

The Chinese University of Hong Kong
Department of Linguistics and Modern Languages
First Term, 2026-27

Course Code: LING6971 Title in English: Special Topics in Experimental Methods – Neuroimaging and Machine Learning in Linguistics Title in Chinese: 實驗方法的專題研究 – 神經影像與機器學習在語言學中的應用
Course Description: Students will learn about different neuroimaging and machine learning methods used in neurolinguistic research. Lectures will cover basic knowledge of experimental design, data processing and analysis when using fMRI, fNIRS, EEG, and MEG; and introduce intervention techniques including neurofeedback, tDCS and TMS. The course will take students through case studies that exemplify common experimental approaches in linguistics. By the end of the course, students will be familiar with a variety of research methods and paradigms, as well as how to apply them appropriately to answer different kinds of research questions.

Learning outcomes

After learning this course, students should be able to: - Describe the techniques introduced, understand the parameters involved, and design a study using the techniques. - Explain the differences between different experimental methods, with their advantages and disadvantages for the analysis. - Identify common challenges that researchers are likely to encounter when conducting the experimental research, and approaches that can be taken to mitigate the challenges. - Understand a concrete example of how experimental methods have been used in each area of neurolinguistic research described in this course.

Course Syllabus

Topic	Contents/fundamental concepts
Methods	Functional magnetic resonance imaging (fMRI) Functional near infrared spectroscopy (fNIRS) Electroencephalography (EEG) and event-related potentials (ERPs) Magnetoencephalography (MEG) Neurofeedback Transcranial direct current stimulation (tDCS) Transcranial magnetic stimulation (TMS)
Areas of investigation	Neuroanatomy of language Language function and network Natural language processing Speech and language impairment
Issues in experimental design and data analysis	Choosing appropriate methods and paradigms Important considerations in statistical analysis Statistical models in neurolinguistics Interpreting findings

Course components (Teaching modes and Learning activities)

Teaching Modes and Learning Activities	
On-site face-to-face	Percentage of time

Lectures on-site face-to-face, including class discussion and presentation	30.3% (30 hours)
<i>Interactive tutorial (hybrid yes/no)</i>	3% (3 hours)
Out-of-classroom	
<i>Assigned reading, class preparation and assignments</i>	66.7% (66 hours)

Learning activities

Lecture (hr) in /out class		Interactive tutorial (hr) in /out class		Lab (hr) in /out class		Discussion of case (hr) in /out class		Field-trip (hr) in /out class		Projects (hr) in /out class		Web-based teaching (hr) in /out class		Other (hr) in /out class	
10		1								1					
M	M;O; NA	M	M;O; NA	M;O; NA	M;O; NA	M;O; NA	M;O; NA	M;O; NA	M;O; NA	M	M;O; NA	M;O; NA	M;O; NA	M;O; NA	M;O; NA

M: Mandatory activity in the course

O: Optional activity

NA: Not applicable

Assessment scheme

Assessment type	Percentage
Exams (All cumulative): Two exams will address knowledge learned in lectures. Mid-term exam 15% ; Final exam 20%	35%
Research Project: Submit a research paper (proposal or literature review) on a topic of experimental design of a Neurolinguistic topic (instructor approval required)	30%
Article Presentation: You will present one research article for developing skills in critically analyzing research articles.	15%
Discussion reports: Submit three discussion reports that are linked to the required readings.	20%

Required and recommended readings

Required readings: There is no required textbook. This is a list of required readings and more required readings will be announced in class if needed. Class 1: Course Intro; Overview of experimental methods - de Zubicaray, Greig I., and Niels O. Schiller (eds). The Oxford Handbook of Neurolinguistics, Oxford Handbooks (2019; online edn, Oxford Academic, 14 Mar. 2019). Chapter 1: Neurolinguistics: A Brief Historical Perspective. - Basics of functional MRI and EEG - Steven J. Luck. (2014). An introduction to the event-related potential technique, 2nd Edition, Massachusetts: The MIT Press. Chapter 1: An Introduction to Event-Related Potentials and Their Neural Origins. - Aamir Saeed Malik, Hafeez Ullah Amin, Chapter 1 - Designing an EEG Experiment, Editor(s): Aamir Saeed Malik, Hafeez Ullah Amin, Designing EEG Experiments for Studying the Brain, Academic Press, 2017, Pages 1-30, Class 2: MRI and neurolinguistics: language related neuroanatomy and pathways - Hickok G. The functional neuroanatomy of language. Phys Life Rev. 2009 Sep;6(3):121-43. doi: 10.1016/j.plrev.2009.06.001. PMID: 20161054; PMCID: PMC2747108. - Cabeza & Kingstone (2006). Handbook of functional neuroimaging of cognition, 2nd Edition), Massachusetts: The
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MIT Press. Chapter 7

Class 3: Task paradigms, block design and event related design

- Amaro E Jr, Barker GJ. Study design in fMRI: basic principles. Brain Cogn. 2006 Apr;60(3):220-32. doi: 10.1016/j.bandc.2005.11.009. Epub 2006 Jan 19. PMID: 16427175.
- <https://www.youtube.com/watch?v=RQrtNVKvIIk>

Class 4: Advanced analysis models: effective connectivity, structural equation modeling, dynamic causal models

- Penny WD, Stephan KE, Mechelli A, Friston KJ. Modelling functional integration: a comparison of structural equation and dynamic causal models. Neuroimage. 2004;23 Suppl 1:S264-74.

Class 5: Basics of fNIRS, study design, and data processing

- Pinti P, Tachtsidis I, Hamilton A, Hirsch J, Aichelburg C, Gilbert S, Burgess PW. The present and future use of functional near-infrared spectroscopy (fNIRS) for cognitive neuroscience. Ann N Y Acad Sci. 2020 Mar;1464(1):5-29. doi: 10.1111/nyas.13948. Epub 2018 Aug 7.
- Yücel, M. A., Lühmann, A. V., Scholkmann, F., Gervain, J., Dan, I., Ayaz, H., ... & Wolf, M. (2021). Best practices for fNIRS publications. Neurophotonics, 8(1), 012101.

Class 7: Basics of MEG

- Fred AL, Kumar SN, Kumar Haridhas A, Ghosh S, Purushothaman Bhuvana H, Sim WKJ, Vimalan V, Givo FAS, Jousmäki V, Padmanabhan P, Gulyás B. A Brief Introduction to Magnetoencephalography (MEG) and Its Clinical Applications. Brain Sci. 2022 Jun 15;12(6):788.

Class 8: Overview of machine learning in neurolinguistics

- John Paul Mueller, Luca Massaron (2021). Machine Learning For Dummies. Second Edition. John Wiley & Sons Inc.

Class 9: Deep learning and linguistics

- Yoav Goldberg (2017). Neural Network Methods in Natural Language Processing. Morgan & Claypool Publishers. Chapters 1, 2, 3, 6, and 7.

Class 10: Neurofeedback, tDCS, TMS for speech and language impairment

- Marzbani H, Marateb HR, Mansourian M. Neurofeedback: A Comprehensive Review on System Design, Methodology and Clinical Applications. Basic Clin Neurosci. 2016 Apr;7(2):143-58.
- Shahin, I., Nassif, A. B., Elnagar, A., Gamal, S., Salloum, S. A., & Aburayya, A. (2021). Neurofeedback interventions for speech and language impairment: A systematic review. Journal of Management Information and Decision Sciences, 24, 1-30.
- Marangolo P. The potential effects of transcranial direct current stimulation (tDCS) on language functioning: Combining neuromodulation and behavioral intervention in aphasia. Neurosci Lett. 2020 Feb 6;719:133329.

Feedback for evaluation

Students are welcome to give comments and feedback by sending them in written form to the instructor's email or talking to the instructor individually.

Grade Descriptors

Grade	Overall Course
A	Demonstration of a thorough understanding of specific experimental methods for addressing recent development in related fields, including the ability to describe the mechanics of the methods, the strengths and weaknesses of each method, and the appropriateness of each method in addressing specific issues in linguistics.
A-	Demonstration of a thorough understanding of specific research methods for addressing recent development in related fields with minor weaknesses. Evidence of this thorough understanding includes the ability to describe the mechanics of the methods, the strengths and weaknesses of each method, and the appropriateness of each method in addressing specific issues in linguistics.

B	Demonstration of a thorough understanding of specific research methods for addressing recent development in related fields with weaknesses that do not affect the execution of the study or the major conclusions that can be drawn from that study.
C	Demonstration of an understanding of specific research methods for addressing recent development in related fields with some weaknesses that may affect the execution of the study and/or the major conclusions that can be drawn from that study.
D	Demonstration of some understanding of specific research methods for addressing recent development in related fields with major weaknesses that clearly affect the execution of the study and/or the major conclusions that can be drawn from that study.
F	Poor understanding of the specific research methods discussed with very limited ability to apply basic knowledge into research in linguistics.

Course schedule

Class/ week	Date	Topic	Requirements
1	11 Sep 2026	Course Intro; Overview of experimental methods; basics of EEG	Readings for discussion: de Zubicaray et al. 2019, Chapter 1 Luck 2014, Chapter 1; Malik & Amin, Designing EEG experiments for studying the brain, Chapter 1
2	18 Sep 2026	MRI and neurolinguistics: language related neuroanatomy and pathways	Readings for discussion: Hickok 2009; Cabeza & Kingstone, 2006, Chapter 7
3	25 Sep 2026	Task paradigms, block design and event related design	Readings for discussion: Amaro & Barker, 2005; https://www.youtube.com/watch?v=RQrtNVKvIIk Research project discussion
4	2 Oct 2026	Advanced analysis models: effective connectivity, structural equation modeling, dynamic causal models	Readings for discussion: Penny et al. 2004; https://es.coursera.org/lecture/functional-mri-2/module-20-effective-connectivity-E7Tsi
5	9 Oct 2026	Basics of fNIRS, study design, and data processing	Readings for discussion: Pinti et al., 2020; Yücel et al., 2021 Tutorial of fNIRS
6	16 Oct 2026	Midterm	Tutorial of fMRI
7	23 Oct 2026	Basics of MEG	Readings for discussion: Fred et al., 2022
8	30 Oct 2026	Overview of machine learning in neurolinguistics	Readings for discussion: Mueller & Massaron 2021
9	6 Nov 2026	Deep learning in linguistics	Readings for discussion: Goldberg 2017, Chapters 1, 2, 3, 6 & 7
10	13 Nov 2026	Neurofeedback, tDCS, TMS for speech and language impairment	Readings for discussion: Marzbani et al., 2016; Shahin et al., 2021; Marangolo 2020
11	20 Nov 2026	Course review	
12	27 Nov 2026	Article presentation	Article presentation
13	4 Dec 2026	Final exam	

Teachers' or TA's contact details

Professor/Lecturer/Instructor:	Professor
Name:	GENG, Xiujuan (Susan)
Office Location:	4F, Hui Yeung Shing Building

Telephone:	39433028
Email:	gengx@cuhk.edu.hk
Teaching Venue:	YIA 401
Website:	Blackboard
Other information:	TBA

Details of course website

All teaching materials will be uploaded (either before or after lecture) onto Blackboard (<https://blackboard.cuhk.edu.hk>) or via email.

Academic honesty and plagiarism

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details may be found at <http://www.cuhk.edu.hk/policy/academichonesty/>.

With each assignment, students will be required to submit a signed [declaration](#) that they are aware of these policies, regulations, guidelines and procedures.

- In the case of group projects, all members of the group should be asked to sign the declaration, each of whom is responsible and liable to disciplinary actions, irrespective of whether he/she has signed the declaration and whether he/she has contributed, directly or indirectly, to the problematic contents.
- For assignments in the form of a computer-generated document that is principally text-based and submitted via VeriGuide, the statement, in the form of a receipt, will be issued by the system upon students' uploading of the soft copy of the assignment.
- Students are fully aware that their work may be investigated by AI content detection software to determine originality.
- Students are fully aware of the AI approach(es) adopted in the course. In the case where some AI tools are allowed, students have made proper acknowledgment and citations as suggested by the course teacher.

Assignments without a properly signed declaration will not be graded by teachers.

Only the final version of the assignment should be submitted via VeriGuide.

The submission of a piece of work, or a part of a piece of work, for more than one purpose (e.g. to satisfy the requirements in two different courses) without declaration to this effect shall be regarded as having committed undeclared multiple submissions. It is common and acceptable to reuse a turn of phrase or a sentence or two from one's own work; but wholesale reuse is problematic. In any case, agreement from the course teacher(s) concerned should be obtained prior to the submission of the piece of work.

The copyright of the teaching materials, including lecture notes, assignments and examination questions, etc., produced by staff members/ teachers of The Chinese University of Hong Kong (CUHK) belongs to CUHK. Students may download the teaching materials produced by the staff members/ teachers from the Learning Management Systems, e.g. Blackboard, adopted by CUHK for their own educational use, but shall not distribute/ share/ copy the materials to a third-party without seeking prior permission from the staff members/ teachers concerned.

Use of Generative Artificial Intelligence (AI) Tools in Teaching, Learning and Assessment

Use of generative AI tools

Students are prohibited from using any AI tools to complete their assignments, presentation and assessment tasks that count towards their final course grade, unless otherwise specified. However, students are allowed to use AI tools to assist learning in general.

Guideline on sharing lecture recordings

1. The copyright of any lecture recordings shared in the course, whether they are produced by teachers, students, or peer note-takers, belongs to the University.
2. Students should not share these recordings with others without obtaining prior written consent from the teacher(s).

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