國立清華大學課程大綱

科號 Course Number			學分 Credit		人數限制 Class Size	
中文名稱 Course Title	人類神經影像學					
英文名稱 Course English Title	Human Neuroimaging					
任課教師 Instructor	姚在府 (Zai-Fu Yao)					
上課時間 Time			上課教室 Room			

課程簡述(必填) (最多 500 個中文字) 本欄位資料會上傳教育部課程網
Brief Course Description (required) (50-200 words if possible, up to 1000 letters

本課程中，首先概述所有方法共有的功能性腦造影的基本概念進行介紹，接著針對每一種腦影像方法進行描述，即腦磁圖 (MEG)、功能性磁共振成像 (fMRI)、正電子發射斷層掃描（PET)、靜息態磁振造影(rsfMRI)、擴散張量磁振造影 (DTI)、功能性近紅外光譜 (fNIRS)、經顱直流電刺激(tDCS)、交流電刺激(tACS)和經顱磁刺激 (TMS)。課程的第二部分涵蓋了功能性神經造影在大預設模式網絡功能等問題上的各種研究應用及機制解釋；意識狀態記錄的可能性和效用；尋找概念的形成記憶痕跡；人的意志和決策歷程；運動認知；語言及思考; 情感狀態和疼痛的機制；腦部手術前的功能定位及其他相關應用、前景及展望。本課程概括這些腦造影方法對當前研究的貢獻，並綜評上述所有方法如何增強我們對神經生理活動與感覺、運動和認知功能之間關係的理解。此外，我們也思索功能性神經影像學(腦造影)對未來認知神經科學、醫學和神經心理學的貢獻。

In this course, I will begin with an overview of the basic concepts of functional brain imaging common to all methods and proceed with a description of each of them, namely magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI), positron emission tomography (PET), resting-state fMRI, diffusion tensor imaging (DTI), functional near-infrared spectroscopy (fNIRS), Transcranial direct-, alternating current stimulation (tDCS and tACS, respectively) and transcranial magnetic stimulation (TMS). Its second part covers the various research applications and mechanistic explanation of functional neuroimaging on issues like the function of the default mode network; the possibility and the utility of recording consciousness; the search for mnemonic traces of concepts; human will and decision-making; motor

cognition; language and thoughts; the mechanisms of affective states and pain; the presurgical mapping of the brain; and others. As such, the volume reviews the methods and their contributions to current research and comments on how they have enhanced our understanding of the relationship between neurophysiological activity and sensory, motor, and cognitive functions. Moreover, it carefully considers the realistic contributions of functional neuroimaging to future cognitive neuroscience, medicine, and neuropsychology endeavors.

請輸入課程內容「中文暨英文關鍵字」至少 5 個, 每個關鍵字至多 20 個中文, 以半形逗點分隔 (必填)

Please fill in at least 5 course keywords (up to 40 letters for each keyword) and use commas to separate them. (required)

中文關鍵字: 功能性神經造影，認知，磁振造影、多模態神經影像，腦電刺激

Keywords: Human Neuroimaging, Cognition, Magnetic Resonance Imaging, Brain Imaging, Brain Stimulation

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課程大綱 Detailed Course Syllabus

Ethical Statement in NTHU course syllabi: This course follows the Guidelines for Collaboration, Co-learning, and Cultivation of Artificial Intelligence Competencies in University Education, which require conditional openness. In compliance with this policy, students in this course are not subject to it and are free to use generative AI, like ChatGPT, without any required disclosure.

● 課程說明(Course Description)

本課程概括了功能性神經影像技術研究認知功能基礎的理論和技術發展。涵蓋的方法包括功能和結構磁振造影、正子斷層掃描、腦電圖、腦磁圖、多模態造影技術和各種腦刺激方法。此外，本課程簡介實驗設計、基礎影像處理和統計推論的關聯。藉由探討大腦與行為之間關係的研究發現及結果探討重要概念，並在課堂間以簡答題方式測試課堂內容及知識獲取程度。
本課程中你會學到:
- 結合了認知行為研究、神經電生理學、神經影像學、神經心理學和認知神經科學的觀點。
- 探討腦造影技術可能及不可能解答人類認知的面向。
- 描述當前的各項人類認知及腦科學的臨床及學術上的應用。
- 文獻回顧當前領域內的進展及神經影像學對未來醫學和神經心理學的實質貢獻。

The course describes theoretical and methodological developments in functional neuroimaging techniques to study the neural basis of cognition, from early scientific efforts to link the brain and behavior to the latest applications of brain imaging methods. Key concepts are illustrated through research studies on the relationship between the brain and behavior, and practice questions are included throughout to test knowledge. Methods covered include functional and structural magnetic resonance imaging, positron emission tomography, electroencephalography, magnetoencephalography, multimodal imaging, and various brain stimulation methods. Experimental design, image processing, and statistical inference are also addressed, with chapters for basic and more advanced data analyses.

- Combines perspectives from cognitive research, electrophysiology, imaging, neuropsychology, and cognitive neurosciences.
- Discusses what imaging can and cannot be expected to reveal about cognition.
- Describes current theoretical and clinical uses, especially in cognition and brain mapping.
- Reviews the field's accomplishments and carefully considers realistic neuroimaging contributions to future endeavors in medicine and neuropsychology.

● 指定用書(Text Books)

1.[書名 Title: Introduction to Human Neuroimaging; 作者 Author: Hans Op de Beeck, Chie Nakatani; 出版社 Publisher: Cambridge University Press]

● 參考書籍(References)

1. [書名 Title: Handbook of Functional Neuroimaging of Cognition (Second Edition); 作者 Author: Roberto Cabeza, Alan Kingstone; 出版社 Publisher: The MIT Press]

2.[書名 Title: The Oxford Handbook of Functional Brain Imaging in Neuropsychology and Cognitive Neurosciences; 作者 Author: Andrew C. Papanicolaou; 出版社 Publisher: Oxford University Press]

3. [書名 Title: Research Methods for Cognitive Neuroscience; 作者 Author: Aaron Newman; 出版社 Publisher: SAGE Publications Ltd]

● 教學方式(Teaching Method)

In this course, the student will study a scholarly paper every week (weekly reading assignments) on a designated topic with reading reflection or short answer questions to evaluate the understanding of the content. Instructors would deliver knowledge to students through lectures and direct instruction and aim to measure the results through testing and assessment.

● 教學進度(Syllabus)

週次 (Week)	課程大綱(Syllabus)	週次 (Week)	課程大綱(Syllabus)
1	導論 General Introduction	9	腦磁波造影 Magnetoencephalography and Magnetic Source Imaging
2	腦造影的歷史及生理視角 A Historical and Physiological Perspective	10	經顱磁電刺激Transcranial Magnetic Stimulation
3	磁振造影的方法及物理原理 The Physics behind Magnetic Resonance Imaging (MRI)	11	神經調節工具及原理 Neuromodulation
4	結構性神經造影 Structural Neuroimaging	12	調節腦部活動的因果方法 Causal Methods to Modulate Brain Activity
5	血液動力學造影方法 Hemodynamic Imaging Methods	13	訊號分析的基礎 Fundamental Analysis of Image Signals
6	功能性神經造影 Functional Neuroimaging: Basic Principles of Functional MRI	14	複雜系統及腦網絡 Complex System and Brain Networks
7	正子斷層掃描 Positron Emission Tomography: Blood Flow and Metabolic Imaging	15	神經造影的臨床應用 Clinical Applications of Functional Neuroimaging
8	擴散張量磁振造影 Diffusion Tensor Imaging: The Confluence of Structural and Functional Images	16	期末評論報告 Final Essay

● 成績考核(Evaluation)

1.. 課堂表現(attendance and performance)25%: 學生課堂出席及互動、邏輯思辯能力。不定期課堂週間進行指定閱讀反思作業(或簡答題)線上繳交。Interaction during class and constructive criticism in the way of logic. Reading reflections (short answer questions) are submitted online during each class and after completing a reading assignment.

2. 口頭報告(oral presentation)/小組討論(group discussion)30%: 學生就相關文獻掌握程度、報告流暢度、結構嚴謹度及組織性進行綜合評量。Criteria include Structure, organization, fluency, and coherence of presentation. For 小組討論(group discussion), 學生經由自身研讀對討論主題有透徹的了解, 具批判性和創造性思維, 傾聽且尊重他人的意見, 學生利用他人的資訊加以討論（不只是說出自己的觀點和知識）。The student displays a thorough knowledge of the topic gained through research; Critical and creative thinking is evident; The student is respectful of others and listens in turn; the student makes use of the information given by others in the discussion (does not simply speak their own opinion and knowledge).

3. 期末評論報告(opinion essay)40%: 繳交一篇針對神經影像領域的最新研究（三年內發表）進行評論。一篇評論觀點文章主要三個評分重點：對所評論的研究中所涉及的主題和問題的簡短概述; 對主要發現的描述; 並簡要解釋統計分析邏輯。報告簡潔扼要 1500 字以內。Submit an essay to provide a scholarly review of recent studies in the neuroimaging field (publication within three years). An opinion essay should have three components: a short overview of the topic and questions addressed in the reviewed paper; a description of the key findings; and a brief explanation of why the statistical analysis is adequate. I encourage critical reviews, but comments must be accurate, well-reasoned, and diplomatic. Moreover, the focus on what was learned, and what might have been done differently is also encouraged. Submissions must be concise and should be limited to 1,500 words.

* All assignments will be evaluated on the basis of content (completeness, correctness, depth, substance, relevance, logical conclusions, creativity, etc.) and format (in accordance with the assignment guidelines, including grammar, punctuation, and spelling).

4. 研究參與體驗 (Research participation for final grade) 5%: 學生可選擇實際參與實驗行為研究，體驗人類行為的奧秘，或書面報告作為期末總成績 5%的成績 Students earn 5 percentage of their final grade either by participating in research studies or by studying for and writing an exam in lieu of participation. Students in this course are strongly encouraged to participate in 3 hours of research as part of their final grade. Option 1: Students will receive course credit, not money, for participating in the studies included in this participant pool. Option 2: Research opt-out exam: Students who choose not to participate in research can write an exam (please contact the instructor for more detail) as an alternative to participating in research. The deadline to fulfill this requirement is the last day of classes, Friday, January 12, 2024.

● 可連結之網頁位址 相關網頁(Personal Website): N/A