusing in particular on two areas: language production and comprehension.

Pedagogy and class organization

Language Communication and the Brain 1.

The pedagogical structure of the UE is based on a combination of theoretical lectures where models and empirical observations will be discussed in depth, followed by "journal clubs", in which students will present and discuss recent articles related to the fields covered, published in international peer-reviewed journals. Classes and debates will be held in English and moderated by the course leaders.

Assessment methods

Typical and atypical cognitive functioning 1

Final Exam (open-ended reflection questions on the different parts of the course).

Language Communication and the Brain 1

The UE will be assessed by continuous assessment (50%) and a final exam (50%). The grade for the continuous assessment includes the grade for the oral presentation. Assessment criteria for the CC include: ability to synthesize, ability to adopt a scientific style, appropriation of disciplinary concepts, ability to argue and critical sense. For the final exam, these criteria concern: ability to use theoretical concepts and systems to analyze and interpret the results of a published study.

Bibliography

Part 1.

- Baddeley, A. D., Eysenck, M., & Anderson, M. C. (2020). Memory, Third Edition. Psychology Press Book.
- Baddeley, A. D., Kopelman, M. D., & Wilson, B. A. (Eds.). (2003). The handbook of memory disorders. John Wiley & Sons.
- Brown, P. C., Roediger III, H. L., & McDaniel, M. A. (2014). Make it stick: The science of successful learning. Harvard University Press.
- Roediger III, H. L., Dudai, Y., & Fitzpatrick, S. M. (Eds.). (2007). Science of memory: Concepts. Oxford University Press.

Part 2

- Lemaire, P., & Didierjean, A. (2018). Introduction à la psychologie cognitive. Bruxelles : De Boeck. (ISBN 2807307841).
- Lemaire, P. (2021). Emotion and Cognition. New York: Routledge (ISBN

978-1032138398). Parution en Français : Emotion et Cognition. Bruxelles : De Boeck. (ISBN 978-2-807337527).

Language Communication and the Brain 1.
- Indefrey, P., & Levelt, W. J. (2004). The spatial and temporal signatures of word production components. Cognition, 92(1-2), 101-144.
-Hickok, G., & Poeppel, D. (2007). The cortical organization of speech processing. Nature reviews neuroscience, 8(5), 393-402.

HSCBK03 – Mobilize fundamental knowledge from different disciplines

Writing : Optional disciplinary courses 2	HSCBX20
Responsible : ALARIO Xavier.	9 ECTS Language : English & French

Formes sonores du langage 2	3 ECTS	
Signification et Interaction 2	3 ECTS	
Épistémologie 4	6 ECTS	
Spécialisation en histoire et philosophie du vivant	5 ECTS	
Computational statistics	3 ECTS	
Apprentissage statistique et réseau de neurones	3 ECTS	
Classification	3 ECTS	
Statistique textuelle	3 ECTS	
Learning and memory	3 ECTS	
Traitement automatique du langage	3 ECTS	
Traitement automatique des langues		

Mandatory prerequisites
A good level of French & English proficiency is necessary.

Structure M2 Cognitive Sciences

Semester 3 track: Language communication and the brain

HSCCK01 – Implement a research approach in a professional context

Scientific workshop	SSCCU01

Responsible : GROSBRAS Marie-Hélène — 3 ECTS, 30h TD, Language : English

Description

To deepen students' general knowledge in various themes addressed by cognitive sciences (e.g., consciousness, decision-making, communication), potentially exposing them to disciplines not covered in the rest of the curriculum (e.g., philosophy, anthropology).

To expose students to the practices of cognitive science research by providing them with opportunities to interact directly with researchers from different disciplines who will present their work.

Skills to acquire:

- To acquire expertise in interdisciplinary knowledge of cognitive functioning.
- To gain expertise in integrating these interdisciplinary approaches.
- To practice communication in English.
- To interact with experts in cognitive sciences.

Pedagogy and class organization

Students will collaboratively define a theme and organize a workshop over one or two days, conducted in English. To do this, they will invite experts from various disciplines and institutional or private settings to present their work related to the chosen theme. During the workshop, students will organize speaking and Q&A sessions. At the end of the workshop, they will need to provide a summary in the form of an audio recording (podcast) in English, highlighting what they have learned about the theme and critically relating contributions from different disciplines.

Assessment methods

Recorded Oral Summary, in English. Graded out of 20.

Experimental research platforms — SSCCU02

Responsible : BADIER Jean-Michel — 3 ECTS, 6h CM, 12h TD, 12h TP, Language : English

Description

This course unit is an introduction to using measurement and exploration tools available across the various platforms affiliated with ILCB. It includes an overview of the different platforms and techniques accessible within the ILCB environment, as well as a theoretical reflection on the origins and acquisition of measured data. The focus will be on the choice of measured parameters, and students will be introduced to stimulation tools. A practical implementation is planned as part of a recording session on the different platforms. Finally, we will discuss the advantages and limitations of the various techniques used, as well as the relevance and challenges of multimodal measurements.

Skills to acquire:

- To acquire expertise in interdisciplinary knowledge of cognitive functioning.
- To gain expertise in integrating these interdisciplinary approaches.

- To practice communication in English.
- To interact with experts in cognitive sciences.

Pedagogy and class organization
The experimental modalities covered are as follows:

- Anatomical and functional Magnetic Resonance Imaging (MRI)
- Electroencephalography (EEG)
- Magnetoencephalography (MEG)

Advanced Probability and Statistics

SSCCU03

Responsible : FREYERMUTH Jean-Marc

3 ECTS
9h CM, 12h TD, 9h TP
Language : English

Description

This course provides a comprehensive introduction to Bayesian inference and its applications in cognitive science, neural data analysis, and linguistics. Starting with a refresher on probability theory, the course will cover fundamental Bayesian concepts, including prior distributions, likelihood, posterior inference, Bayesian hypothesis testing, model selection, and the basics of MCMC algorithms.

The practical sessions will focus on real-world applications, such as memory retention modeling, spike train data analysis, and probabilistic context-free grammar induction. Emphasizing both intuitive understanding and hands-on implementation, the course equips students with the ability to effectively deploy Bayesian models using R, Python, and specialized tools such as JAGS and Stan.

Skills to acquire:

- Proficiency in basic probability calculations and their role in Bayesian inference.
- Practical expertise in implementing, and validating Bayesian models for real-world datasets in cognitive science, neuroscience and linguistics.
- Hands-on experience using R/ Python, Jags, Stan.
- Understanding the key differences between the Frequentist and Bayesian paradigms.

Pedagogy and class organization

The course combines lecture, exercises sessions and practical classes. Students will engage in coding exercises, data analysis, and project-based learning to reinforce theoretical concepts through implementation.

Assessment methods

Continuous evaluation (30%): project evaluation
Final exam (70%): written exam.

References

Bruno Nicenboim, Daniel J. Schad, Shravan Vasishth (2025). Introduction to Bayesian Data Analysis for Cognitive Science. https://bruno.nicenboim.me/bayescogsci/ch-complexstan.html

Michael D. Lee, Eric-Jan Wagenmakers (2014). Bayesian Cognitive Modeling: A Practical Course, Cambridge University Press, 265p.

Shay Cohen (2019). Bayesian Analysis in Natural Language Processing. Morgan & Claypool; Reprint edition. 311p.

HSCCK02 – Integrate transdisciplinary fundamental knowledge

Machine learning as a model in cognitive science SSCCU04

Responsible : FOURTASSI Abdellah and SCHATZ Thomas. 6 ECTS
30h CM, 30h TD, 0h TP
Language : English/French

Description

The class is organized into a number of cases studies around both classical and more recent results from the scientific literature, starting with fundamental case studies where implementation issues are kept simple (ECUE Machine learning in cog. sci : fundamental examples) and progressing towards case studies with more in-depth review of implementation aspects (ECUE Machine learning in cog. sci : advanced case studies). Classes blend practical sessions and lectures, with guided hands-on programming and analyses interlaced with lectures providing scientific context, relevant mathematical and computational concepts, and general discussion of the role of machine learning in cognitive (neuro)science theory.

Skills to acquire

- DESIGN: being able to design simple cognitive (neuro)science studies involving machine learning models of cognition and the brain
- IMPLEMENT: being able to implement simple cognitive (neuro)science studies involving machine learning models of cognition and the brain

Pedagogy and class organization

In the second ECUE, which is shared across the cognitive science and computer science Masters, we will seek to team up students with different backgrounds so that they can learn from each other

Mandatory prerequisites
"Programming tools," Mathematics for cognitive science," and " Machine learning" classes from AMU's cognitive science Master (MASCO) or equivalent

Language, communication and the brain 2. SSCCU05

Responsible : STRIJKERS Kristof

6 ECTS
30h CM, 30h TD, 0h TP
Language : English

Description
This course (following up on LCC1 seen during track preparation in M1) has the aim of developing students' expertise in new areas of language-brain models, building on and extending the theoretical knowledge acquired in M1. These new themes include language evolution (comparative research), bi- and multilingualism, the integration of perception and production, conversational brain dynamics, and neural coding (neurosemantics, neurosyntax, neuropragmatics).

Skills to acquire:
In terms of skills, students will (a) gain expert knowledge of the state of the art in the cognitive neuroscience of language, (b) acquire mastery in reading, presenting and discussing empirical work on the relationship between brain and language, (c) learn to evaluate and formulate hypotheses on the relationship between brain and language, (d) be able to organize and moderate a debate in which different points of view are presented, and (e) improve their level of (spoken) English. All these skills can be mobilized by students in the context of their scientific or professional internship, but also in the longer term, during their future career in scientific research.

Pedagogy and class organization
The pedagogical structure of the UE is based on a combination of theoretical lectures where models and empirical observations will be discussed in depth, followed by “journal clubs”, in which students will present and discuss recent articles related to the fields covered, published in international peer-reviewed journals. Classes and debates will be held in English and moderated by the course leaders.

Mandatory prerequisites
Having passed LCC1 in the track preparation course.

Recommended prerequisites
Basic knowledge on the cognitive neuroscience of language.

Assessment methods
CC: This course will be evaluated in 'controle continue', where we will evaluate the two oral presentations on scientific articles about topics we saw during the theoretical classes (CM) which each student must perform, and how well the student manages to link each presentation to the theory seen in class.

Bibliography

- - Indefrey, P., & Levelt, W. J. (2004). The spatial and temporal signatures of word production components. Cognition, 92(1-2), 101-144.
- Hickok, G., & Poeppel, D. (2007). The cortical organization of speech processing. Nature reviews neuroscience, 8(5), 393-402.

- Pickering, M. J., & Garrod, S. (2013). An integrated theory of language production and comprehension. Behavioral and brain sciences, 36(4), 329-347.

HSCCK03 – Mobilize fundamental knowledge from different disciplines

Conversational dynamics and dialogue	HCOCU20
Responsible : BLACHE Philippe	6 ECTS 20h CM, 20h TD, 20h TP Language : English

Description
Skills to acquire:

- Presentation of the notion of conversational interaction and interpersonal dynamics
- Description and modeling
- Dialogue systems and conversational agents
- Project

Skills to acquire

- Description, annotation tools, modeling
- Theory of interaction
- Architecture of dialogue systems

Pedagogy and class organization
Each instructor covers a specific chapter of the course, providing both lectures and practical sessions.
A project supervised by three instructors is developed at the end of the course.

Recommended prerequisites
Statistiques, description linguistique, Python

Assessment methods
Project and final exam.

Bibliography
Understanding Dialogue - Language Use and Social Interaction
Martin J. Pickering & Simon Garrod
Cambridge University Press, 2021

Writing : Optional disciplinary courses 3	HSCCX20
	3 ECTS Language : English & French

Formes sonores du langage 3	3 ECTS
Signification et Interaction 3	3 ECTS

Computational neurosciences 3	3 ECTS
Mental functions	3 ECTS
Modèles de langage	3 ECTS
Modèles de langage	
Prédiction structurée pour le traitement auto. de la langue	3 ECTS
Prédiction structurée pour le traitement auto. de la langue	
Mathématiques de la science des données	3 ECTS
Mathématiques SD 1	
Statistique de la science des données	3 ECTS
Mathématiques SD 1	

Mandatory prerequisites
A good level of French & English proficiency is necessary.

Semester 4 track: Language communication and the brain

HSCDK01 – Implement a research approach in a professional context

Cognitive engineering	SSCDU01
Responsible : LEGOU Thierry	6 ECTS 40h CM, 20h TD, 30h TP Language : French

Description
Mise à niveau et présentation des outils et techniques de prototypage rapide qui rendent l'accès à ces techniques à des non spécialistes.
Formation au découpage fonctionnel d'un projet qui permet d'identifier les différentes fonctions (électrodes, pré amplification conditionnement, stockage ou transmission bluetooth, pour les répartir au sein d'un groupe de travail, pour identifier les ressources déjà existantes dans la communauté open hardware/ open software.
Formation à l'organisation et planification du travail (gantt rapide, identification du chemin critique, des aspects faciles du projet et des aspects plus challenge), proposition d'un plan A de développement et d'un plan B. Pour appliquer les connaissances transmis sur l'analyse des tâches et l'organisation du développement d'un système, les étudiants devront les mettre en oeuvre sur des sujets proposés comme par exemple :

- Mesure du rythme cérébral et extractions des fréquences référencées (alpha, beta,…).
- Le degrés de synchronie entre deux « inter actants » en mesurant extrayant des signaux physio(ECG, EEG).
- Une approche Art et NeuroPhysio, mesurer l'effet du rythme (stimulation visuelle ou auditive) sur les signaux physio ou au contraire « sonifier » ou

visualiser les variations des signaux cérébraux et physio.
- Mind control (à partir de d'un mobile (voiture par exemple).
- La BCI.

Skills to acquire :

- Familiarization with tools and techniques for rapid prototyping accessible to non-specialists.
- Functional Decomposition: Training in breaking down a project into functional components (e.g., electrodes, pre-amplification conditioning, storage, Bluetooth transmission) to allocate tasks within a team and identify existing resources in the open hardware/open software community.
- Project Organization and Planning: Skills in organizing and planning work, including quick Gantt charts, identifying critical paths, and distinguishing easy tasks from more challenging aspects.
- Development Plans: Ability to propose a Plan A for development and a contingency Plan B, applying knowledge of task analysis and system development organization.

Pedagogy and class organization

Pour développer le projet, chaque groupe suivra le plan de développement préalablement défini en amont de la semaine. À la fin de chaque journée, chaque groupe présentera aux autres le travail accompli ainsi que les éventuels blocages rencontrés. Cette méthode de travail collaboratif permet de simuler un environnement professionnel, similaire à celui d'une entreprise, favorisant l'entraide et le partage d'idées pour surmonter les défis.

Assessment methods

La conduite du projet et les résultats obtenus à la fin de la semaine seront évalués, tout comme un court reportage de moins de cinq minutes. Ce reportage, filmé à l'aide d'un téléphone, retracera les étapes et les moments clés de la semaine. Il permettra de documenter le processus de développement du projet et de mettre en avant les compétences et les contributions des participants.

Internship and master thesis — SSCDU02

Responsible : CASINI Laurence, CHAMPAGNE-LAVAU Maud — 24 ECTS, 500h

Language : English/French

Description

Research Laboratory or Company Field Internship.

Skills to acquire

Some of the skills that a students can acquire during this type of internship include:

- Problem-Solving: Enhancing skills in identifying and solving practical problems using cognitive science methods.
- Project Management: Gaining experience in managing projects, including planning, executing, and evaluating outcomes.

• Communication Skills: Developing skills in communicating complex cognitive science concepts to non-specialists and stakeholders. • Critical Thinking: Enhanced ability to analyze situations, question assumptions, and evaluate evidence. • Networking: Building professional relationships and networking with other professionals in cognitive sciences and related fields. **Pedagogy and class organization** - Internship Follow-up Sessions: 12 hours of tutorials - Professional Integration Training Sessions: 6 hours of tutorials
Assessment methods Internship report and oral presentation evaluated by a jury.

Structure M2 Cognitive Sciences

Semester 3 track: Cognitive functions in typical and atypical individuals

HSCCK01 – Implement a research approach in a professional context

Scientific workshop	SSCCU01
Responsible : GROSBRAS Marie-Hélène	3 ECTS 30h TD Language : English
Description To deepen students' general knowledge in various themes addressed by cognitive sciences (e.g., consciousness, decision-making, communication), potentially exposing them to disciplines not covered in the rest of the curriculum (e.g., philosophy, anthropology). To expose students to the practices of cognitive science research by providing	

them with opportunities to interact directly with researchers from different disciplines who will present their work.

Skills to acquire:

- To acquire expertise in interdisciplinary knowledge of cognitive functioning.
- To gain expertise in integrating these interdisciplinary approaches.
- To practice communication in English.
- To interact with experts in cognitive sciences.

Pedagogy and class organization

Students will collaboratively define a theme and organize a workshop over one or two days, conducted in English. To do this, they will invite experts from various disciplines and institutional or private settings to present their work related to the chosen theme. During the workshop, students will organize speaking and Q&A sessions. At the end of the workshop, they will need to provide a summary in the form of an audio recording (podcast) in English, highlighting what they have learned about the theme and critically relating contributions from different disciplines.

Assessment methods

Recorded Oral Summary, in English. Graded out of 20.

Experimental research platforms

SSCCU02

Responsible : BADIER Jean-Michel

3 ECTS
6h CM, 12h TD, 12h TP
Language : English

Description

This course unit is an introduction to using measurement and exploration tools available across the various platforms affiliated with ILCB. It includes an overview of the different platforms and techniques accessible within the ILCB environment, as well as a theoretical reflection on the origins and acquisition of measured data. The focus will be on the choice of measured parameters, and students will be introduced to stimulation tools. A practical implementation is planned as part of a recording session on the different platforms. Finally, we will discuss the advantages and limitations of the various techniques used, as well as the relevance and challenges of multimodal measurements.

Skills to acquire:

- To acquire expertise in interdisciplinary knowledge of cognitive functioning.
- To gain expertise in integrating these interdisciplinary approaches.
- To practice communication in English.
- To interact with experts in cognitive sciences.

Pedagogy and class organization

The experimental modalities covered are as follows:

- Anatomical and functional Magnetic Resonance Imaging (MRI)
- Electroencephalography (EEG)
- Magnetoencephalography (MEG)

Advanced Probability and Statistics

SSCCU03

Responsible : FREYERMUTH Jean-Marc

3 ECTS
9h CM, 12h TD, 9h TP
Language : English

Description

This course provides a comprehensive introduction to Bayesian inference and its applications in cognitive science, neural data analysis, and linguistics. Starting with a refresher on probability theory, the course will cover fundamental Bayesian concepts, including prior distributions, likelihood, posterior inference, Bayesian hypothesis testing, model selection, and the basics of MCMC algorithms.

The practical sessions will focus on real-world applications, such as memory retention modeling, spike train data analysis, and probabilistic context-free grammar induction. Emphasizing both intuitive understanding and hands-on implementation, the course equips students with the ability to effectively deploy Bayesian models using R, Python, and specialized tools such as JAGS and Stan.

Skills to acquire:

- Proficiency in basic probability calculations and their role in Bayesian inference.
- Practical expertise in implementing, and validating Bayesian models for real-world datasets in cognitive science, neuroscience and linguistics.
- Hands-on experience using R/ Python, Jags, Stan.
- Understanding the key differences between the frequentist and Bayesian paradigms.

Pedagogy and class organization

The course combines lecture, exercises sessions and practical classes. Students will engage in coding exercises, data analysis, and project-based learning to reinforce theoretical concepts through implementation.

Assessment methods

Continuous evaluation (30%): project evaluation
Final exam (70%): written exam.

References

Bruno Nicenboim, Daniel J. Schad, Shravan Vasishth (2025). Introduction to Bayesian Data Analysis for Cognitive Science.
https://bruno.nicenboim.me/bayescogsci/ch-complexstan.html

Michael D. Lee, Eric-Jan Wagenmakers (2014). Bayesian Cognitive Modeling: A Practical Course, Cambridge University Press, 265p.

Shay Cohen (2019). Bayesian Analysis in Natural Language Processing. Morgan & Claypool; Reprint edition. 311p.

HSCCK02 – Integrate transdisciplinary fundamental knowledge

Machine learning as a model in cognitive science — SSCCU04

Responsible : FOURTASSI Abdellah

6 ECTS
30h CM, 30h TD, 0h TP
Language : English/French

Description

This course is an introduction to machine learning with a strong emphasis on neural networks. The course aims to introduce some fundamental concepts of machine learning and illustrate them using neural network models.To understand how neural networks work, a number of mathematical concepts will be introduced, including the notions of functions, derivatives, multivariable functions, and gradients. This will allow for the introduction of the gradient descent algorithm, which is central to optimizing neural networks.
Different neural network architectures will be described: multilayer perceptrons, convolutional networks, and recurrent networks.
To implement neural networks, we will use the TensorFlow and Keras libraries through three projects, each based on one of the three architectures presented.

Skills to acquire:

- Understand basic concepts of learning, particularly the loss function and its optimization on labeled data.
- Master an implementation of neural networks, especially using the TensorFlow and Keras libraries.
- Learn to conduct experiments involving neural networks on various topics.

Pedagogy and class organization

The course consists of lectures and tutorial sessions, during which key concepts are introduced and illustrated with exercises, as well as practical lab sessions, during which students work on the three projects that have been proposed to them.

Mandatory prerequisites

Programming in Python, with the level required corresponding to that of the first-semester Master's Python course.

Typical and atypical cognitive functioning 2 — SSCCU10

Responsible : CASINI Laurence

6 ECTS
30h CM, 30h TD, 0h TP
Language : English

Description

The course aims at understanding how humans make voluntary decisions and adaptively act in the environment. The course addresses the neural bases and cognitive processes of central executive functions in humans. These functions form the capacity to act not only in response to external events but also in relation with intentions and choices stemming from motives and beliefs. The course will address this issue from the viewpoint of psychology, cognitive and computational neuroscience. Moreover, these functions will also be addressed in the case of atypical functioning and neuropathologies.
The course will be organized in two parts, the first one mainly centered on attention and preparation, both processes aimed at optimizing sensorimotor activities and the second one on cognitive control and decision making in link with motivation.
Skills to acquire:
On successful completion of these courses, students should be able to:
•Explain, discuss and elaborate on the key concepts regarding human executive functions, decision-making, motivation and attention
•Describe the basics regarding the neural, functional and computational architecture of these functions,
•Read and develop a critical view on original research papers on these topics
•Start developing experimental protocols and computational models on these topics.
Pedagogy and class organization
There will be three types of courses: lectures, experimental activities to illustrate a cognitive function (e.g., ranging from reading and presenting/explaining scientific papers to actual experimentation and/or data processing), and professional/expert testimony on a cognitive function and its atypical functioning.

Assessment methods
Continuous assessment with various assignments defined at the beginning of each year.

HSCCK03 – Mobilize fundamental knowledge from different disciplines

Writing : Optional disciplinary courses	SSCCX01
Responsible :	9 ECTS Language : English & French

Computational neurosciences 3	3 ECTS
Mental functions	3 ECTS
Mathématiques de la science des données Mathématiques SD 1	3 ECTS
Statistique de la science des données Mathématiques SD 1	3 ECTS

Mandatory prerequisites
A good level of French & English proficiency is necessary.

Semester 4 track: Cognitive functions in typical and atypical individuals

HSCDK01 – Implement a research approach in a professional context

Cognitive engineering	SSCDU01
Responsible : LEGOU Thierry	6 ECTS 40h CM, 20h TD, 30h TP Language : French

Description

Mise à niveau et présentation des outils et techniques de prototypage rapide qui rendent l'accès à ces techniques à des non spécialistes.
Formation au découpage fonctionnel d'un projet qui permet d'identifier les différentes fonctions (électrodes, pré amplification conditionnement, stockage ou transmission bluetooth, pour les répartir au sein d'un groupe de travail, pour identifier les ressources déjà existantes dans la communauté open hardware/ open software.
Formation à l'organisation et planification du travail (gantt rapide, identification du chemin critique, des aspects faciles du projet et des aspects plus challenge), proposition d'un plan A de développement et d'un plan B. Pour appliquer les connaissances transmis sur l'analyse des tâches et l'organisation du développement d'un système, les étudiants devront les mettre en oeuvre sur des sujets proposés comme par exemple :

- Mesure du rythme cérébral et extractions des fréquences référencées (alpha, beta,…).
- Le degrés de synchronie entre deux « inter actants » en mesurant extrayant des signaux physio(ECG, EEG).
- Une approche Art et NeuroPhysio, mesurer l'effet du rythme (stimulation visuelle ou auditive) sur les signaux physio ou au contraire « sonifier » ou visualiser les variations des signaux cérébraux et physio.
- Mind control (à partir de d'un mobile (voiture par exemple).
- La BCI.

Pedagogy and class organization

Pour développer le projet, chaque groupe suivra le plan de développement préalablement défini en amont de la semaine. À la fin de chaque journée, chaque groupe présentera aux autres le travail accompli ainsi que les éventuels blocages rencontrés. Cette méthode de travail collaboratif permet de simuler un environnement professionnel, similaire à celui d'une entreprise, favorisant l'entraide et le partage d'idées pour surmonter les défis.

Assessment methods

La conduite du projet et les résultats obtenus à la fin de la semaine seront évalués, tout comme un court reportage de moins de cinq minutes. Ce reportage, filmé à l'aide d'un téléphone, retracera les étapes et les moments clés de la semaine. Il

permettra de documenter le processus de développement du projet et de mettre en avant les compétences et les contributions des participants.

Internship and master thesis

SSCDU02

Responsible : CASINI Laurence, CHAMPAGNE-LAVAU Maud

24 ECTS
500h
Language : English/French

Description

Research Laboratory or Company Field Internship.

Skills to acquire

Some of the skills that a students can acquire during this type of internship include:

- Problem-Solving: Enhancing skills in identifying and solving practical problems using cognitive science methods.
- Project Management: Gaining experience in managing projects, including planning, executing, and evaluating outcomes.
- Communication Skills: Developing skills in communicating complex cognitive science concepts to non-specialists and stakeholders.
- Critical Thinking: Enhanced ability to analyze situations, question assumptions, and evaluate evidence.
- Networking: Building professional relationships and networking with other professionals in cognitive sciences and related fields.

Pedagogy and class organization

- Internship Follow-up Sessions: 12 hours of tutorials
- Professional Integration Training Sessions: 6 hours of tutorials

Assessment methods

Internship report and oral presentation evaluated by a jury.