Autumn/Winter 2022 | Issue 26

澳大新語 UMagazine

腦科學 + BRAIN SCIENCES

本期附《澳門大學年度簡報2021/2022》
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總編輯: 張惠琴　**Chief Editor:** Katrina Cheong

副總編輯: 張愛華　**Deputy Chief Editor:** Ella Cheong

編輯: 葉浩男、盛惠怡　**Editors:** Davis Ip, Debby Seng

翻譯: 蘇恩霆　**Translator:** Anthony Sou

顧問:
人文學院副院長、翻譯傳譯認知研究中心主任李德鳳教授
社會科學學院藝術設計中心主任梁藍波特聘教授
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人文學院中國語言文學系榮休教授鄧景濱

Advisors:
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Lampo Leong, Distinguished Professor and Director, Centre for Arts and Design, Faculty of Social Sciences
Timothy Simpson, Associate Professor, Department of Communication, Faculty of Social Sciences
Tang Keng Pan, Professor Emeritus, Department of Chinese Language and Literature, Faculty of Arts and Humanities

排版: 何杰平　**Design:** Jack Ho

地址:
中國澳門氹仔大學大馬路澳門大學N6行政樓G012室

Address: Room G012, Administration Building, University of Macau, N6, Avenida da Universidade, Taipa, Macau, China

聯絡:
電話: (853) 8822 8833
傳真: (853) 8822 8822
電郵: prs.publication@um.edu.mo

Contact:
Tel: (853) 8822 8833
Fax: (853) 8822 8822
Email: prs.publication@um.edu.mo

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《**澳大新語**》創於2009年，為澳門大學官方刊物之一，每年出版兩期，旨在展示澳門大學的創見和突破、報導教研和社會服務的最新發展和成果。

Published biannually since 2009, ***UMagazine*** is one of the University of Macau's official publications and aims to report innovative ideas and research breakthroughs of the University of Macau. It also showcases the latest developments and achievements of the university in teaching, research, and service.

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編者的話

EDITOR'S WORDS

人們的一言一行、所思所憶均來自大腦。因此，「我們是誰？」不單是哲學問題，也是無數科學家深耕的研究領域。在澳門大學，不同學科的專家近年加強合作，為解開腦部的奧秘探尋更多線索，致力以研究成果解答實際的醫療和社會問題。

今期的封面專題探討澳大認知與腦科學研究的成果，涉及成癮、語言、腦圖譜、腦機接口、腦與腸道的關係、兒童腦發展等課題，並且介紹相關的研究資源和學位課程，全面呈現這些研究的重要意義。

我們也介紹大學在推動澳門智慧旅遊發展方面的研究，以及為支持本地大健康產業而開辦的新課程。與此同時，歷史系主任楊斌教授帶領我們從小小的海貝一窺橫跨各大洲、延綿數千載的全球史。環球法律學系主任Rostam J. Neuwirth教授則剖釋了人工智能技術帶來的種種法律挑戰，進而探討人工智能時代所需的法律框架。

此外，「學術研究」介紹了一種由澳大研究人員開發、有望改進癌症治療和醫學成像的新型近紅外有機納米海綿，並且細探新型冠狀病毒疫情下內地有關線上教育的輿論。「書院發展」則帶領讀者了解蔡繼有書院的全人教育理念，以及體育活動在呂志和書院的重要教育功能。

Our brains control all our thoughts and actions. The question 'Who are we?' is therefore not only a philosophical challenge, but also a scientific question that many researchers attempt to answer. In recent years, faculty members from different disciplines at the University of Macau (UM) have strengthened collaboration in this regard. They strive to unravel the mystery of the brain and translate their research results into solutions to medical and social problems.

The cover story of this issue's *UMagazine* features research results in cognitive and brain sciences at UM, with a highlight on projects on addiction, language, brain mapping, brain-computer interfaces, connections between the brain and the gut, and early brain development. It also showcases the university's extensive research resources and degree programmes in this field.

We also look at UM's efforts to promote smart tourism in Macao and the new degree programmes offered by the university to meet the needs of the local health industry. In addition, Prof Yang Bin, head of the Department of History, takes us on a cowrie shell journey through global history that spans different continents and several millennia, while Prof Rostam J. Neuwirth, head of the Department of Global Legal Studies, discusses the contemporary proliferation of artificial intelligence (AI) technologies and the need for a legal framework to address them.

The Academic Research column explores two UM research topics, namely a near-infrared nanosponge developed by UM scientists that promises to improve cancer therapy and medical imaging, as well as public opinion about online education in mainland China during the COVID-19 pandemic. Finally, the RC Development column provides an overview of whole-person education in Choi Kai Yau College and the importance of sports in education in Lui Che Woo College.

張惠琴 Katrina Cheong

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跨學科研究探尋腦部奧秘

Multidisciplinary Efforts to Unlock the Brain's Secrets

文 / 葉浩男 · 圖 / 何杰平、編輯部
Chinese & English / Davis Ip · Photo / Jack Ho, Editorial Board

腦部決定了我們是誰，控制著我們所有的思想、情感和行為。為了揭露腦部的奧秘，澳門大學協同創新研究院認知與腦科學研究中心開展了一些極具跨學科特質的項目。探索認知與腦科學雖然挑戰極大，但這也成為研究人員投身其中的原因。

全球關注腦科學研究

腦部是人體最複雜的器官。成人腦部平均只有1.5公斤，約佔全身重量2%，跟一個保齡球的重量相若，卻使用身體約20%的能量。讀到這句話時，你的腦部數以千億計的神經細胞已被激活，互相傳遞生物電和化學訊號。這些複雜的訊號傳遞使我們得以接收和解讀眼球傳來的視覺訊息、從中識別詞語、將詞語組合成句、理解並形成記憶。人類對腦部的認識啟發了不少檢測及治療腦疾病的技術，以及人工神經網絡等電腦計算方法。

雖然人類對腦部的探索已有不少進展，但對於高等認知功能、記憶和自我意識如何產生等重大問題還是幾乎一無所知。根據世界衛生大會在2020年通過的一項決議，癲癇和其它神經系統疾病是導致「殘疾調整生命年」（即因過早死亡而損失的壽命加上因生活在不完全健康的狀態下而損失的生命年數）的主因，也是全球第二大死亡原因。然而，很多跟神經系統有關的疾病的發病機制仍是未解之謎，導致相關藥物的開發往往以失敗告終。

為了在認知機制、腦疾病和類腦人工智能等方面尋求根本性的科研突破，美國、歐盟、日本和其它國家多年前已開展長期的大型研究計劃。中國也在2021年啟動「科技創新2030—腦科學與類腦研究」重大項目，支持全國各地開展先進研究。

匯聚不同領域專家

澳大在2017年成立協同創新研究院（以下簡稱研究院），致力促進澳門、粵港澳大灣區及海內外高校的跨學科研究，培養創新型人才。其下設的認知與腦科學研究中心（以下簡稱研究中心）匯聚校內不同學院和研究院的專家，開展極具跨學科特質的項目。研究中心主任、健康科學學院教授袁振說：「我們每個思想和行為都來自腦部，因此我們研究中心的項目除了直接與自然科學相關，還涉及人文、社會科學、法律、教育和工商管理等領域。」

作為澳門領先的腦科學研究機構，研究中心重點開展成癮與決策、腦與語言認知、兒童發展、認知老化和腦疾病、腦影像與腦網絡圖譜方面的研究。該中心設有四個實驗平台，提供各類先進儀器。其中，神經影像實驗室備有一台研究專用的3T功能磁共振成像系統，以及一系列近紅外光譜腦成像系統和腦電檢測設備；腦干預實驗室有經顱電、磁刺激等多種腦刺激系統；認知與行為抽查實驗室則有一系列眼動追蹤儀和無線生理訊號記錄儀；高性能計算平台提供GPU平台，可用於深度學習任務或作為虛擬數據中心。

袁教授說，藉著這些先進設備和廣泛的跨學科合作，研究中心成員過去兩年發表了超過200篇學術期刊文章，近期多份知名期刊，包括《大腦皮層》《神經成像》《皮層》《認知神經動力學》《今日材料生物》和《臨床及轉化醫學》均刊登他們的研究成果。

研究切合澳門所需

研究中心不少項目均與澳門社會息息相關。其中，一些研究人員近兩年分析了不少成癮人士的腦部掃描，為預防和干預行為成癮提供新線索。「遊戲和賭博成癮的神經認知機制」項目負責人是社會科學學院副院長（研究）、心理學系教授胡文詩。胡教授說，在長達兩年的數據收集期中，參加者要接受多次掃描和提供資料，使研究人員得以了解遊戲和賭博成癮如何演變，從而找出可用於治療或判斷成癮程度的生物標記。

澳大研究人員也借助澳門作為一個多語言社會的特質，在另一個重點項目中招募一些居民以中文（廣東話和普通話）、英文和葡文作聽說讀寫和執行同步傳譯等跨語言任務，期間記錄他們的腦神經網絡活動。該項目負責人、人文學院副院長、翻譯傳譯認知研究中心主任李德鳳教授表示，他們的目標是分析不同語言的使用如何影響大腦的執行功能，並且為構建一個皮質表層大腦圖譜資料庫打下基礎，該資料庫將會向全球科學家開放。

語言與腦部的關係也是重要的研究領域。袁教授的團隊對比了人類與獼猴腦部中跟語言生成息息相關的布羅卡區，其後在立體像素層面找到20多個相信是演化自同一個結構的位置，有助日後構建跨物種的腦網絡圖譜。

一些研究項目則涉及神經認知障礙疾病。澳門轉化醫學創新研究院代副院長、中華醫藥研究院助理教授趙永華與袁教授合作，分析長者腸菌樣本中瘤胃球菌、毛螺菌、脫硫弧菌和大腸桿菌的增幅跟認知功能之間的負面關係。趙教授說，研究結果顯示，分析腸道中某些微生物的增減，可能有助於評估長者患上阿茲海默症等認知障礙疾病的風險。

另一方面，研究中心的一個團隊開發了多種腦機接口，並在國際和全國性的腦控打字比賽奪冠，更創

下世界紀錄。電機及電腦工程系副教授萬峰研究基於不同類型的「視覺誘發電位」的腦機接口超過10年，不斷提出新的算法，促進人與電腦的連接。他的團隊正在加緊開發更高效、能「即戴即用」的腦機接口。

教育學院幼兒教育及兒童發展中心代主任、副教授張娟的團隊則主要研究兒童發展、腦與語言認知，包括閱讀障礙和自閉症兒童的腦部。他們曾利用基於「事件相關電位」的技術開展一項研究，發現華人自閉症兒童對英文重音的知覺敏感度低於健康兒童。他們也發現，自閉症兒童的右腦比左腦更活躍。張教授說，這些研究成果可以為干預兒童的行為問題提供理論參考和實踐方向。

研究中心成員也在探討許多其它課題，包括催產素這種荷爾蒙如何影響腦部區分自我與他人、開發用於裝載藥物穿越腦血管屏障到達神經膠質瘤的納米粒子、中文母語者在理解真確和虛構的中文組合詞時不同腦區域的活動，以及人們執行各類遞移推理任務時和有不誠實表現時的腦區功能性連接。

培養下一代認知神經科學家

澳大除了推動校內學者開展跨學科研究，還與不同機構緊密合作，包括於2019年與中國科學院生物物理研究所設立認知與腦科學聯合實驗室，促進粵港澳大灣區認知神經科學的研究合作。通過這些跨機構協作，研究中心正在培養新一代的認知神經科學家和專業人士，為學生提供研究資源和跨學科指導，包括由中心教學人員招收並指導博士生。另一方面，澳大與中國科學院生物物理研究所聯合開辦博士課程，學生在兩所機構的專家共同指導下開展研究。

研究中心也於2022/2023學年開辦理學碩士學位（認知神經科學）課程，指導學生學習在神經語言學、神經教育學、神經經濟學、神經影像學、類腦智能等方面用於探究大腦功能的知識與創新研究方法。該課程還致力培養學生深入理解和整合跨學科研究成果、觀點和研究方法，以探究心智、大腦和行為。

袁教授相信，澳大認知與腦科學研究的成果對澳門社會的貢獻和國際學術影響力將會與日俱增。「我們希望研究中心每項研究都能為破解大腦的奧秘提供線索。『我們是誰？』不僅是哲學問題，也是與所有人密切相關的科學問題，值得我們鍥而不捨地追尋答案。」

The brain defines who we are, controlling all our feelings, thoughts, and behaviours. To unlock its secrets, members of the Centre for Cognitive and Brain Sciences (CCBS) under the Institute of Collaborative Innovation (ICI) at the University of Macau (UM) are advancing some multidisciplinary research projects. While the tasks may seem daunting, the researchers are motivated to expand existing knowledge of cognition and the brain.

Brain Research: A Global Priority

The brain is our most complex organ. The average adult brain weighs only 1.5 kg, about 2 per cent of our total weight and as heavy as a bowling ball, but it expends about 20 per cent of our body's energy. As you read this sentence, hundreds of billions of neurons in your brain are being activated to send bioelectrical and chemical signals to each other. These complicated signal transmissions allow us to receive and interpret visual information from our eyes, recognise words, put them together into a sentence, understand it, and form memories of it. Knowledge of the brain has given rise to many technologies for detecting and treating brain diseases and has inspired computational methods such as artificial neural networks.

Despite much progress, deeper questions, such as the origins of high-level cognitive functions, memory, and self-consciousness, remain a mystery. In 2020, the World Health Assembly recognised that epilepsy and other neurological disorders are the leading cause of disability-adjusted life years (which combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health) and the second leading cause of death worldwide. However, the pathogenesis of many of these disorders is still unknown, leading to failure after failure in drug development.

In search of breakthroughs in cognitive mechanisms, brain diseases, brain-inspired artificial intelligence, and other fields, the United States, the European Union, Japan, and other countries and regions have launched long-term and large-scale programmes. In 2021, China put forward the Science and Technology Innovation 2030 - 'Brain Science and Brain-Like Research' Key Programme to support cutting-edge studies across the country.

Bringing Together Experts in Different Fields

Founded in 2017, the ICI supports multidisciplinary research and the training of innovative professionals in collaboration with institutions in Macao, in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), as well as across China and overseas. As part of the ICI, CCBS is dedicated to multidisciplinary projects that bring together expertise from all UM faculties and institutes. 'Every thought and action originate in the brain, so CCBS projects go beyond natural sciences to include arts, humanities, social sciences, law, education, business administration, and other fields,' says Yuan Zhen, head of CCBS and professor in the Faculty of Health Sciences.

As a leading brain research institution in Macao, CCBS focuses on behavioural addiction and decision-making, brain and language cognition, child development, cognitive ageing, and brain disorders, as well as neuroimaging and brain connectome. The centre has four core laboratories with state-of-the-art equipment. The Neuroimaging Core Laboratory has a 3T functional magnetic resonance imaging system, a series of functional near-infrared spectroscopy systems, and electroencephalography devices. The Brain Intervention Core Laboratory is equipped with brain stimulation systems for repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS). The Behavioural Data Acquisition Core Laboratory is equipped with eye trackers and wireless physiological recording systems. The High-Performance Computing Core Laboratory has GPU computing platforms to carry out deep-learning tasks and perform as virtual data centres.

According to Prof Yuan, the advanced facilities and extensive multidisciplinary collaboration enabled

袁振教授
Prof Yuan Zhen

一名研究參加者在澳大接受腦部掃描
The brain of a research participant is being scanned at UM

CCBS members to publish more than 250 articles in academic journals over the past two years, including leading titles such as *Cerebral Cortex*, *Neuroimage*, *Cortex*, *Cognitive Neurodynamics*, *Materials Today Bio*, and *Clinical and Translational Medicine*.

Research Aligned with Macao's Priorities

Many CCBS projects are closely aligned with Macao's priorities. For example, to study how gaming and gambling alter brain structures and functions, CCBS members have produced numerous brain scans of addicts to inspire new approaches for the prevention and treatment of behavioural addiction. The research project titled 'The Neurocognitive Mechanisms of Gaming and Gambling Addiction' is led by Anise Wu, associate dean of the Faculty of Social Sciences and professor in the Department of Psychology. All project participants have their brains scanned multiple times over a period of two years for data collection, so that researchers can understand how gaming and gambling addiction evolve over time and identify biomarkers that can be used to treat or determine the level of addiction.

In another key project, researchers are analysing multilingualism in Macao to reveal brain network activity associated with language use. They have recruited residents to speak, read, listen, and write in Chinese (Cantonese and Mandarin), English and Portuguese, as well as to perform cross-linguistic tasks such as interpreting. The project's principal investigator is Prof Li Defeng, associate dean of the Faculty of Arts and Humanities and director of the Centre for Translation, Interpretation and Cognition. According to Prof Li, the project aims to discover how the use of different languages affects executive functions and to build a surface-based brain atlas database that will be open to researchers around the world.

The relationship between language and the brain is another key area of research. By comparing the brains of humans and macaques, Prof Yuan's team discovered over 20 sites at the voxel level that are likely to have a common evolutionary origin in Broca's area, which plays an essential role in human language production. 'This discovery is an important step towards creating a cross-species map of brain networks,' says Prof Yuan.

Many CCBS projects focus on neurocognitive disorders. For instance, Zhao Yonghua, interim associate head of the Macau Institute for Translational Medicine and Innovation and assistant professor in the Institute of Chinese Medical Sciences, together with Prof Yuan, analysed the negative impact of the increase in Ruminococcus gnavus, Lachnospira eligens, Escherichia coli, and Desulfovibrio piger in the gut microbiota on cognitive functions of the elderly. 'This can help us evaluate the risk of neurocognitive disorders, such as Alzheimer's disease, in the elderly,' says Prof Zhao.

Meanwhile, a CCBS research team has developed various brain-computer interfaces. Members of the team have won championships in international and national brain-controlled typing competitions and have even set a world record. The team is led by Wan Feng, associate professor in the Department of Electrical and Computer Engineering. For more than a decade, Prof Wan has developed BCIs based on different types of visually evoked potential (VEPs) and designed new algorithms to accelerate the connection between humans and computers. For instance, his team is currently developing more efficient 'plug-and-play' BCIs.

On the other hand, Zhang Juan, interim director of the Centre for Early Childhood Education and Child Development and associate professor in the Faculty of Education, is leading her team to study child development, brain, and language cognition, including the brain of children with dyslexia and autism. One of their studies using ERP technology shows that Chinese children with autism were less sensitive than normal children to changes in the stress of English words. In addition, the brain's right hemisphere is found to be more activated in children with autism than the left hemisphere. 'These findings can provide theoretical references and directions for interventions for children's behavioural problems,' says Prof Zhang.

CCBS members also explore topics such as the role of the hormone oxytocin in our 'self-other distinction', the development of a nanoparticle that helps detect gliomas by carrying drugs through the blood-brain barrier to tumours, the activity of brain regions of native Chinese speakers when they try to interpret valid and invalid Chinese compound words, as well as the functional connectivity between brain regions when people perform different transitive inference tasks or act dishonestly.

Training the Next Generation of Neuroscientists

UM not only promotes multidisciplinary research among faculty members, but also maintains strong partnerships with many institutions. For example, UM and the Institute of Biophysics (IBP) of the Chinese Academy of Sciences established a joint laboratory for cognition and brain sciences in 2019 to promote research and training across the GBA. Through collaborating with other institutions, CCBS nurtures the next generation of cognitive neuroscientists and professionals by providing students with multidisciplinary training and access to research facilities. Many PhD students conduct research under the supervision of CCBS members, while those enrolled in the joint PhD programme of UM and IBP are trained by faculty members from both institutions.

In the 2022/2023 academic year, CCBS launched the Master of Science in Cognitive Neuroscience programme, to train students with innovative approaches for exploring brain functions in terms of neurolinguistics, neuroeducation, neuroeconomics, neuroimaging, and brain-inspired intelligence. The programme also aims to help students understand and integrate interdisciplinary research findings and tools for the study of mind, brain, and behaviour.

Prof Yuan is confident that UM's portfolio in cognitive and brain research will benefit the Macao community in the long run and will gain further recognition in international academic circles. 'Each of CCBS's research projects will hopefully shed some light on the brain's mystery. The question "Who are we?" is not only a philosophical question, but also very much a scientific one. It matters to everyone and deserves our relentless search for answers,' says Prof Yuan.

高性能計算平台
A high-performance computing platform

研究人員檢視過往賭局結果等視覺訊息會否導致認知偏差
The researchers would examine whether people develop cognitive biases due to visual information such as the outcome of previous bets

行為成癮對腦部的影響

The Impact of Behavioural Addiction on the Brain

文 / 葉浩男．圖 / 何杰平，部分由受訪者提供
Chinese & English / Davis Ip．Photo / Jack Ho, with some provided by the interviewee

行為或物質成癮不代表性格缺陷，而是腦部出了問題。為了研究遊戲和賭博行為如何影響腦部，澳門大學認知與腦科學研究中心的成員近兩年間分析了不少成癮人士的腦部掃描，為改進預防和干擾行為成癮的方法提供新線索。

遊戲和賭博成癮

「遊戲和賭博成癮的神經認知機制」項目的負責人為社會科學學院副院長（研究）、認知與腦科學研究中心成員、心理學系教授胡文詩。她說：「成癮是指人無法控制自己，無法停止做一件可能會傷害自己的事情。一旦成癮，即使努力停止有關行為也很容易故態復萌，因為他們的腦部已經改變，受制於作出成癮行為的慾望。」

胡教授說，目前已有大量關於毒品和酒精等物質的成癮研究，近年也有越來越多專家關注行為成癮。賭博成癮（又稱「賭博失調」或「強迫性賭博」）早已列入正式的疾病分類系統，而遊戲障礙（又稱「遊戲成癮」）則在2019年第72屆世界衛生大會上才列入《國際疾病分類》。不少研究表明遊戲成癮和賭博成癮密切相關。

胡教授指出，澳門博彩業和娛樂行業歷史悠久，適合開展關於遊戲和賭博成癮的研究。「我們的研究項目有兩大目的，分別是研究成癮機制下的神經可塑性機理，以及探究多種感官類環境因素線索對於成癮行為的交互作用。」

腦部激勵機制失調

研究行為成癮，為何要掃描腦部？胡教授表示，物質成癮和行為成癮均與大腦的「激勵機制」（又稱「獎勵機制」）息息相關，多巴胺這種神經傳導物質在其中扮演重要角色。「我們接收一些刺激，例如吃了一件甜品或贏了一場遊戲時，一個位於中腦的區域會產生多巴胺。多巴胺經神經傳導路徑到達腦部不同區域，使我們產生一種滿足感，並對這種感覺形成記憶。」激勵機制讓我們有動力進食、繁殖和執行其它重要任務。當多巴胺不足時，我們會感到沒有動力、難以集中。

不過，如果攝取一些物質或做一些行為導致短時間內產生過量多巴胺，我們起初會感到很滿足，後來卻會使腦部習慣了這些行為和物質帶來的刺激，改變不同腦區域的神經細胞之間的連接，最終我們要尋求越來越多同類的刺激，才能保持程度相若的滿足感。「一旦缺乏成癮物質或行為帶來的刺激，成癮者就會變得非常低落，身體也會出現很多其它問題。」

2020年，胡教授的團隊開展了研究項目的先導計劃。在一項關於撲克牌遊戲的前期研究中，他們發現，在作出有風險的賭注並勝出時，大腦的激勵機制會被激活。期間，與一般人士相比，賭博成癮人士的大腦獎勵機制激活程度較低。這或許解釋了為何成癮人士會傾向比其他人尋求更多、更大的刺激。

研究人員還發現，賭博成癮者等待賭局結果時，他們腦部內與獎勵機制相關的區域受到不少刺激，在其他人士的腦部卻觀察不到這種反應。胡教授說：「這點很可能反映成癮者所沉迷的不單是博彩的獎賞，還有下注和等待結果的過程。」

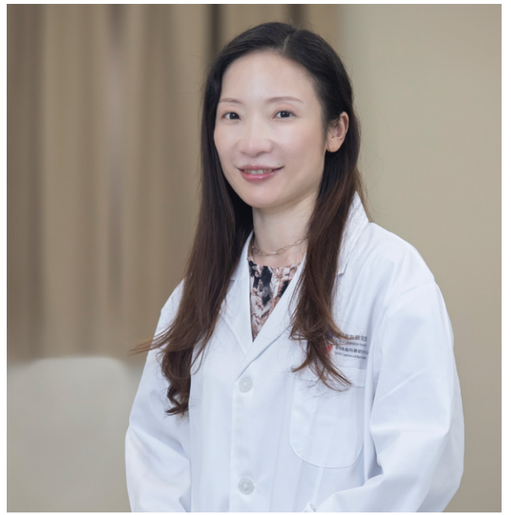
尋找預防和治療成癮新方法

2021年初，胡教授的團隊與聖公會澳門社會服務處正式合作收集數據，招募有網絡遊戲或博彩習慣的人士和其他人士執行一系列決策性任務，期間以功能磁共振成像（一種通過檢測血液流動來測量腦活動的技術）系統掃描他們的腦部，並且開展訪談和問卷調查，藉此了解不同程度成癮的人士在決策和自我抑制控制等認知功能上的差異。

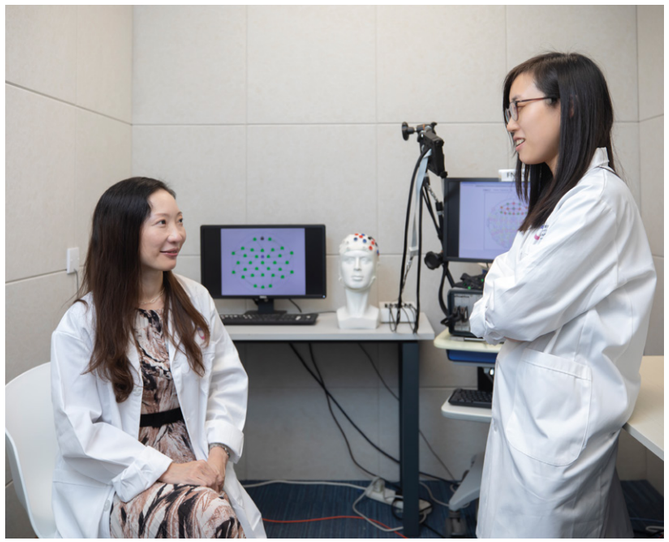
胡教授說，數據收集過程長達兩年，期間參加者要接受多次掃描和提供資料，使研究人員得以了解遊戲和賭博成癮如何隨時間推移而演變，從而找出有機會用於判斷成癮程度的生物標記。研究人員也會用眼動追蹤儀等儀器，了解人們參與網絡遊戲或博彩活動時，周邊的視覺刺激（例如光暗、過往賭局結果的不同呈現方式）、聲音和氣味是否會對行為成癮造成不同影響。

亞太地區多地近年積極發展博彩業，網絡遊戲和網絡博彩也在全球大行其道。因此，胡教授相信研究項目的成果不但能惠及澳門社會，還能為全球各地的專家和機構提供研究數據。通過這個項目，研究團隊也與聖公會澳門社會服務處建立了長期的合作關係。雙方除了招募市民參加研究，也會加強知識交流和合作，進一步推動社區教育和干預服務。

通過深入了解和呈現大腦與行為成癮的關係，研究團隊也期望鼓勵有行為成癮的人士了解到成癮是源於多種複雜因素，不代表他們有壞的本質。「行為成癮是一種牽涉腦部的慢性病。就像有其它身體狀況的人一樣，行為成癮者應該尋求專業治療，努力改善生活。」

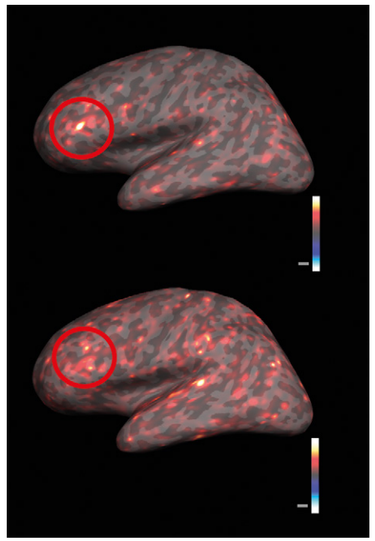


胡文詩教授
Prof Anise Wu



胡文詩教授（左）和研究助理李雯慧

Prof Anise Wu (left) and research assistant Caren Lei



這些功能性磁共振成像掃描顯示研究參加者執行不同風險的決策任務時的腦部活動的差異

The fMRI scans show differences in brain activity of research participants when they perform different risky decision-making tasks

Substance or behavioural addiction is not a personality flaw, but a brain problem. To study how gaming and gambling change the brain, members of the Centre for Cognitive and Brain Sciences (CCBS) at the University of Macau (UM) have analysed numerous brain scans of addicts over the past two years to inspire new approaches for the prevention and treatment of behavioural addiction.

Gaming and Gambling Addiction

At UM, Anise Wu, associate dean (research) of the Faculty of Social Sciences and professor in the Department of Psychology, is leading a research project titled 'The Neurocognitive Mechanisms of Gaming and Gambling Addictions'. 'Addiction is our inability to stop doing something that can harm us,' says Prof Wu, a member of CCBS. 'When people try to stop their addictive behaviours, they may easily relapse because their brains have adapted to craving such behaviours.'

Prof Wu says there is a large body of research on addiction to substances such as drugs and alcohol, and in recent years there has also been a growing interest in behavioural addiction. Gambling addiction, also called gambling disorder or compulsive gambling, has long been included in formal disease classification systems, while gaming disorder, also known as gaming addiction, was not included in the *International Classification of Diseases* until the 72nd World Health Assembly in 2019. Many studies suggest that these two types of addiction are closely linked.

Prof Wu adds that Macao is an ideal place to study gaming and gambling addiction given the city's long-standing casino and entertainment industries. 'Our research project has two major goals: to study the neuroplasticity mechanisms underlying addiction, and to investigate the interplay of various environmental sensory influences on addictive behaviour,' she explains.

A Hijacked Reward System in the Brain

What can brain scans tell us about addiction? According to Prof Wu, the brain's reward system is involved in both substance and behavioural addiction, and the neurotransmitter dopamine plays an important role in this system. 'When you receive a stimulus, such as eating a dessert or winning a game, an area in the midbrain produces dopamine. Dopamine goes through neural signalling pathways to different areas of the brain to give us a feeling of satisfaction and create memory of that feeling,' she says. The reward system motivates us to eat, reproduce, and perform other vital tasks. 'Having lower levels of dopamine makes us lose motivation and concentration,' she adds.

The problems come when we consume substances or engage in activities that cause a rapid and excessive production of dopamine. In the beginning, we may feel satisfied, but then connections between the neurons among our brain areas will be altered to make us accustomed to the stimulus from these substances and activities. The result is that we will crave more and more of the same stimulus just to keep the same level of satisfaction. 'Once the stimulus from the addictive substance or behaviour stops, the addicts become depressed and would have many other health problems,' she says.

In 2020, Prof Wu's team launched a pilot project. In a preliminary study on poker games, the team found that the brain's reward system was activated when risky decisions were made and won. Compared to healthy individuals, people with repetitive gambling behaviours showed a lower activation level in the reward system. This could explain why people with addictions seek more and stronger stimuli than others.

The researchers also found that certain brain areas associated with the reward system were activated in addicted gamblers when they were waiting for the outcome of a bet, a response not observed in other people's brains. 'This may mean that addicts crave not only for the rewards of a bet, but also the process of betting and waiting for a potentially rewarding outcome,' says Prof Wu.

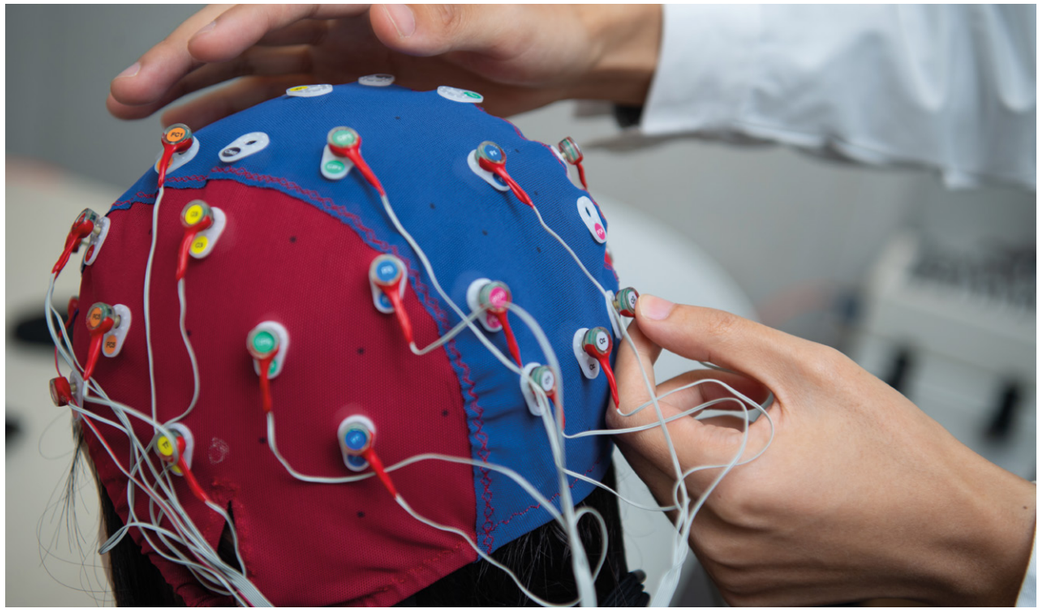
Exploring New Ways to Prevent and Treat Addiction

In early 2021, Prof Wu's team, in collaboration with the S.K.H. Macau Social Services Coordination Office, began to collect data and recruit people with online gaming or gambling habits and others for the research project. The brains of the research participants were scanned with a functional magnetic resonance imaging system (fMRI, a technique that measures brain activity by detecting blood flow) while they performed a range of decision-making tasks. Interviews and questionnaires were conducted to understand the differences in cognitive functions such as decision-making and inhibitory control among people with different levels of addiction.

Prof Wu expects that most participants will have their brains scanned multiple times over the two-year data collection period, so that researchers can understand how gaming and gambling addiction evolve and identify biomarkers that can potentially be used to determine the level of addiction. Researchers also used eye trackers and other tools to see if visual stimuli (e.g. different levels of lighting and different ways to display previous gambling results), sounds, and smells in the environment where people play games or gamble have different impacts on the development of behavioural addiction.

As the gambling industry continues to grow rapidly across the Asia-Pacific, online gambling and gaming are also becoming more common worldwide. Prof Wu therefore believes that the research project will not only benefit the local community, but also provide useful data for experts and institutions around the world. Through this project, the research team has established a long-term partnership with the S.K.H. Macau Social Services Coordination Office. They not only recruit participants for the study, but also have plans for knowledge sharing and collaboration to further develop community education programmes and intervention services.

By comprehensively understanding and showing how behavioural addiction changes the brain, the research team also hopes to help those affected recognise that addiction is the result of a variety of complex factors, and it does not represent a bad personality. 'Behavioural addiction is a chronic disease that affects the brain. Just like those with other illnesses, people with behavioural addiction have a lot of ways to seek professional treatment to improve their lives,' says Prof Wu.



澳大團隊招募市民以不同語言閱讀、說話、聆聽或進行同步傳譯，收集關於認知活動的數據。

A UM research team recruits residents to read, speak, listen, or provide simultaneous interpretation in different languages. The researchers collect data on participants' cognitive activities when they perform these language tasks.

多語言使用與大腦的執行功能

Multilingualism and the Brain's Executive Functions

文 / 葉浩男 · 圖 / 何杰平，部分由受訪者提供

Chinese & English / Davis Ip · Photo / Jack Ho, with some provided by the interviewees

精通多語的人比較聰明嗎？從小接觸不同語言能使大腦發展「贏在起跑線」嗎？為了尋找新的證據解答這些問題，澳門大學認知與腦科學研究中心開展了一個研究項目，建立多語言、多模態和多群體的大腦表層功能腦圖譜。

執行功能：大腦空中交通管制塔

「跨語言處理中的執行功能：基於神經認知的研究」項目負責人、研究中心成員、人文學院翻譯傳譯認知研究中心主任李德鳳教授說，「智力」可以是指一個人的認知能力，包括控制思想、情緒和行為來實現目標的能力。這類高層次認知能力稱為「執行功能」，缺乏執行功能就無法有策略地思考和行動。

哈佛大學兒童發展中心的學者曾說，如果大腦是一個同時處理很多航班升降的機場，「執行功能」就是機場的空中交通管制塔，把來自四周的資訊按輕重緩急處理。李教授指出，執行功能主要有三種：一）抑制控制，即為達到目標而抑制衝動的能力，例如為健康而節食、為學習而放棄玩樂；二）工作記憶，即暫時儲存一些資訊來指導決策和行動，例如解決數學問題時記著題目；三）認知靈活性，即因應變化而調整行動，例如發現一間餐廳滿座後另覓地方用膳。這些執行功能並非與生俱來，而是經年累月發展，是幼兒和青少年教育的重要一環。

「雙語優勢」存在嗎？

有研究指出多語者的執行功能較強，例如能更有效地處理與本身認知有矛盾的資訊，該假設稱為「雙語優勢」，但缺乏確鑿證據。李教授說：「能說不同語言自然有助溝通、生活、學習和工作，但這個行為本身能否提高認知能力，學術界卻未有共識。過去很多研究的結果相互矛盾，而且可重複性較低。」

此外，李教授指過往不少研究沒有充分考慮執行功能會否受教育水平和社會經濟地位的差異所影響。「另一方面，執行功能分很多類，多語者即使可能某類執行功能較強，他們的其它執行功能可能與單語者的相若，甚至較差。」

認知與腦科學研究中心、心理學系助理教授張浩云說，雙語經驗並非一個絕對的分類變量。不同雙語者使用兩種語言的具體經驗存在很大差異。語言習得年齡、語言熟練度、語言優勢、在不同語言之間切換的頻率和情境等因素，都可能會調節雙語經驗和執行功能的關係。

大腦表層語言功能圖譜

多語者和單語者的執行功能到底有否差異？如果有，以不同語言聽、說、讀、寫會不會對執行功能有不同影響？認知與腦科學研究中心、科技學院助理教授黃瑞松說，為了解答這些問題，澳大研究人員正在利用功能磁共振成像技術，建立一個多語言、多模態和多群體的表層腦圖譜，將包括逾千幅大腦皮層影像。

黃教授說，全球各地的科學家都在繪製人和其它動物的各類腦圖譜。這些圖譜由不同掃描技術生成，顯示大腦不同的功能活動、基因表達、結構和各個腦區之間的聯繫。繪製大腦圖譜不單要掃描腦部，還要對影像作一系列處理和分析，包括對不同人的大腦地圖的配準與平均。

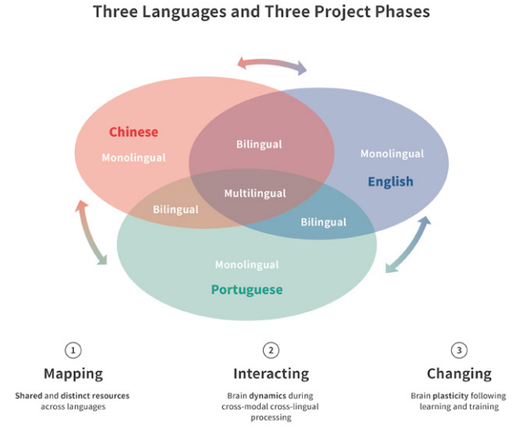
目前大多數腦圖譜以「基於三維體積」的方法作配準，但近年有研究指出，經「基於大腦皮層表面」的方法處理的圖譜更能完整保留與大腦皮層激活和不同區域運接相關的細節。黃教授指出，「澳大大腦圖譜」正是以嶄新的「基於大腦皮層表面」的方法建構。

澳門多語環境有利研究

為甚麼在澳門推動這項研究？認知與腦科學研究中心成員、英文系副教授李麗青表示：「澳門是多語言、多文化的社會，多種教育模式並存，有利於招募不同語言和生活背景的研究對象。」現有類似的腦圖譜的分析對象多為英語使用者，澳大研究團隊則會招募約250名不同年齡層和語言背景的人士，讓他們以中文（廣東話和普通話）、葡文或英文閱讀、說話、聆聽或進行同步傳譯，期間研究人員用功能磁共振成像平台掃描他們的腦部，並以眼動追蹤設備收集認知活動數據。

憑藉這些影像和數據，研究團隊將能探討單語者、雙語者和多語者大腦內與執行功能相關的神經表徵，也能分析人們作單語處理和跨語言處理（例如同步傳譯）、執行單模態和多模態任務（例如同時閱讀和聆聽）時，與語言不直接相關的腦區域的激活程度。研究團隊也會研究語言訓練會否影響執行功能的發展。

李德鳳教授說，「澳大大腦圖譜」將於網上向全球的科學家開放，為各地的認知與腦科學研究提供基礎數據，研究成果也將有助進一步了解語言控制相關的認知與神經機制，為早期教育、語言教育、翻譯教育和預防腦退化等領域的研究提供借鑒。



澳大的多模態多語言圖譜項目涉及三種語言和三個研究階段

UM's multimodal and multilingual language mapping project involves three languages and three research stages

Are multilingual people smarter than those who understand only one language? Does learning multiple languages at a young age have a positive impact on brain development? In search of new insights to unravel these mysteries, the Centre for Cognitive and Brain Sciences (CCBS) at the University of Macau (UM) has launched a research project to establish a multilingual, multimodal, and multigroup surface-based functional brain atlas.

Executive Functions: 'Air Traffic Control Tower' of the Brain

Prof Li Defeng, a member of CCBS and director of the Centre for Studies of Translation, Interpreting and Cognition in the Faculty of Arts and Humanities, is leading the research project titled 'Executive Functions in Cross-lingual Processing: A Neurocognitive Investigation'. He says intelligence refers to our cognitive abilities, including our ability to control our minds, emotions, and actions to achieve our goals. These kinds of high-level cognitive abilities are called 'executive functions' (EF), without which one cannot think or act strategically.

Researchers in the Center on the Developing Child at Harvard University describe executive functions as something 'much like an air traffic control tower at a busy airport' that handles multiple flights simultaneously by prioritising information from all directions. According to Prof Li, there are three main areas of EF. First, inhibitory control is the ability to override a thought to achieve a goal, such as eating less to stay healthy or sacrificing the fun of playing for learning. Secondly, working memory is the ability to temporarily store information to guide decisions and actions, such as remembering the question when solving a math problem. Finally, cognitive flexibility is the ability to adapt our behaviour and thinking to a changing environment, such as finding an alternative when you enter a restaurant and discover that it is fully booked. Developing these skills, which are not inborn but developed over time, is an important part of educating children and adolescents.

Is There a 'Bilingual Advantage'?

Some studies suggest that people who speak different languages have better EF, including the ability to deal with information that contradicts their own perceptions. However, there is not yet conclusive evidence for this 'bilingual advantage' hypothesis. 'Multilingualism obviously brings many advantages in learning, studying, living, and communicating with others,' says Prof Li. 'But the question is whether multilingualism in itself improves cognitive abilities. There is no consensus among scientists on this question, because many research results are contradictory and not very reproducible.'

According to Prof Li, many of the previous studies overlooked the impact of different levels of education and socio-economic status on the development of EF. 'Moreover, some studies only looked at one area of EF. It may be that multilingualism improves performance in one area but has no effect or even impairs it in another.' says Prof Li.

According to Zhang Haoyun, assistant professor in CCBS and the Department of Psychology, bilingualism is not a univariate variable. Rather, there is a large variation in the level of bilingual functioning (i.e., degree of bilingualism) characterising individuals who speak two languages. Factors such as age of acquisition, language proficiency, language dominance, frequency of intra-sentential and between-clause code-switching, and language processing contexts are all likely to modulate the degree of bilingualism and, in turn, modulate the relationship between bilingualism and executive functions.

Surface-based Functional Brain Atlas of Language Functions

Are there significant differences between the EF of multilingual people and those of people who speak only one language? If so, do the different ways of using languages (listening, speaking, reading, and writing) affect our EF differently? According to Huang Ruey-Song, assistant professor in CCBS and the Faculty of Science and Technology, to find answers to these questions, researchers at UM are using functional magnetic resonance imaging (fMRI) and other techniques to create a multilingual, multimodal, and multigroup surface-based functional brain atlas that will contain more than 1000 maps of the cerebral cortex.

'Scientists around the world have already created many types of atlases of the brains of humans and other animals,' says Prof Huang. These atlases, which consist of scans using various techniques, show the different activities and gene expression in brains, their structure, and the connections between brain regions. To create a brain atlas, scientists not only have to scan the brains of many subjects, but also perform precise image processing steps, including registration and averaging of maps across different brains.

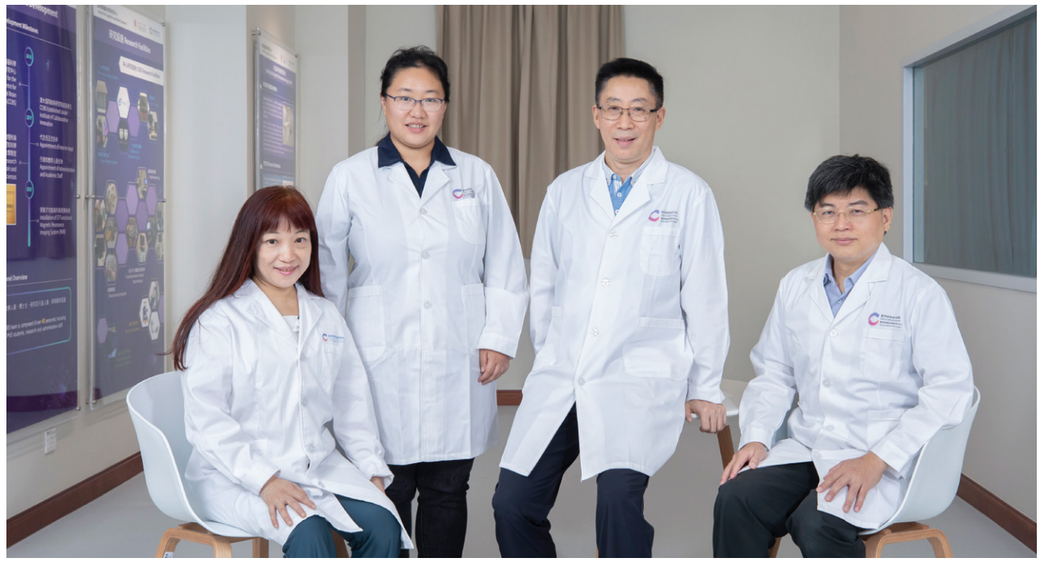
'Most existing brain atlases use volume-based methods for cross-subject averaging, but recent studies suggest that "surface-based methods" can preserve more detail of cortical activation and connectivity between brain regions,' says Prof Huang, who adds that the UM brain atlas will be created using some of the latest surface-based mapping methods.

Multilingual Macao Ideal for Research

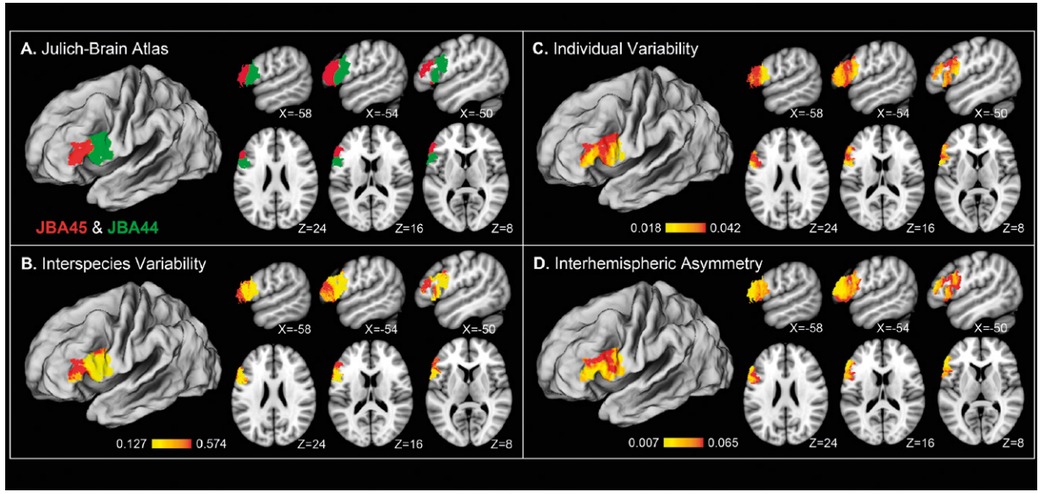
Why is Macao the right place for this research project? 'The co-existence of different languages, cultures, and educational systems in the city allows us to easily recruit research participants from diverse linguistic and social backgrounds,' says Victoria Lei, a member of CCBS and associate professor in the Department of English. While similar brain atlases have primarily captured English speakers, the UM research team will invite about 250 people to read, speak, listen, or provide simultaneous interpretation between Chinese (Cantonese and Mandarin), Portuguese, or English. When the research participants perform these language tasks, the researchers will scan their brains using an fMRI scanner and collect data on cognitive activity using eye-tracking devices.

Using fMRI scans and data, the research team will be able to identify the neural representations and networks of different languages that are related to EF in the brains of monolingual, bilingual, and multilingual people. Researchers will also be able to analyse the activation of brain regions not directly related to language when people perform monolingual and multilingual processing tasks (such as simultaneous interpreting), as well as unimodal and multimodal tasks (such as reading and listening at the same time). In the later stage of this project, the team will also investigate whether language training affects the development of EF.

According to Prof Li, the UM Surface-Based Brain Atlas Database, which will be accessible to scientists around the world, will provide fundamental data for cognitive and brain science research in various fields. He believes that the research findings from this project will lead to a deeper understanding of the cognitive and neural mechanisms of language control and provide useful leads for research in areas such as early childhood education, language teaching, translation training, and neurodegenerative disease prevention.



左起:李麗青教授、張浩云教授、李德鳳教授、黃瑞松教授
From left: Prof Victoria Lei, Prof Zhang Haoyun, Prof Li Defeng, Prof Huang Ruey-Song



不同人類腦部在結構連接方面的差異性
Variability in structural connectivity between different human brains

繪製腦網絡圖譜 探索高級認知能力

Mapping the Brain Network to Explore Higher-level Cognitive Functions

文 / 葉浩男．圖 / 何杰平，部分由受訪者提供
Chinese & English / Davis Ip．Photo / Jack Ho, with some provided by the interviewee

腦部是一個錯綜複雜的網絡。探究其奧秘的其中一個方法是繪製一幅顯示腦部每個結點和連接的「腦網絡圖譜」。澳門大學認知與腦科學研究中心的一個團隊正在這方面深入研究，包括繪製對照人類與獼猴腦部的跨物種腦網絡圖譜。

腦部運作機制

認知與腦科學研究中心主任、健康科學學院教授袁振指出：「腦部不同區域都發揮著獨特的功能。與此同時，各腦區域內部和彼此之間的神經細胞通過生物電和化學訊號等方式相互通訊，從而整合各個腦區域的功能，形成認知功能的基礎。」

隨著掃描和影像分析技術的躍進，科學家繪製了大量腦網絡圖譜，涉及：基因表達、細胞構築、連接和功能等多種繪製方案；分子、神經細胞、神經環路和全腦網絡等多種尺度；人類、獼猴、大鼠等各種動物；不同性別和年齡層等群體。袁教授說：「腦網絡圖譜有助我們深入了解腦部活動的運作機制。科學家也在繪製跨物種的腦網絡圖譜，作為跨物種腦研究的基石。」

跨物種研究有甚麼作用？袁教授說：「透過研究其它動物，尤其是與人類有共同祖先的其它靈長類動物，我們能探索人類在進化期間如何發展出語言能力等高級認知能力。」

不過，現時跨物種腦網絡圖譜仍然稀少，繪製方法尚在探索階段，其中一大困難是要識別不同動物的哪些腦部區域具有「同源性」（即從同一個結構演化而來），另一挑戰是要依據連接屬性的差異劃定這些同源區域之間的邊界。

語言能力的演化

袁教授的團隊近年在腦網絡圖譜研究方面有不少突破，邁向繪製全腦層面的腦網絡圖譜的目標。在一個研究項目中，他們分析了人類與獼猴腦部的布羅卡區，從而了解兩者神經細胞之間的物理連接（結構連接）有何異同。

布羅卡區與語言生成息息相關，位於腦部的前額葉皮質，分為三角部和鳥蓋部這兩部分，得名於19世紀法國醫生、神經學家兼解剖學家保羅．布羅卡。布羅卡當年遇到兩名病人，他們都在前額受傷後失去說話能力，但仍能聽懂別人說話。當時不少學者認為腦部功能沒有明顯的區域之分，但布羅卡深入研究後提出不同腦區域有不同功能，這個觀念後來被稱為「腦部功能定位」，深刻影響腦科學的發展。

當兩個物種的某些部分有共同的進化起源時，這些部分就是「同源」。袁教授的團隊從公開數據庫收集了人類與獼猴腦部的磁共振影像後，利用23對同源神經纖維束，構建出人類與獼猴布羅卡區域在3D立體像素（體素）層面的同源映射關係。

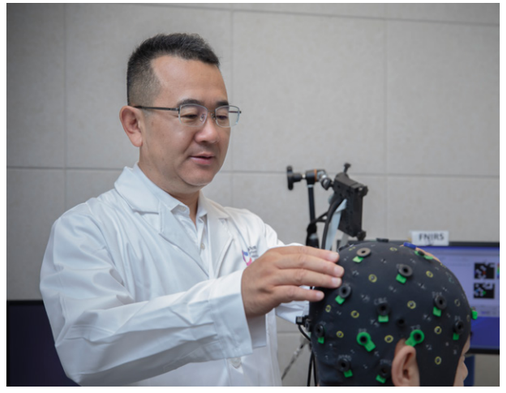
他們接著分析了人類與獼猴的同源位點的結構連接，發現兩者在三角部的差異較大、在鳥蓋部的差異較少，因此推論三角部很可能是靈長類動物進化時較為活躍的區域。研究團隊還發現，無論是人類還是獼猴，不同個體之間的同源位點在三角部的連接差異較大、在鳥蓋部的差異較少。

袁教授也指出，左腦和右腦的形態學特徵、連接和功能均有一定差異，這種現象名為「半球不對稱性」或「半球偏側化」。研究團隊發現，無論人類還是獼猴，他們三角部的大腦連接的半球偏側化程度相對較小，在鳥蓋部相對較高。

此外，他們發現人類與獼猴和背側語言處理通路（即與語言生成相關的神經纖維束）的關聯性差異較大，和腹側語言處理通路（即與語言理解相關的神經纖維束）的關聯性差異則較小。袁教授說：「這些發現能讓我們更深入地理解為何有一些高級的認知能力是人類獨有。」

跨物種腦網絡圖譜

要進一步推動腦網絡圖譜的跨物種研究，就需要對腦部有更精準的施加同源約束關係的分區方案，因此袁教授的團隊也設計了兩個人類與獼猴腦區域的分區方法。「我們將會整合這些腦部分區的結果和其它研究成果，逐步構建跨物種全腦網絡圖譜。我們還會繼續以不同方式研究語言能力的神經機制，包括從多個層次繪製腦網絡圖譜。這些領域的研究不但有助改善腦疾病的治療、開發更智能的技術，還能幫助我們人類了解自己為何與眾不同。」



袁振教授
Prof Yuan Zhen

One of the best ways to understand our brain, which is essentially a complex network, is to draw a comprehensive map of nodes and neural connections in the brain (known as a connectome). To advance research in this area, a team at the Centre for Cognitive and Brain Sciences (CCBS) of the University of Macau (UM) has been working on several projects, including the creation of a connectome that shows the cross-species alignment of brain areas in humans and macaques.

How the Brain Works

'Every brain region plays a different role, but at the same time neurons in the same region and throughout the brain communicate with each other by sending bioelectrical and chemical signals, so that the

functions of different brain regions are integrated to make cognitive abilities possible,' says Yuan Zhen, head of CCBS and professor in the Faculty of Health Sciences.

Thanks to recent advances in image scanning and analysis, scientists have created connectomes of different mapping schemes, such as gene expression, cytoarchitecture, connection, and function, and at different scales, including molecular, neuron, neural circuit, and the whole-brain network, in a variety of animals such as humans, macaques, and rats of different genders and ages. 'Connectomes are remarkable tools that can help us gain insights into the mechanisms of brain activities,' says Prof Yuan, who adds that scientists have created connectomes specifically for cross-species brain research.

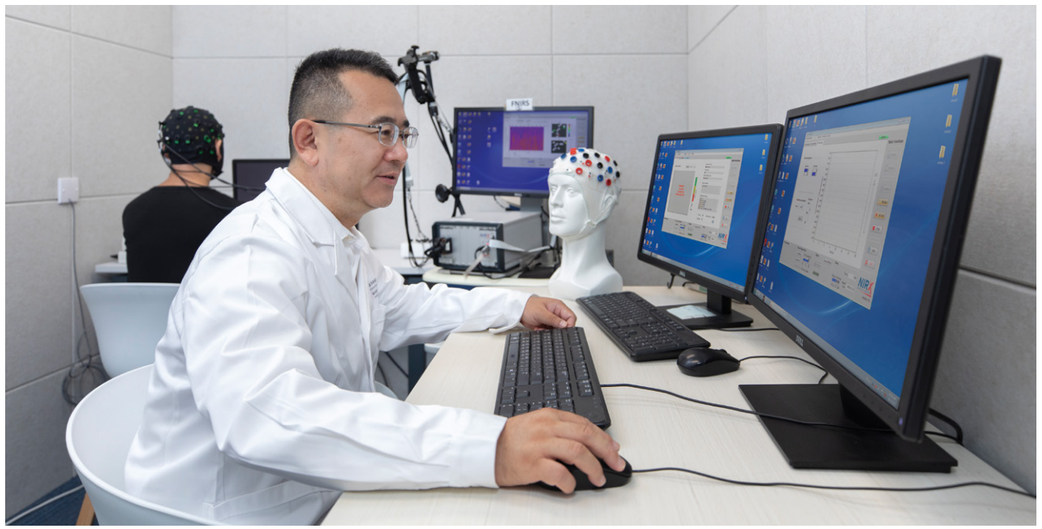
What is the purpose of cross-species brain research? 'We study different animals, including other primates with whom we have a common ancestor, in order to explore how humans have developed high-level cognitive abilities, including the ability to speak, during evolution,' says Prof Yuan.

Nevertheless, the number of cross-species connectomes is still very limited, and the methods to create them have yet to be fully developed. One of the reasons that such connectomes are difficult to create is that it is hard to determine which brain areas of two species are homologous – that is, whether they evolved from the same structure. There are also challenges in defining the boundary between these different homologous areas based on connectional attributes.

Evolution of Language Abilities

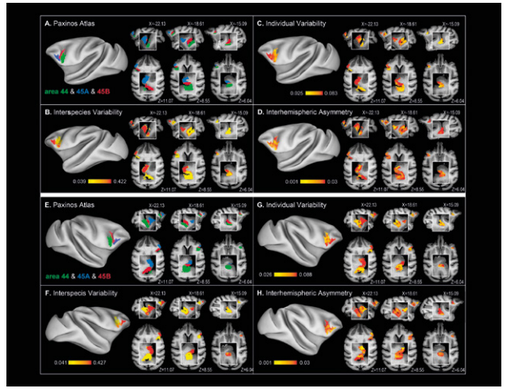
Over the past few years, Prof Yuan's team made several breakthroughs in connectome research, moving towards mapping the brain at the whole-brain level. In one of their projects, they studied the Broca area of humans and macaques to find out their similarities and differences in structural connectivity, which denotes the physical connections between neurons.

The Broca area plays a key role in language production. It is located in the prefrontal cortex and consists of two parts, namely the pars triangularis and the pars opercularis. The area was named after Paul Broca, a 19th-century French physician, neurobiologist, and anatomist. Two of his patients lost their ability to speak after injuring their frontal lobe but could understand others' conversations.



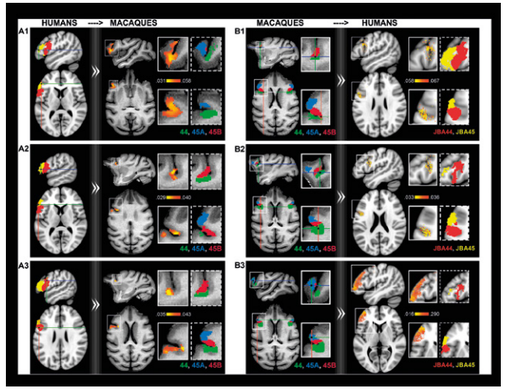
袁振教授的團隊研究人類與獼猴腦部的布羅卡區

Prof Yuan Zhen's team studies the Broca area in human and macaque brains



不同獼猴腦部在結構連接方面的差異性

Variability in structural connectivity between different macaque brains



熒光位置為人類與獼猴腦部的部分同源位點

The fluorescent parts are some of the homologues between human and macaque brains

This prompted Broca to undertake in-depth studies that suggested that different regions of the brain have different functions, contrary to the prevailing view at that time that all parts of the brain are essentially the same in terms of their functions. Broca's argument, later known as cerebral localisation, had a profound impact on the development of brain research.

When two species have certain parts that share a common evolutionary origin, these parts are called homologous. Prof Yuan's team identified 23 pairs of homologous bundles of nerve fibres (nerve tracts) in the Broca area between humans and macaques at the voxel level, after analysing MRI data from overseas brain atlases. In other words, they discovered mapping relationships between the voxel-level tracts in the Broca areas of the two primates.

The researchers then examined the structural connectivity of these homologous tracts, and found that the two primates have greater variability in the pars triangularis than in the pars opercularis. This suggests that pars triangularis is likely to be a more active area in primate evolution. When the researchers looked at the human brains only, they found greater variability in the pars triangularis than in the pars opercularis, which also holds for macaque brains.

The left and right brains differ in morphological attributes, connection, and function, a phenomenon known as 'hemispheric asymmetry' or 'lateralisation', says Prof Yuan. Their team also investigated how much these homologous tracts differ in the left brain from those in the right brain. The researchers found that variabilities in the brains of humans and macaques are smaller in the pars triangularis than in the pars opercularis.

At the same time, they discovered that language-related tracts in the dorsal stream (a visual pathway involved in our ability to locate objects) are quite different in the two primates, while language-related tracts in the ventral stream (a visual pathway involved in our ability to recognise objects) are rather similar. 'These findings can lead us to a deeper understanding of why only humans have certain high cognitive skills,' says Prof Yuan.

A Cross-species Connectome

To further advance connectome research, it is important to create more accurate maps that define specific areas of the brain (i.e., parcellations). To tackle this issue, Prof Yuan's team has developed two parcellations of humans and macaques. 'With the parcellations and our other research outcomes, we are steadily advancing towards the creation of a cross-species connectome at the whole-brain level,' he says. 'We will continue to investigate the neural mechanisms underlying language abilities in several projects, including mapping the brain at different scales. Breakthroughs in these fields will not only help us treat brain diseases and develop smarter technologies, but also figure out what makes our species so unique.'

萬峰教授(右)的研究團隊開發了多種用於腦控打字的算法

Prof Wan Feng's (right) research team has developed many algorithms for brain-controlled typing

人腦連接電腦　意念化為行動

Turning Thoughts into Actions with Brain-Computer Interfaces

文 / 葉浩男 · 圖 / 何杰平，部分由受訪者提供

Chinese & English / Davis Ip · Photo / Jack Ho, with some provided by the interviewee

試想像安坐家中，單靠意念就能開關電視、調校燈光或在手機輸入文字，你想擁有這種「超能力」嗎？科學家數十年來開發連接人腦和電腦的系統（簡稱「腦機接口」）。澳門大學有研究團隊開發了多種腦機接口，並憑其研究成果在國際和全國性的腦控打字比賽上奪冠，更創下世界記錄。

形式多樣的讀心術

澳大電機及電腦工程系、認知與腦科學研究中心副教授萬峰說，一些企業近年在美國和澳洲等地開展臨床試驗，將芯片植入大腦，在一定程度上識別用家想法，從而控制電腦或機械裝置，例如使殘疾人士能操控義肢。「這種方法雖然較為高效，但要在腦部動手術，有時甚至要在髖骨鑽洞植入芯片，風險甚高。」

因此，很多科學家研究毋須動手術就能使用的非入侵式腦機接口，例如裝有電極、能夠偵測腦電波的頭套。萬教授說：「以腦控打字為例，我們可在電腦熒幕顯示數個彩色方格，每格均有一個英文字母，並以特定的頻率重複閃爍。我們注視其中一個方格時，大腦會產生與方格閃爍相同頻率或倍數頻率的腦電活動，頭套只要偵測出相關的腦電訊息，即『穩態視覺誘發電位』，就能指令電腦輸出對應的字母。」

腦控打字世界記錄

萬教授研究基於不同類型的腦機接口超過10年，不斷提出新的算法，加速人與電腦的連接，多項成果見於領域重要學術期刊。他還帶領學生與香港大學的研究人員合作參與大型賽事。在2019世界機器人大會腦控機器人大賽暨第三屆中國腦機接口比賽，澳大與港大組成兩支聯隊參賽，兩隊隊長均為澳大電機及電腦工程系學生。其中一支聯隊獲得技術賽綜合成績總冠軍及特等獎、「基於視覺誘發電位」和「運動想像」的腦機接口項目賽冠軍及一等獎，並且創下腦控打字最快的世界記錄，輸入一個英文字母平均只需0.4秒。

在2020年同一個賽事，澳大 — 港大聯隊在技術賽中蟬聯全場總冠軍及特等獎，同時獲得「基於事件誘發腦電」的腦機接口系統單項賽冠軍，並在技術錦標賽中的七個單項比賽中獲得四項第一。

結合人工智能與腦機接口

萬教授指出，近年來腦機接口性能雖然不斷提升，但有關技術仍不足以用作大規模的商業使用。「例如，一大挑戰是人腦之間差異可以很大，同一台裝備未必人人適用。即使只有一個用家，其腦部的狀態也會不時變化，因此裝置每次啟用前都要花不少時間『校準』，無法『即戴即用』。」

有見及此，萬教授團隊運用遷移學習方法，即利用以其他用家過往產生的數據訓練而成的深度學習模型，令裝置更快適應當前的用家。他們也在開發即時因應腦部變化而更改處理腦電波數據的方法，以及提出利用「神經反饋訓練」調控用家的腦活動，令他們使用腦機接口時更有效率。

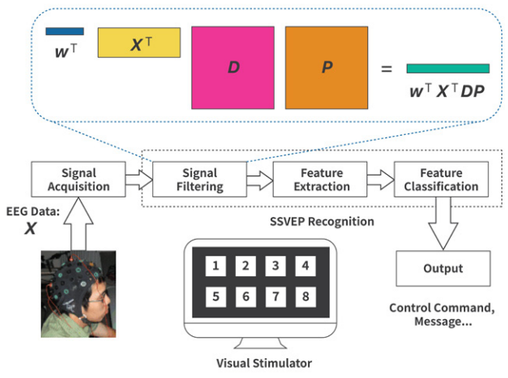
此外，長時間透過顯示閃爍方格或類似方法來刺激腦部，難免令人視覺疲倦。萬教授率先關注到用家視覺疲倦的問題，他的團隊於是開發了一些算法，使裝置能按腦部狀態的轉變調整熒幕上的視覺刺激，減少用戶的視覺疲勞和精神負擔。

萬教授指出，使用基於「穩態視覺誘發電位」的腦機接口時，頭套上有多個電極偵測腦電波，電腦需要整合來自不同電極的訊號，期間需要以「空間濾波算法」來強化與「穩態視覺誘發電位」有關的腦電訊號。他的團隊因此提出了一個理論框架，用於系統地分析近年流行的近20類「空間過濾算法」，並以這個理論框架為基礎發展了三款新的算法，提升腦控打字的速度。

腦機接口技術影響深遠

萬教授相信，腦機接口將會對我們的生活和工作帶來翻天覆地的變化，令我們能夠有如在科幻電影般用意念處理不同事情。例如一些嚴重病患者和傷殘人士也能重拾自主生活的能力，甚至太空人也能借腦機接口更高效地執行複雜的任務。

萬教授的團隊正在加緊開發更高效、能夠「即戴即用」的腦機接口，及利用腦機接口的「寫心術」以改善增強腦功能，方向包括：可以自主控制的異步系統；跨協議、跨設備平台、跨用家及時間等的泛用技術；領域知識與深度學習結合的方法先進算法；運用神經反饋以治療腦疾病或提升學習能力等。「我們透過發展更好的腦機接口技術，以期實現人與機器的無縫結合及雙向閉環調控。」



基於穩態視覺誘發電位的腦機接口的標準運作流程

A flowchart of a standard SSVEP-based BCI

Imagine if you were able to control your TV, adjust your lights, and type on your mobile phone with only your brain while sitting comfortably at home. Would you like to obtain this superpower? In recent decades, scientists have made remarkable progress in building brain-computer interfaces (BCIs). At the University of Macau (UM), a research team has developed some different types of BCIs. Members of the team have also won championships in international and national brain-controlled typing competitions and have even set a world record.

Different Ways to Read Minds

According to Wan Feng, associate professor in the Department of Electrical and Computer Engineering and the Centre for Cognitive and Brain Sciences at UM, there have been various commercial attempts to implant microchips in human brains for clinical trials in countries such as the United States and Australia. These chips can partially decode thoughts to control computers and machines, allowing people with disabilities to control prosthetic arms and legs. 'This type of BCI should be quite effective, but it requires brain surgery, including drilling a hole in the skull to implant the chip, which poses significant risks to users,' says Prof Wan.

To avoid these risks, scientists are developing non-invasive BCIs that do not require surgery. Instead of implanting a chip in the brain, an individual can wear an electroencephalogram (EEG) cap that records brain waves. 'Take brain-controlled typing as an example: We can show on the computer screen several coloured boxes, each containing a letter of the English alphabet and flashing at a certain frequency. When we look at one of these boxes, our brain generates electrical activity at the same frequency or at a multiple of the frequency of the visual stimulus,' says Prof Wan. 'The related brain signals are called steady state visually evoked potentials [SSVEP], and they can be interpreted as computer commands to enter the letter we want.'

左起：萬峰教授、王澤博士、黃志岷博士
From left: Prof Wan Feng, Dr Wang Ze, and Dr Edwin Wong

A World Record in Brain-Typing

For over a decade, Prof Wan has developed BCIs based on different types of visual evoked potential (VEP) and designed algorithms to accelerate the connection between humans and computers. He has published his research findings in many academic journals in the field. Under his guidance, Prof Wan's students collaborated with researchers from the University of Hong Kong (HKU) in major competitions. In 2019, they formed two teams, both led by students from UM's Department of Electrical and Computer Engineering, to compete in the World Robot Conference Brain-Computer Interfaces Contest cum the Third China Brain-Computer Interfaces Contest. One of the teams won the grand championship and the special prize, as well as the championship and a first prize in both the 'VEP' track and the 'Motor Imagery' track. In addition, a member of the team managed to type a document with an average speed of 0.4 seconds per letter, setting a world record.

At the same event in 2020, the UM-HKU team won the grand championship and the special prize again. The team also won the championship in the Event-Related-Potentials-based BCI category, as well as first prizes in four out of seven other categories.

Artificial Intelligence for BCIs

Prof Wan says that despite many advances, BCIs are not yet robust enough for large-scale commercial use. One of the challenges is that people have different brain shapes and EEG patterns, so the same EEG device may not work for everyone. Even if there is only one user, the patterns of his or her brain activities will change over time. 'Most EEG devices are not fully plug-and-play as they require a long calibration before we can use them,' he says.

For this reason, Prof Wan's team is using transfer learning, a machine learning method involving deep learning models pre-trained on data from other users, to develop technology for EEG devices so that they can adapt more quickly to the brains of users. Moreover, his team is also developing methods to adapt the way computers analyse brain waves to real-time changes in the brain. The team has also proposed using neurofeedback to adjust the brain activities of users to better connect with BCIs.

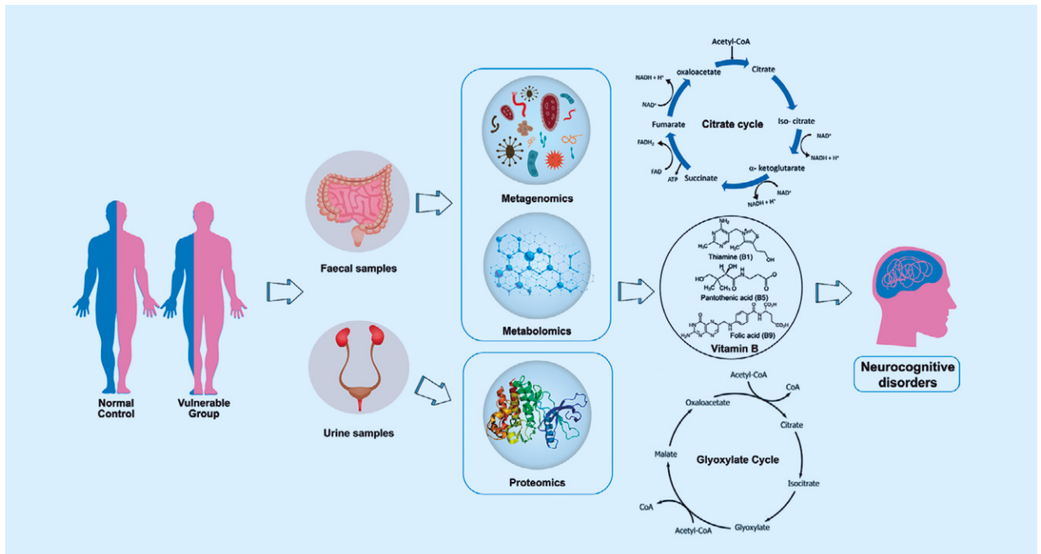
Another challenge is that VEP-based devices cause visual fatigue after prolonged use. Prof Wan, who is one of the first researchers to address this problem, has developed ways to adjust the visual stimuli on the screen to reduce visual fatigue and the mental workload of users.

According to Prof Wan, an SSVEP-based BCI captures brain waves by placing multiple electrodes on the scalp, so the signals detected by the electrodes can be combined for further decoding. During this process, algorithms are applied for 'spatial filtering', which can enhance EEG signals related to SSVEPs. Prof Wan's team has proposed a framework for understanding approximately 20 popular spatial filtering algorithms. Using this framework, the team has developed three new algorithms that can speed up brain-controlled typing.

Far-reaching Influence of BCIs

Prof Wan believes that BCIs will radically change the way we live and work by enabling people to do many things at the speed of thought, as seen in science fiction movies. He adds that the BCI will be a powerful tool, allowing people who suffer from disabilities and other serious illnesses to regain the ability to live independently. BCIs will also help astronauts perform complicated tasks much more efficiently.

Prof Wan's team is working to develop more efficient 'plug-and-play' BCIs to empower the brain. Their research interests include the following: asynchronous systems that can be controlled autonomously; generalised technologies that can be applied across different protocols, platforms, users, and in time periods; advanced algorithms that combine domain knowledge with deep learning; and the use of neurofeedback to treat brain diseases or improve learning ability. 'By developing better technologies for BCIs, we hope to achieve seamless integration between humans and computers to enable bidirectional closed-loop control,' says Prof Wan.



趙永華教授的團隊運用宏基因組學、代謝組學和蛋白質組學數據，分析易患認知障礙長者的多組學特徵。
Prof Zhao Yonghua's team analyses the gut microbiota of the elderly by using macrogenomic, metabolomic and proteomic data.

腸道如何影響神經認知障礙

The Links between Gut and Neurocognitive Disorders

文 / 葉浩男 · 圖 / 何杰平，部分由受訪者提供
Chinese & English / Davis Ip · Photo / Jack Ho, with some provided by the interviewees

如果懷疑自己有神經認知障礙，你可能不單要掃描腦部，還要檢查腸道。澳門大學一個研究團隊發現，分析腸道中某些微生物的增減，可能有助評估長者患上阿茲海默症等神經退行性疾病的風險。

腸道：第二大腦

澳大認知與腦科學研究中心主任、健康科學學院教授袁振指出：「阿茲海默症主要影響長者，令他們逐漸失去獨立生活的能力，只有少數藥物被指有助暫時減輕症狀，至今仍是不治之症。隨著人口老化，全球很可能會有越來越多阿茲海默症患者，帶來巨大的公共衛生挑戰，因此科學家早已從不同角度研究這種疾病的成因，腦部與腸道的聯繫是焦點之一。」

袁教授說，腦部與腸道有密切的生物化學和物理聯繫，這些聯繫的網絡名為「腸腦軸」。「腸道有超過一億個神經細胞，與腦部的神經細胞互通訊息，專家因此稱之為『第二大腦』。此外，腸道內數以萬億的微生物（統稱「腸道菌群」）也會影響腦部，例如細菌在新陳代謝時會產生大量小分子物質（即「代謝物」），部分能進入腦部。」過去一些研究指出，部分代謝物或會引致神經退行性疾病。

腸道菌群失衡影響腦部

澳大中華醫藥研究院助理教授、澳門轉化醫學創新研究院代副院長、中醫生趙永華說：「健康的腸道呈現微生物種類的多樣性，但這種多樣性會隨年齡而下降，期間致病性細菌的比例通常會增加，形成失衡。」他的團隊認為，腸道菌群失衡與神經退行性疾病有所關連，並且找到新證據支持這項假設。

分析腸道菌群

趙教授在澳大的團隊於2019年起開展「澳門認知功能障礙長者中醫『體—病—證』辨識與腸道微生物組學和代謝組學特徵性變化的相關性研究」，其中一環與澳門鏡湖護理學院、北京中醫藥大學、中山大學和深圳市人民醫院的專家合作。

研究團隊於2019年在澳門招募了400名長者，通過匹配教育程度、生活習慣和慢性疾病等因素，從中篩選出21名認知功能正常的人士，當中8人為中醫平和體質，被列為「對照組」；13人為易患認知障礙的中醫陰虛體質，被列為「風險組」。研究人員採集了這些長者的排泄物、對他們的認知能力（包括記憶力、專注力和語言能力）評分，並在2021年再次評估這21名長者的認知能力。

研究人員從宏基因組學、代謝組學和蛋白質組學等多個層面出發，分析在2019年收集的長者排泄物的微生物和代謝物的差異。這類分析涉及多個「組學」，因此稱為「多組學分析」。研究人員發現「對照組」長者的認知能力分數在兩年後沒有太大變化，但多數「風險組」長者的分數明顯下降，並且有惡化跡象，其中三人更患上輕度認知障礙症，說明具有某種腸菌和代謝特徵的陰虛體質長者更易發生認知障礙。

趙教授說，相比「對照組」的腸菌樣本，「風險組」的腸菌樣本中的瘤胃球菌、毛螺菌、脫硫弧菌和大腸桿菌的升幅顯著增高，反映這些細菌可能對認知功能有負面影響。此外，兩組樣本的糞便代謝物中的乙醛酸／三羧酸循環和B族維生素，以及在「尿液外泌體」中的真核翻譯起始因子2亞基1(eIF2α)　和單胺氧化酶 A (MAO-A) 的表達水平均存在顯著差異。

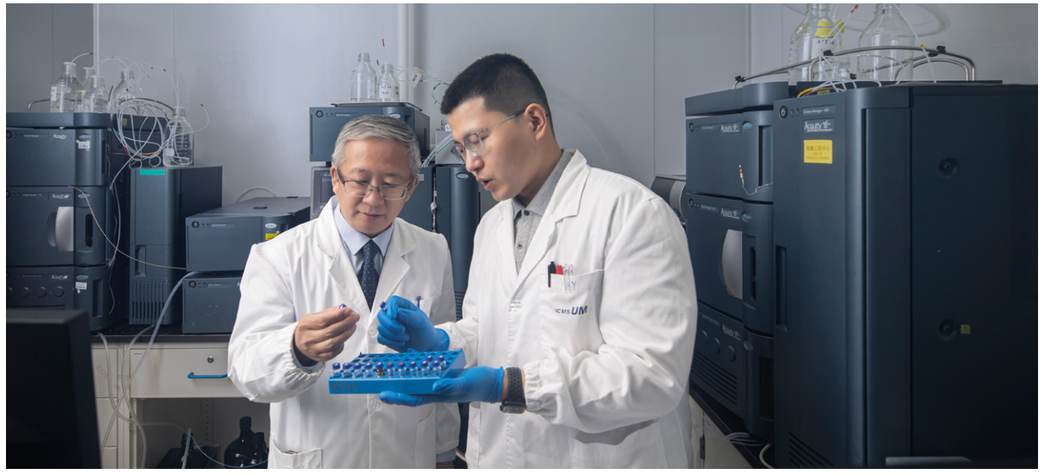
評估神經退行性疾病風險

趙教授的團隊的研究反映，我們或許能夠透過分析腸道菌群的多組學特徵、B族維生素消化與吸收和三羧酸循環，結合中醫體質分析，更為精準地評估長者患上神經退行性疾病的風險，從而及早制訂干預方案。研究人員計劃招募更多長者參與下一階段的研究，試圖透過改變腸道菌群生態環境提升治療神經退行性疾病的成效。

古希臘醫學之父希波克拉底曾說：「所有疾病始於腸道。」趙教授指出，雖然我們暫時未能確定腸道的轉變導致神經認知障礙的確切路徑，但腸道與腦部的關連無疑比許多人所想的緊密得多：「保持腸道健康不僅有助消化，還會對腦部和全身帶來莫大益處。」

袁振教授
Prof Yuan Zhen

趙永華教授
Prof Zhao Yonghua



趙永華教授（左）和博士生韓炎

Prof Zhao Yonghua (left) and PhD student Han Yan

If you suspect you are suffering from a neurocognitive disorder (NCD), you might not only need to be administered a brain scan, but also a gut examination. According to the findings of a research team at the University of Macau (UM), analysing the increase or decrease of certain microbes in the gut may help assess the risk of NCDs and neurodegenerative diseases (NDs) such as Alzheimer's disease (AD) in older people.

The Gut: The Second Brain

'AD mainly affects the elderly, who gradually lose their ability to live independently,' says Yuan Zhen, head of the Centre for Cognitive and Brain Sciences (CCBS) and professor in the Faculty of Health Sciences at UM. 'Although some drugs can alleviate the symptoms, there is still no cure for AD. As the population ages, it is likely that more and more people will suffer from AD, posing a huge challenge to global public health. Therefore, scientists have been studying the causes of the disease from different perspectives, with the "brain-gut crosstalk" being one of the focal points.'

The gut and the brain are physically and biochemically connected through a network known as the 'gut-brain axis', says Prof Yuan. 'Experts refer to the gut as "the second brain" because it contains over 100 millions of neurons that send and receive signals with neurons in the brain.' The gut microbiota, which is the ecosystem of the trillions of bacteria and other microbes in the gut, also affects the brain. For example, some metabolites, which are small molecules produced by bacteria in the gut during metabolism, can enter the brain. Previous studies show that some of these metabolites can cause NCDs.

Imbalance of Gut Microbiota Affects the Brain

'A healthy gut is characterised by the diversity of microbial species, but the diversity of gut microbiota decreases with age. During this process, the proportion of pathogenic bacteria usually increases, causing an imbalance,' says Zhao Yonghua, assistant professor in the Institute of Chinese Medical Sciences at UM. The research team of Prof Zhao, who is also interim associate head of the Macau Institute for Translational Medicine and Innovation and a registered Chinese medicine doctor, believes that the imbalance in the gut is related to NCDs, and the team has found new evidence to support this hypothesis.

Analysis of Gut Microbiota

In 2019, Prof Zhao's team launched a correlated study on the differentiation between Chinese medical 'Constitution-Disease-Syndrome' and the characteristics of gut microbiota and metabolomics in the elderly with cognitive dysfunction in Macao. Part of the project was conducted in collaboration with experts from Kiang Wu Nursing College of Macau, Beijing University of Chinese Medicine, Sun Yat-sen University, and Shenzhen People's Hospital.

After recruiting 400 elderly residents in Macao in 2019, 21 participants with normal cognitive function were selected through a rigorous matching of education levels, lifestyles, and chronic diseases. Eight of them were classified as the 'control group' with a balanced Chinese medicine constitution, while 13 were classified as the 'vulnerable group' with a Yin deficiency constitution, which is prone to NCDs. The team collected the faeces and urine of the elderly and ran a test to determine their 'neurocognitive scores' in areas such as memory, attention, and language. These steps were repeated with the same participants in 2021.

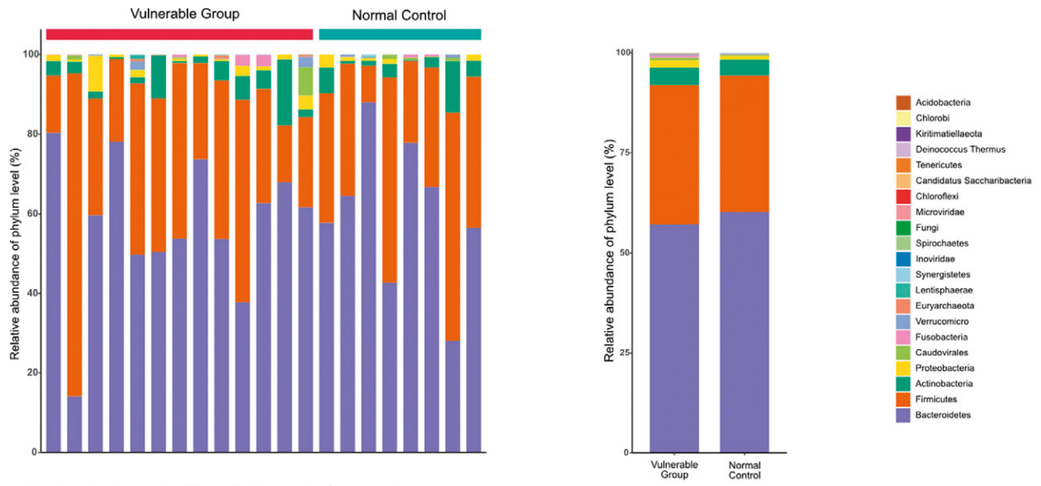
To determine the differences in the microbiota and metabolites in the excreta of two groups of participants in 2019, the researchers conducted a multi-omics analysis assessing different types of data, including metagenomics, metabolomics, and proteomics. They found that the neurocognitive scores of each person in the control group did not change much. However, most participants in the vulnerable group presented a significant decline in their scores, with signs of further deterioration in their cognitive function. In addition, three members in the vulnerable group developed mild NCD, suggesting that NCDs are more likely to occur in Yin-deficient older people with certain gut bacterial and metabolic characteristics.

Moreover, the increase in Ruminococcus gnavus, Lachnospira eligens, Escherichia coli, and Desulfovibrio piger was significantly higher in the faeces of the vulnerable group than that in the control group. 'This suggests a possible negative impact of these bacteria on cognitive functions,' says Prof Zhao. He adds that the two groups showed significant differences in the levels of glyoxylate and dicarboxylate metabolism and vitamins B in the faecal metabolites, as well as in the levels of expression of eukaryotic translation initiation factor 2 subunit 1 (eIF2α) and amine oxidase A (MAO-A) in the urine exosomes.

Assessing the Risk of NCDs

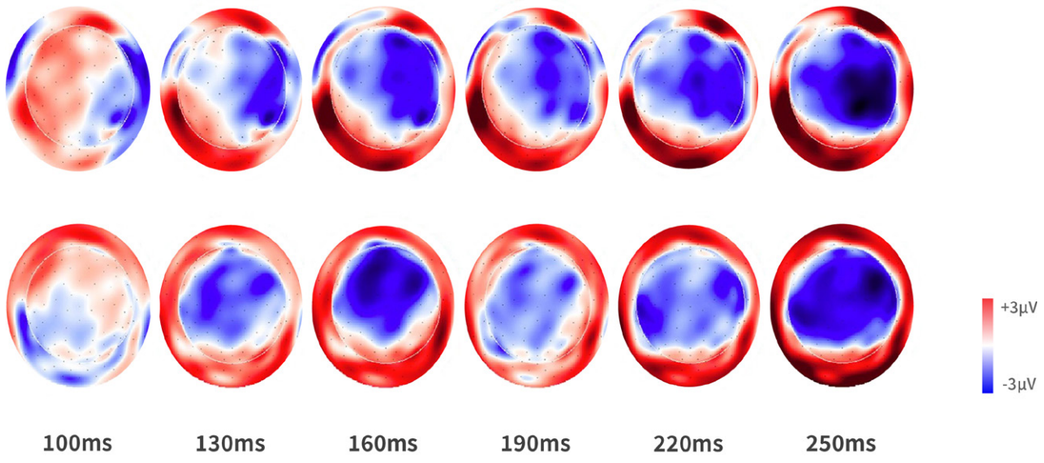
The findings of Prof Zhao suggest that it may be possible to assess the risk for developing NCDs among the elderly by examining multi-omics characteristics of bacteria in their gut, vitamin B digestion and absorption, and the tricarboxylic acid cycle, so that early intervention could be planned. In the next phase of the research project, the team may recruit more elderly people to find out whether changes in the gut microbiota ecological environment can exert a satisfactory therapeutic effect on NCDs.

'All disease begins in the gut,' said Hippocrates, an ancient Greek physician known as the 'Father of Medicine'. 'While we aren't sure of the exact pathway by which changes in the gut lead to NCDs, our gut and brain are definitely much more closely "crosstalked" than many have thought,' says Prof Zhao. 'A healthy gut not only helps with digestion, but also benefits the whole body, including the brain.'



風險組與對照組長者的腸道菌群中各類微生物（以「門」為單位）的比例

Proportions of different microorganisms at the genus level in the gut microbiota of the elderly in the vulnerable group and the control group



研究團隊招募在澳門以廣東話為母語、正在學習英文的健康兒童與自閉症兒童參加研究，測試他們對英文重音的知覺敏感度。本圖顯示這兩組兒童在測試期間頭皮內的一些事件相關電位的分佈（上方為自閉症兒童的結果、下方為健康兒童的結果）。

Healthy and autistic children who speak Cantonese as their first language and are learning English are tested to see how sensitive they are to stress in English. This figure shows the distribution of certain event-related potentials during the tests. The top row shows the results of autistic children, while the bottom row shows the results of healthy children.

兒童認知行為的大腦神經機制

Neural Mechanisms of Early Brain Development

文 / 葉浩男 · 圖 / 何杰平，部分由受訪者提供

Chinese & English / Davis Ip · Photo / Jack Ho, with some provided by the interviewee

零至八歲是腦部發育最快的階段，對往後的人生軌跡有莫大影響。因此，澳門大學認知與腦科學研究中心的成員不斷探索兒童認知行為的神經機制，從而促進對認知異常的早期介入，以及推動智能和人格的健康發展。

神經細胞連結迅速增加

教育學院幼兒教育及兒童發展中心代主任、認知與腦科學研究中心成員、副教授張娟指出，兩歲兒童腦部的體積已達成人的80%。嬰兒出生時，腦部已具備與成人腦部相若的神經細胞。我們往後發展的不同高級認知功能，例如感知、思考、學習和溝通能力，主要是神經細胞不斷產生稱為「突觸」、可以互相傳遞生物電和化學訊號的神經連結所致。

張教授說，三歲兒童的腦部約有1,000萬億個突觸，是成人的兩倍，而過量的突觸在青春期後才逐漸消除。「年幼時由神經細胞和突觸構成的神經網絡會影響一生，奠定往後學習、適應變化和身心健康的基礎。」

張教授也指出，兒童的腦部發育與人際互動和環境因素息息相關。情緒管理和學習等高級認知功能均需要腦部的額葉和內側顳葉的參與，而這些腦區域對早期發育時的經歷極為敏感。如果兒童在最初四、五年沒有經歷充足的環境刺激或遭受不良體驗，例如受到過量壓力，他們在處理情緒和建立積極人際關係等方面的技巧（統稱「社會情緒行為」）很可能會有所缺失或發展遲緩，這也會顯著提高精神疾病的發病率。「因此，我們的團隊探索父母的反應會如何影響子女的即時情緒反應、思維能力、心理韌性和自我概念，並且以數學模型預測父母不同反應對子女的影響。」

語言與情緒感知

張教授研究團隊的另一方向是探討不同年齡人士面對母語或第二語言中與情緒相關的詞彙時腦部的反應。「情緒感知是兒童成長時學習的重要能力。我們必須準確感知他人的說話傳達出甚麼情緒，社交生活才會順利。」

她指出，關於情緒的詞彙可分為兩類，一類是「情緒標籤詞」，例如「快樂」和「悲傷」等直接標記情緒的詞彙；另一類是「情緒負載詞」，即令人聯想起不同情緒的詞語，例如「生日」通常傳遞正面情緒、「地震」令很多人產生負面感覺。

張教授的團隊在一項研究中觀察到，與正面或負面情緒相關的詞彙會在腦部誘發一種名為N170的「事件相關電位」（一類由感官、認知或動態事件引發的腦電波，簡稱ERP），但兩者誘發電位的方式不同。此外，這些詞彙都會在右腦的頂葉誘發一種名為「晚期正電位」的ERP，其中情緒負載詞比情緒標籤詞誘發的電位更大。她的另一項研究則顯示，第二語言的情緒標籤詞也能潛移默化地影響我們感知情緒的方式，但第二語言中的情緒負載詞似乎沒有影響。

張教授的團隊也曾對以中文為母語、英文為第二語言的華人自閉症兒童開展研究。他們發現，與健康兒童相比，自閉症兒童對英文重音的知覺敏感度較低。此外，在處理語言時，他們的右腦比左腦更活躍，而健康兒童則相反。

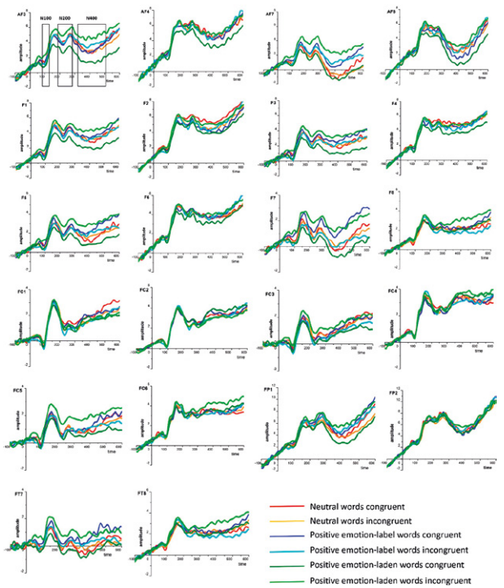
除了這些基於ERP的研究，張教授的團隊還運用行為實驗、功能磁核共振成像、功能近紅外光譜技術等方式，了解腦部如何處理不同類型的情緒，探索語言與情緒的關係。「通過檢測與情緒相關的腦部激活模式，我們能進一步了解兒童如何發展關於情緒的重要能力和在發展中存在的潛在障礙。」

把握早期介入最佳時機

深入研究兒童腦部發育對預防和治療疾病大有益處。世界衛生組織資料顯示，全球約有10%兒童和青少年有精神障礙，但大多數人都沒有尋求或接受治療。這些問題包括癲癇、發育障礙、抑鬱症、焦慮症和行為障礙，不少與腦部發育相關。張教授說：「由於兒童的腦部可塑性高，越早發現異常，介入效果越好。」

許多研究也表明，兒童越早有充足的語言輸入，日後的語言能力就越強，而青春期之前是學習語言的關鍵時期。因此，兒童如果有語言或情緒管理方面的障礙，越早介入成效越大。過去有研究發現，閱讀干預（如對話式閱讀、集體朗讀和製作詞彙表）能改變有閱讀障礙的兒童的腦部激活模式，效果在幼童身上尤其明顯。

張教授說，兒童腦部每個發育階段都非常重要，必須深入了解確切的神經機制，才能及時篩查出腦部的異常發展。「兒童腦部發育不單受營養、先天基因等因素影響。周圍的人與他們的互動和環境也會實實在在影響腦部結構和認知能力。給孩子一個快樂的童年，絕對有充分的科學理據。」



參加研究的中英雙語者觀看各類與情緒相關的詞彙時，他們的頭皮上貼有多個電極，用於檢測他們的腦電活動。圖為檢測結果。

Chinese-English bilinguals taking part in a research project had electrodes stuck to their scalps when they looked at words associated with different emotions. The electrodes measured their electrical activity in the brain, as shown in the figure.

Our brain grows fastest from birth to the age of eight, exerting a long-lasting impact on the rest of our life journey. Members of the Centre for Cognitive and Brain Sciences (CCBS) at the University of Macau (UM) are therefore researching the neural mechanisms underlying children's cognitive behaviours to promote early intervention for cognitive disorders, as well as intellectual and personality development.

Rapid Growth of Neural Connections

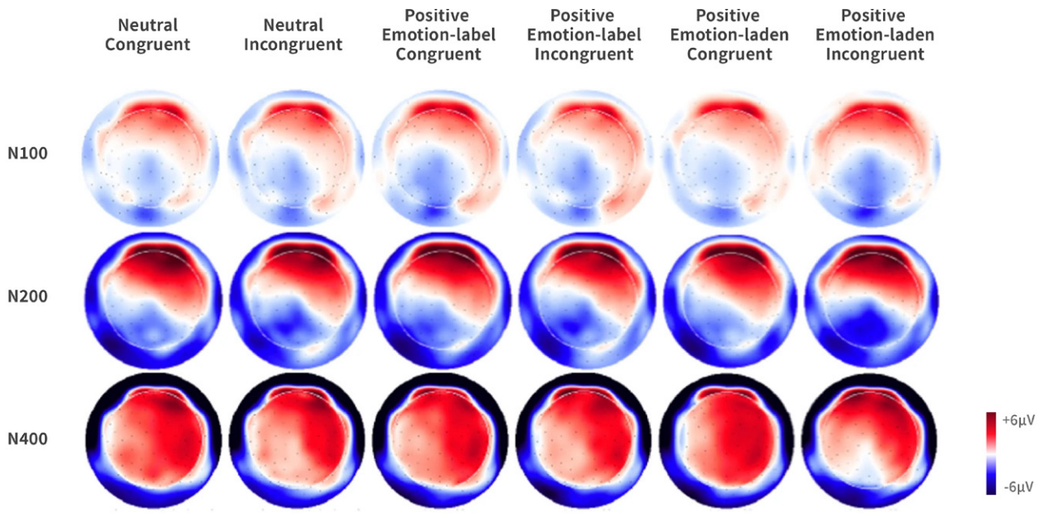
The brain of a two-year-old can reach 80 per cent of the size of an adult's, says Zhang Juan, associate professor and interim director of the Centre for Early Childhood Education and Child Development in the Faculty of Education, and also a CCBS member. She says the brain contains as many neurons at birth as it will need in adulthood. To develop various high-level cognitive skills, such as the ability to perceive, think, learn, and communicate, neurons constantly make new neural connections through structures called 'synapses', which can transmit bioelectrical and chemical signals to each other.

The brain of an average three-year-old child has about 100 trillion synapses, which are twice as many as adults, and the excessive synapses steadily drop after adolescence. 'The networks of neurons and synapses formed in childhood have a profound impact as the foundation for our learning, adaptation to change, and physical and mental well-being,' says Prof Zhang.

Prof Zhang adds that early brain development is strongly influenced by interpersonal interactions and environmental factors. High-level brain functions, such as learning and emotion management, involve the frontal and medial temporal lobes, which are particularly sensitive to experiences during early development. Therefore, if children have inadequate or poor environmental experiences in their first four or five years of life, such as excessive stress, it is likely that their ability to deal with emotions and build positive personal relationships (collectively known as 'social-emotional skills') will show deficits and delays, with a significant increase in the incidence of mental illness. 'That's why our team is studying how parents' responses affect their children's timely emotional responses, thinking skills, resilience, and self-concept. We also use mathematical models to predict how parental response preferences influence their children's behaviours,' says Prof Zhang.

Language and Emotion Perception

Prof Zhang's research team also studies the brain responses of people of different ages when they are presented, in their first and second languages, with words associated with emotion. 'Emotion perception



研究團隊招募中英雙語者觀看以不同方式呈現、傳遞情緒的各類詞彙。本圖顯示他們看到這些詞彙時，頭皮內N100、N200和N400這三種事件相關電位的分佈。

The research team has invited Chinese-English bilinguals to look at words associated with emotions represented in different ways. This figure shows the distribution of three event-related potentials, namely N100, N200 and N400, in the scalp when they saw the words.

張娟教授
Prof Zhang Juan

is an essential skill that children must acquire. Without the ability to read the emotions of others when they speak, we wouldn't be able to lead successful social lives,' she says.

According to Prof Zhang, there are two types of emotion words: emotion-label words and emotion-laden words. Emotion-label words, such as 'happy' and 'sad', directly express emotions. By contrast, emotion-laden words indirectly evoke various emotions with elaboration. For instance, 'birthday' usually conveys a positive emotion, while 'earthquake' prompts a negative emotion.

In a research project, Prof Zhang's team observed that words associated with positive or negative emotions triggered N170, which is a type of event-related potential (brainwaves triggered by a specific sensory, cognitive, or motor event, or ERP), but in different ways. These words also elicited another type of ERP, namely the late positive component (LPC), in the right parietal lobe, with emotion-laden words eliciting larger LPC than emotion-label words. In another study, she found that emotion-label words in a second language can unconsciously affect the way we interpret emotions, while emotion-laden words in a second language do not seem to have this impact.

Prof Zhang's team also studied Chinese children with autism who speak Chinese as their first language and English as their second language. The researchers found that children with autism were less sensitive to stress in English than typically developing children. In addition, their right hemisphere is more activated than the left hemisphere when processing language, while the opposite is true for healthy children.

Apart from ERP-based studies approaches, Prof Zhang's team used behavioural experiments, functional magnetic resonance imaging (fMRI) and functional near-infrared spectroscopy (fNIRS) to find out how the brain processes different emotions and what role language plays in emotions. 'By tracking the activation patterns in the brain associated with emotions, we can gain further insights into how children learn vital emotional skills and what obstacles might stand in the way,' she says.

Seizing the Moment for Early Intervention

Thorough research into the development of children's brains can be of great benefit for the prevention and treatment of diseases. According to the World Health Organization, 10 per cent of children and adolescents worldwide have experienced a mental disorder, but the majority of them do not seek help or treatment. These disorders include epilepsy, developmental disabilities, depression, anxiety, and behavioural disorders, many of which are associated with brain development. 'Since children's brains have an enormous capacity to change, the earlier you intervene in brain disorders, the more effective it is,' says Prof Zhang.

Moreover, many studies have shown that the earlier children receive rich language input, the better their language skills will be, and that the critical period for language learning is before puberty. Therefore, if children have problems in language or emotional management, earlier intervention is always better. Previous research has also found that reading interventions (such as dialogic reading, choral reading, or making word lists) can change brain activation patterns in children with dyslexia, especially an early age.

'Every stage of early brain development is important, and a deep understanding of the precise neural mechanisms is key to the timely detection of abnormal brain development,' says Prof Zhang. 'The growth of children's brains is shaped not only by nutrients and genes, but also interpersonal interactions and the environment in which they live, which have a real impact on brain structure and cognitive abilities, so there is every scientific reason to raise a happy child.'

跨學科研究智慧旅遊

Smart Tourism: An Interdisciplinary Exploration

文 / 余偉業 · 圖 / 何杰平 · 英文翻譯 / 蘇恩霆、資深校園記者任凝
Text / Kelvin U · Photo / Jack Ho · English Translation / Anthony Sou, Senior UM Reporter Connie Ren

澳門大學的智慧旅遊研究團隊以大學研發的智慧城市技術，結合人文歷史、綜合旅遊、商業營銷等學科的優勢，開展跨學科創新研究，助力澳門建設世界旅遊休閒中心。

跨學科合作研究

《世界旅遊經濟趨勢報告（2022）》指出，新冠疫情的持續加速了全球以科技創新、數字化手段助力旅遊復甦。國家《「十四五」文化和旅遊發展規劃》提出積極發展智慧旅遊，而澳門特區《第二個五年規劃（2021-2025年）》則明確推動「智慧+」全面升級，將智能技術用於旅遊、教育等重點領域。

澳大作為澳門一所國際化綜合性公立大學，以研究力量、人才培育助力澳門建設智慧旅遊城市。澳大亞太經濟與管理研究所的智慧旅遊研究團隊聯動海內外學者開展跨學科合作，透過大數據、物聯網等智慧手段，豐富澳門作為世界旅遊休閒中心的內涵，從而吸引更多高質量的旅客。

智慧旅遊研究團隊由澳大發展基金會智慧旅遊講座教授、亞太經濟與管理研究所副所長、工商管理學院講座教授羅振雄領軍，與14位來自旅遊、科技、教育和法律等範疇的澳大學者展開跨學科研究。羅振雄教授在2021年獲《國際當代酒店管理雜誌》評為「世界上最多產的旅遊／酒店研究人員」，其出版物已被引用超過54,000次，亦被Alper-Doger Scientific Index嘉許為2022年度全球最具影響力學者之一。羅振雄教授表示，智慧旅遊是在智慧城市的基礎上發展，以科技提升城市旅遊營運的效率，滿足旅客的不同需求。

研究團隊目前積極開展大規模、長期的跨學科項目，包括羅振雄教授與海外學者合作的「以用戶生成數據提高旅遊目的地競爭力」、科技學院副教授黃承發與工商管理學院副教授蘇小恩合作的「基於深度強化學習之個人化旅遊規劃機器人」、中華醫藥研究院教授胡元佳與健康科學學院副教授陳勁、工商管理學院副教授陳曉雲合作的「利用智慧技術發展澳門醫旅遊」，在多個領域探索澳門發展智慧旅遊的方向。

支持業界加強競爭力

智慧旅遊是澳門轉型為智慧城市的重要驅動力之一，而澳大智慧城市物聯網國家重點實驗室可為智慧旅遊研究提供技術支撐。羅振雄教授表示，凡是以科技為手段，例如是運用雲計算、物聯網和5G等技術，提升遊客在行程之前、期間和往後的體驗，均可視為智慧旅遊的表現。他強調，「哪怕科技多麼先進，旅遊的核心價值是永恆不變的，就是為旅客締造美好難忘的觀光體驗，衣食住行環環相扣，任何一環做得不足都會扣分。」

羅教授正透過用戶生成的實時數據，掌握旅客的行程軌跡及遊覽行為，並且分析其親身感受，從而瞭解他們的確實需求。此外，亞太經濟與管理研究所定期舉辦研討會，向業界、政府分享前沿學術成果，交流相關行業最新發展，幫助旅遊業持份者充分瞭解有待優化之處，加強澳門作為旅遊目的地的競爭力。

為旅遊轉型培育專才

智慧旅遊的發展，離不開高等院校培養智慧型旅遊人才。澳大承擔著培育旅遊專才的重大社會責任，2019年開設綜合度假村及旅遊管理學系，以滿足澳門、國家和世界各地旅遊業對綜合性人才的需求。該學系致力裝備學生掌握相關學科的前沿知識和技能，強調理論與實踐結合，重視培養前瞻意識，使人才培育迎合旅遊企業和市場所需。

綜合度假村及旅遊管理學系主任、澳大發展基金會傑出學人苗莉教授加入澳大前先後於美國普渡大學和奧克拉荷馬州立大學任教10多年，專注研究款客服務及旅遊體驗中的人際動態關係、人與科技交互。苗教授說，在智慧旅遊時代的背景下，該學系將借助在澳大計算機科學、大數據分析等學科的優勢，對學位課程的設計進行調整和拓寬，例如在教學中加入「元宇宙」和「旅遊＋」等元素，提高學生的跨學科知識和能力。

苗莉教授指出，學系會因應未來趨勢調整課程設計。隨著旅遊智能化加速，旅客對個性化服務的需求不斷增加，逐漸改變傳統的旅遊行為。澳門經濟已邁入新階段，由重視服務品質的「服務經濟」進入強調使用者體驗的「體驗經濟」，旅遊人力資源亦因此由「勞動密集型」轉向「體驗密集型」，即透過創新意念、數字科技等手段，為旅客帶來每次都不一樣的遊覽體驗。

苗教授說：「我們要提高人才培育的層次，加強學

羅振雄教授
Prof Rob Law

生對環境認知和與旅客共情的能力，掌握旅客口味，使款客服務或商品得到旅客正向的情感投射。」

塑造更鮮明的旅遊特色

在澳大這所綜合性公立大學，研究團隊開展跨學科項目時別具優勢。研究人員憑藉大學的智慧城市技術，結合人文、歷史、綜合旅遊、商業營銷等學科的優勢，探索深化「旅遊+」跨界融合之路，助力澳門塑造更具特色的旅遊形象。其中，機電工程系副教授黃承發與團隊利用人工智能中的深度強化學習技術，設計一個預測路線的圖神經網路，開發移動應用程式，通過旅客輸入的喜好和位置，只需2.7秒就能規劃個人化旅遊路線。

與此同時，黃教授還開展虛擬實境（Virtual Reality，以下簡稱VR）智慧導賞項目，對澳門具歷史意義或文化價值的建築作全方位數字化記錄和實境建模。其中，澳大圖書館作為澳門首間引入360度全景虛擬導覽技術的圖書館，就是研究團隊VR建築智慧導賞項目的首個成果。「旅客透過VR系統參觀日常難以觀賞的景點，激發他們親臨澳門一睹建築風采。我們會以澳大圖書館為例，把VR智慧導賞技術延伸至澳門的歷史建築，例如聖堂、廟宇等宗教場所，這些都是澳門的文化底蘊。」

黃教授說：「我們計劃結合兩個研究項目的成果，在動態規劃旅遊路線的應用程式加入VR建築導賞和社區特色店資訊，令不熟悉澳門的旅客都能透過智能行程規劃感受澳門特色。未來我們將繼續發揮大學智慧城市技術優勢，加強呈現澳門世界遺產的特色。」

未來研究方向

羅振雄教授表示，亞太經濟與管理研究所將繼續擔當業界、教育界和研究機構的橋樑，透過前沿研究協助旅遊業界捕捉市場機遇。研究團隊正在潛心鑽研世界各地成功的智慧旅遊案例，吸收當地創新的應用經驗，供澳門乃至大灣區其它城市借鑑。「每一個城市案例都有其參考價值，但發展智慧旅遊需要因地制宜，因此我們今後需要依據澳門的特色，探索出自己的發展模式。」

澳大以研究力量、人才培育助力澳門建設智慧旅遊城市

UM is committed to supporting Macao in its development into a smart tourism destination through research and education

The University of Macau's (UM) Smart Tourism Research Team is leveraging the smart city technologies developed at UM and the university's strengths in humanities, history, integrated tourism, marketing, and other areas to carry out innovative interdisciplinary research, in order to help build Macao into a world centre of tourism and leisure.

Interdisciplinary Collaboration and Research

Because of the continuation of the COVID-19 pandemic, countries around the world are actively exploring the use of innovative technology and digital approaches to accelerate tourism recovery, according to the Report on World Tourism Economy Trends (2022). In China, the 14th Five-Year Plan for the Development of the Culture and Tourism Sector envisages the progressive development of smart tourism. The Second Five-Year Plan (2021-2025) of the Macao Special Administrative Region also shows the local government's vision of upgrading different industries with smart technology, with priorities given to key areas such as tourism and education.

As an international comprehensive public university in Macao, UM is committed to supporting Macao in its development into a smart tourism destination through research and education. The university has formed a Smart Tourism Research Team under the Asia-Pacific Academy of Economics and Management (APAEM), aligning outstanding domestic and foreign scholars to conduct interdisciplinary research. With the assistance of various advanced technologies such as big data and the Internet of Things, Macao will be developed as a world centre of tourism and leisure to offer diverse tourism products and attract more high-quality tourists.

Dedicated to interdisciplinary research, the Smart Tourism Research Team consists of 14 UM scholars in areas such as tourism, technology, education, and law. The team is led by Rob Law, University of Macau Development Foundation Chair Professor of Smart Tourism, deputy director of APAEM, and chair professor in the Faculty of Business Administration (FBA). In 2021, he was named the world's most prolific researcher in tourism/hospitality by the *International Journal of Contemporary Hospitality Management*. Prof Law's publications have been cited more than 54,000 times. The Alper-Doger Scientific Index recognised him as one of the most influential scholars worldwide in 2022. Prof Law says that smart tourism is developed upon the basis of smart cities, leveraging technologies to enhance the efficiency of urban tourism operations to meet the different needs of tourists.

The research team has launched several large-scale and longitudinal interdisciplinary projects. These projects include Advancing Tourist Destination Competitiveness via Leveraging User-Generated Data, by Prof Law and his overseas collaborators; A Custom Tour Itinerary Robot based on Deep Reinforcement Learning, by Faculty of Science and Technology (FST) Associate Professor Wong Seng Fat and FBA Associate Professor Amy So Siu Yan; and Using Smart Technology to Develop Medical Tourism in Macao, by Institute of Chinese Medical Sciences Professor Hu Yuanjia in collaboration with Faculty of Health Sciences Associate Professor Chan Ging and FBA Associate Professor Chen Xiaoyun. Through these projects, the scholars aim to explore the future of smart tourism in Macao from different perspectives.

苗莉教授

Prof Miao Li

Making the Industry More Competitive

Smart tourism is an important driving force that propels the transformation of Macao into a smart city. In this regard, UM's State Key Laboratory of Internet of Things for Smart City can provide technical support for smart tourism research. According to Prof Law, technologies that can enhance visitors' experiences before, during, and after their trips, such as cloud computing, the Internet of Things, and 5G, can all be considered as smart tourism technologies. 'However, no matter how much our technologies have evolved, the core value of tourism remains the same, says Prof Law. 'It is always about creating a wonderful and unforgettable travelling experience for visitors. Among all elements, shopping, food, accommodation, and transport are linked together as a whole, a visitor's experience will be affected if any of these elements falls below expectation.'

黃承發教授

Prof Wong Seng Fat

Using real-time data generated by users, Prof Law seeks to identify the itineraries and behaviours of visitors and to analyse their personal experiences to understand their needs. APAEM regularly organises seminars to share its academic results with industry and the government to exchange ideas on the latest developments. This enables industry stakeholders to identify room for improvement, which contributes to enhancing Macao's competitiveness as a tourist destination.

Training Professionals for Tourism Transformation

To promote smart tourism development, it is important to provide relevant training for university students. With a strong sense of responsibility to nurture tourism professionals for Macao, UM established the Department of Integrated Resort and Tourism Management (DRTM) in 2019 to respond to the demand for talent in integrated tourism in Macao, China, and beyond. The department is committed to equipping students with cutting-edge knowledge and skills in related disciplines, emphasising not only the integration of theory and practice, but also the development of a forward-thinking mindset, in order to train professionals that can meet the needs of tourism enterprises and the market.

The head of DRTM is Miao Li, University of Macau Development Foundation Professional Fellow, who taught at Purdue University and Oklahoma State University for over a decade before joining UM. She has extensive research experience in the field of dynamic interpersonal relationships and human-technology interaction in hospitality and travel experience. According to Prof Miao, to usher in the era of smart tourism, the department will draw on the strengths of academic disciplines at UM such as computer science and big data analytics for curriculum enhancement. For example, new topics such as the metaverse and 'Tourism+' will be added to existing programmes to enhance students' interdisciplinary knowledge and skills.

Prof Miao says that her department will revise programme curricula to keep up with future trends, adding that the acceleration of smart tourism development has led to a demand for personalised services and this will gradually change traditional tourist behaviour. She adds that the structure of human resources in Macao's tourism sector will change from 'labour-intensive' to 'experience-intensive' as the local economy enters a new phase, moving from a service-based economy with a focus on service quality to an experience-based economy with an emphasis on customer experience. This means that the local industry will take advantage of innovative ideas and digital technology to offer visitors something new every time they visit the city.

'We need to take our education of professionals to the next level by strengthening students' understanding of the environment and their ability to empathise with visitors, so that they can anticipate the needs of the visitors and offer customer services or products that can evoke positive emotions,' says Prof Miao.

Creating Distinctive Tourism Characteristics

The Smart Tourism Research Team leverages the strengths of UM as a comprehensive public university in areas such as smart city technology, arts, humanities, history, integrated tourism, and marketing to explore avenues for deepening 'Tourism+' interdisciplinary development and amplifying Macao's brand image as a tourist destination with distinctive characteristics. Prof Wong is leading his team in the Department of Electromechanical Engineering to develop a graph neural network for itinerary prediction in a mobile application based on deep reinforcement learning. After analysing the personal preferences and locations entered by visitors, the app can create a personalised itinerary within 2.7 seconds.

Moreover, Prof Wong has launched a project to create Virtual Reality (VR) smart architectural tours. The project aims to digitalise historical and culturally significant buildings in Macao through reality modelling to preserve them. As the preliminary result of the project, the UM Library is the first library in Macao to offer 360-degree VR tours. 'The VR system allows people to visit attractions that are difficult to reach, which may encourage them to visit the buildings in person. With the experience of digitalising the UM Library, we will apply our VR technology to historical buildings in Macao, including churches and temples, as they are the city's cultural heritage,' says Prof Wong.

澳大圖書館作為澳門首間提供360度虛擬實境導賞的圖書館。該導賞是智慧旅遊研究團隊VR建築智慧導賞項目的首個成果。

The UM Library is the first library in Macao to offer 360-degree VR tours. The project is the preliminary result of the Smart Tourism Research Team in VR smart architectural tours.

'We are planning to integrate the outcomes of the two research projects so that users of our app can explore historical buildings through VR tours and obtain information about distinctive shops in Macao. This will enable visitors who are not familiar with Macao to fully experience the city through smart itinerary planning. In the future, we will continue to leverage the university's smart city technologies to showcase the charm of Macao's world heritage,' Prof Wong adds.

Future Research Directions

Prof Law points out that APAEM will continue to act as a bridge between industry practitioners, faculty members, and researchers, helping the industry to explore market opportunities through cutting-edge research. The research team is currently studying successful cases of smart tourism around the world to gather their experience for the smart tourism development of Macao and other cities in the Greater Bay Area. 'While all the successful cases are worth studying, smart tourism development needs to be tailored with regard to the local context. For this reason, we should try to develop our own model based on the characteristics of Macao,' says Prof Law.

新課程培養大健康產業人才

New Programmes Nurture Health Industry Professionals

文 / 張愛華 · 圖 / 何杰平，部分由受訪者提供 · 英文翻譯 / 蘇恩霆
Text / Ella Cheong · Photo / Jack Ho, with some provided in the interviewees · English Translation / Anthony Sou

澳門特別行政區政府根據國家發展戰略，把握粵港澳大灣區和橫琴粵澳深度合作區的發展機遇，以中醫藥研發製造為切入點，大力發展大健康產業。順應國家、大灣區及澳門對大健康產業人才的需求，澳門大學已進一步完善相關學科建設，包括開辦全球公共衛生和醫藥管理等領域的學位課程，培養大健康產業所需的複合型人才。

教研力量支撐中醫藥產業發展

以中醫藥研發製造為切入點的大健康產業在澳門正蓄勢待發。澳大作為澳門特區一所國際化公立大學，20年前已為澳門產業發展培養優秀人才和儲備研究力量。

成立於2002年的中華醫藥研究院（以下簡稱研究院）致力於中醫藥創新研究和生物醫藥類碩博士教育，為澳門培養高端和國際化的中醫藥人才。2011年獲批成立的中藥質量研究國家重點實驗室（以下簡稱實驗室）聚焦中藥質量創新技術方法及中藥新藥研發關鍵技術研究，同時致力研究中醫藥質量國際標準，在推進中醫藥標準化和國際化方面取得可喜的成績。

研究院暨實驗室堅持「聚焦中藥質量研究、聚力澳門多元發展」，開展原創研究和加強成果轉化。學術方面，實驗室發表了SCI期刊論文超過3,000篇，總引用達6.8萬餘次，論文數量和質素逐年上升。實驗室融入人工智能、先進材料等技術，在藥物發現、藥物傳輸、質量標準、國際註冊等領域取得突破。成果轉化方面，實驗室與澳門中藥研發中心上下游聯動，開展創新藥物、經典名方、名優品種、快速檢測等10餘項產學合作項目。國際影響方面，立項和完成的20餘項中藥質量標準載入《美國藥典》《歐洲藥典》和《中國藥典》。實驗室主編的SCI期刊《Chinese Medicine》持續作為中醫藥領域的旗艦期刊。實驗室也獲澳門特區政府頒發2021年度專業功績勳章。

研究院位於澳大校園北面的科研大樓，與健康科學學院的實驗室共用一幢大樓。研究院院長、中醫藥及免疫學專家陳新教授表示，大學在科學技術發展基金支持下於2020年成立澳門中藥研發中心，並正籌備成立澳門中藥檢測中心，進一步完善中藥研發平台，推進中醫藥產學研一體化。研究院將全力配合政府的產業政策，力圖以中醫藥為突破口，促進大健康產業發展。「我們擁有國際化師資團隊，教研實力雄厚。經過20年耕耘培養了800多名碩士和博士畢業生，支持澳門和國家的中醫藥產業。不少畢業生在澳門、內地和其它地區的產業園、藥企、醫院、衛生部門擔任主管，有些畢業生還在橫琴深合區創立生物科技公司，推動大健康產業發展。」

配合大健康產業優化學科佈局

2021年9月《橫琴粵澳深度合作區建設總體方案》發佈，為中醫藥產業提供新機遇。《澳門特別行政區經濟和社會發展第二個五年規劃（2021-2025年）》也指出，澳門新的經濟增長在於以中醫藥研發製造為切入點的大健康、現代金融、高新技術、會展商貿和文化體育等產業。為進一步推動澳門中醫藥產業發展，澳門特區政府在2022年1月將衛生局原來轄下的藥物事務廳升格為藥物監督管理局，《中藥藥事活動及中成藥註冊法》同時生效。這一系列政策為大健康產業的發展注入強大動力。

根據澳門、大灣區和國家對大健康產業人才的需求，澳大近年持續優化學科專業建設，對學系進行調整和優化學科專業的佈局。2021年，澳大結合健康科學學院及中華醫藥研究院的教學資源設立了三個學系：生物醫學系、藥物科學系、公共衛生及醫藥管理學系，並且引入新課程和優化現有課程。澳大目前通過三個學系提供三個學士學位課程（生物醫學、生物信息學、藥物科學及科技）和四個碩士學位課程 （數據科學—精準醫學、中藥學、全球公共衛生、醫藥管理)。此外，澳大還開辦一個聚焦生物醫藥學的博士課程。

研究精神科臨床流行病學、精神科臨床醫學等課題的公共衛生及醫藥管理學系主任項玉濤教授表示，公共衛生是改善人群健康的科學，其核心科學部分包括預防、流行病學、監測、生物信息學、衛生醫藥管理和實驗室科學，「過去兩年多，全球很多高等院校都特別重視公共衛生專業，澳大也非常及時地成立了公共衛生及醫藥管理學系，並從危機管理的角度開設理學碩士學位（全球公共衛生）課程，旨在培訓具備全球公共衛生科學、公共衛生流行病學、統計分析、流行病和衛生政策管理以及相關風險管理知識的學生。」

畢業生投身醫療健康行業

澳大在2002年已開設以研究為導向的碩士學位（醫藥管理）課程，培養了一批優秀畢業生。

公共衛生及醫藥管理學系副主任胡元佳教授表示，畢業生有的在國家部委以堅實的理論為基礎，為國家的醫藥發展戰略貢獻良策；有的在本澳和內地政府部門

陳新教授
Prof Chen Xin

或醫院工作，並擔任重要主管職位，成為健康中國戰略實施的中流砥柱；有的在輝瑞、強生、葛蘭素史克、恒瑞醫藥、邁瑞醫療等海內外頂尖醫藥企業工作；有的在科睿唯安、艾昆緯等全球著名的數據庫及諮詢機構工作，部分已成業界翹楚。此外，有畢業生到海外讀博，其後在歐美一流大學及研究機構任職，在異國他鄉擔當著講好中國故事的使者。

2018年取得哲學碩士學位（醫藥管理）的張京璐畢業後跟合夥人創辦了多間生物醫藥科技公司，目前主力帶領在內地和美國的團隊開發高新技術產品。他說：「澳大的醫藥管理課程非常多元化和國際化，有系統地拓展學生分析問題的思路，使我學會在不同角度和立場思考問題。可以說，整個研究生階段為我目前開發醫療技術和管理研發團隊奠下關鍵的基礎。」

澳大將於2023/2024學年開辦理學碩士學位(醫藥管理)課程，培養醫藥管理專才，胡元佳教授說：「因應澳門和國家對大健康產業人才的需求，計劃開辦的理學碩士學位（醫藥管理）課程將以教學和實踐為導向，集中提高研究生的實踐能力，培養更能滿足中醫藥產業所需的人才。」

從全球醫藥管理角度提供培訓

醫藥管理是一門多學科領域，涉及使用醫學科學、管理、經濟學、社會學、法律和國際商業中的原理和理論來解決醫學領域的問題。新的理學碩士學位（醫藥管理）課程教學團隊成員之一、中華醫藥研究院助理教授吳靄琳本身是藥劑師，曾在澳門藥物監管部門工作多年，主要研究醫藥系統的最新發展和醫藥產品的監管。

吳靄琳教授2017年加入澳大，現任研究院的課程主任（國際事務）。她表示，以教學和實踐為導向的理學碩士學位（醫藥管理）課程立足本澳、面向區域及國際，並以全球視角為學生提供跨社會和藥事管理學、健康產業創新和社會醫學等學科的知識，「我們集中培養學生熟練運用有關藥學、醫學、社會學、技術創新、經濟學、法學、管理學等方面的理論、方法和技術，以培養能從事醫藥管理和推動政策可持續發展的複合型人才。我們的課程涉及中西醫藥管理領域，部分內容針對澳門情況，也有部分內容是從全球最新的醫藥管理發展視角出發，為畢業生創造更全面的有利條件，從而日後在澳門、全國以至全球拓展事業。」

理學碩士學位(醫藥管理)課程教學團隊（左起）：趙靜教授、歐陽德方教授、胡元佳教授、陳勁教授、項玉濤教授、卞鷹教授、吳靄琳教授、胡豪教授

The faculty team of the master's degree programme in Medicinal Administration. From left: Prof Zhao Jing, Prof Ouyang Defang, Prof Hu Yuanjia, Prof Chan Ging, Prof Xiang Yutao, Prof Bian Ying, Prof Ung Oi Lam, Prof Hu Hao

In line with the national development strategy, the Macao Special Administrative Region (SAR) government has laid out a plan to seize the opportunities brought by the Guangdong-Hong Kong-Macao Greater Bay Area and the Guangdong-Macao In-Depth Cooperation Zone in Hengqin and to develop the health industry with Chinese medicine research and development (R&D) and manufacturing as an entry point. In response to the demand for health industry professionals in Macao, the Greater Bay Area, and the entire country, the University of Macau (UM) has optimised its academic programmes and has launched degree programmes in areas such as global public health and medicinal administration with the goal of training interdisciplinary professionals for the industry.

Supporting the Chinese Medicine Industry through Education and Research

As an international public university in the Macao SAR, UM began to nurture outstanding professionals and accumulated research resources for the development of the Chinese medicine industry in Macao 20 years ago; this industry is poised to grow today.

Established in 2002, the Institute of Chinese Medical Sciences (ICMS) is dedicated to training high-calibre and globally oriented professionals in Chinese medicine for Macao through innovative Chinese medicine research as well as master's and doctoral degree programmes in the areas of biomedical sciences and medicinal science. Approved and established in 2011, the State Key Laboratory of Quality Research in Chinese Medicine (SKL-QRCM) focuses on the study of innovative technologies and methodologies in quality research in Chinese medicine as well as key technologies for the R&D of new Chinese medicines. The lab is also dedicated to research on international quality standards for Chinese medicine and has made impressive progress in pushing forward the standardisation and internationalisation of Chinese medicine.

ICMS and SKL-QRCM strive to conduct quality research in Chinese medicine, initiate research on original topics, and strengthen the transfer of research results to help promote economic diversification of Macao. In terms of academic performance, professors working in the laboratory have published over 3,000 articles in journals covered by the Science Citation Index (SCI), with a total of over 68,000 citations, and the quantity and quality of the papers have improved year on year. With the integration of technologies such as artificial intelligence and advanced materials, the laboratory has made breakthroughs in areas such as drug discovery, drug delivery, quality standardisation, and international registration. In terms of the transfer of research results, the laboratory and the Macao Centre for Research and Development in Chinese Medicine have joined hands at various stages to carry out more than ten industry-academia collaboration projects on innovative drugs, classic Chinese medicine recipes, famous varieties, and rapid testing. In terms of international influence, the laboratory has established quality standards for more than 20 Chinese medicinal plants for authoritative publications such as *United States Pharmacopeia*, *European Pharmacopoeia*, and *Chinese Pharmacopoeia*. *Chinese Medicine*, an SCI-indexed journal edited by SKL-QRCM staff, continues to be the flagship journal in the field of Chinese medicine. The laboratory was also awarded the Medal of Merit – Professionals by the Macao SAR government in 2021 for its achievements.

Located in the Research Building in the north of UM's campus, ICMS shares the same building with the laboratories of the Faculty of Health Sciences (FHS). According to Chen Xin, director of ICMS and an expert in Chinese medicine and immunology, UM established the Macao Centre for Research and Development in Chinese Medicine in 2020 with the support of the Science and Technology Development Fund, adding that it is in the process of establishing the Macao Centre for Testing of Chinese Medicine to further improve the R&D platform for Chinese medicine and promote the integration of industry, universities, and research institutes in Chinese medicine. ICMS is fully committed to supporting the Macao SAR government's industrial development policy and aims to use Chinese medicine as an entry point to promote the development of the health industry. 'We have an international faculty team with strong teaching and research capabilities. After 20 years of hard work, we have produced more than 800 master's and PhD degree graduates to support the development of the Chinese medicine industry in Macao and the entire country,' says Prof Chen. 'Many of the graduates have gone on to work as executives in industrial parks, pharmaceutical companies, hospitals, or health departments in Macao, mainland China, and other regions. Some of them have set up biotechnology companies in the cooperation zone in Hengqin to contribute to the development of the health industry.'

澳大新課程培養大健康產業人才
UM offers new programmes to nurture professionals for the health industry

Optimising Disciplinary Layout for the Health Industry

Released in September 2021, the Master Plan of the Development of the Guangdong-Macao In-depth Cooperation Zone in Hengqin has provided new opportunities to promote the development of the Chinese medicine industry. According to the Second Five-Year Plan for Economic and Social Development of the Macao SAR (2021-2025), Macao's future economic growth will come from the health industry, with Chinese medicine R&D and manufacturing as an entry point, as well as the industries of modern finance, high technology, exhibitions, trade, culture, and sports. To further promote the development of the Chinese medicine industry in Macao, the Macao SAR government upgraded the Health Bureau's former Department of Pharmaceutical Affairs to the Pharmaceutical Administration Bureau in January 2022, and a law governing pharmaceutical activities within the scope of traditional Chinese medicine and the registration of traditional Chinese medicines came into force at the same time. This series of policies has provided an impetus for the development of the health industry.

To respond to the demand for health industry professionals in Macao, the Greater Bay Area, and the entire country, UM has optimised its academic programmes and disciplinary layout in recent years. In 2021, the university combined the teaching resources of FHS and ICMS to create three departments, namely the Department of Biomedical Sciences, the Department of Pharmaceutical Sciences, and the Department of Public Health and Medicinal Administration. The university also introduced new academic programmes and enhanced existing programmes. Through the three departments, UM currently offers three bachelor's degree programmes, in biomedical sciences, bioinformatics, and pharmaceutical sciences and technology, and four master's degree programmes, in data science – precision medicine, Chinese medical science, global public health, and medicinal administration. In addition, UM offers a PhD programme in biomedical sciences.

Xiang Yutao, head of the Department of Public Health and Medicinal Administration, who is an active researcher in areas such as clinical psychiatric epidemiology and clinical psychiatry, says that public health is a science concerned with improving the health of populations, adding that the core scientific components of public health include prevention, epidemiology, surveillance, bioinformatics, health and medicinal administration, and laboratory science. 'Over the past two years or so, many universities around the world have placed a special emphasis on the development of public health programmes. UM also established the Department of Public Health and Medicinal Administration in a timely manner and launched the Master of Science in Global Public Health programme via the department from a crisis management perspective. The programme aims to equip students with knowledge of global public health, epidemiology based on public health, statistical analysis, epidemic disease, health policy management, and related risk management,' says Prof Xiang.

Graduates Pursue Careers in Medicine and Health Industries

In 2002, UM began to offer a research-oriented Master of Philosophy in Medicinal Administration programme, which has produced many outstanding graduates for the industry.

According to Hu Yuanjia, associate head of the Department of Public Health and Medicinal Administration, graduates of the programme are working in different sectors of society: Some are working in state-level departments or committees in China to help shape the national policy for pharmaceutical development; Some are working in supervisory positions in government departments or hospitals in Macao or mainland China to support the implementation of the Healthy China initiative; Some are working in top pharmaceutical companies in China or abroad, including Pfizer, Johnson & Johnson, GSK, Jiangsu Hengrui Medicine, and Mindray Medical International; Some are working in the world's leading analytics companies or consultancies such as Clarivate and IQVIA, and a few of them have become industry leaders. In addition, some of the graduates have gone on to pursue further studies abroad and work in leading universities and research institutes in Europe and the United States.

A graduate of the master's programme in 2018, Zhang Jinglu has co-founded several biomedical technology companies with his partners and is currently leading research teams in mainland China and the United States to develop high-tech products. 'The medicinal administration programme offered by UM is globally oriented and covers a wide range of topics. It aims to systematically enhance students' analytical skills and has taught me how to view problems from different perspectives. I can say that my postgraduate study has laid an important foundation for my current work in the development of medical technology and the management R&D teams,' says Zhang.

UM plans to launch a master of science programme in medicinal administration in the 2023/2024 academic year. 'In response to the demand of Macao and the entire country for healthy industry professionals, the Master of Science in Medicinal Administration programme will be course-based and practice-driven to enhance the practical skills of postgraduate students and cultivate professionals who can better meet the needs of the development of the Chinese medicine industry,' says Prof Hu.

Providing Medicinal Administration Training from a Global Perspective

Medicinal administration is a multidisciplinary field that incorporates principles and theories of medical science, management, economics, sociology, law, and international business to solve problems in the medical field. Ung Oi Lam, assistant professor in ICMS and a member of the faculty team for the Master of Science in Medicinal Administration programme, is a pharmacist who worked for many years in a pharmaceutical regulatory unit in Macao to study the latest developments of pharmaceutical systems and the regulation of pharmaceutical products.

Prof Ung joined UM in 2017 and is currently the programme director (global affairs) of ICMS. She says that while placing a focus on Macao, the master's programme is also regionally and globally oriented, as it aims to provide knowledge across disciplines such as social and administrative pharmacy, health industry innovation, and social medicine for students from a global perspective. 'We focus on nurturing students who are skilled in the application of theories, methods, and techniques related to pharmacy, medicine, sociology, technological innovation, economics, law, and management, with a view to producing medicinal administration professionals who can promote the sustainable development of related policies,' says Prof Ung. 'Our programme covers both Chinese and western medicinal administration. Some of the courses are specifically tailored to the context of Macao, while some other courses aim to provide training based on the latest global trends in medicinal administration, so that graduates will be better equipped to pursue career development in Macao, in mainland China, or even in other parts of the world.'

張京璐
Zhang Jinglu

楊斌：
從海貝探究鮮為人知的全球史

Yang Bin: Exploring Little-Known Global History through Cowrie Shells

文/盛惠怡、資深校園記者古詠軒、資深校園記者任凝．圖/何杰平，部分由受訪者提供

Chinese & English / Debby Seng, Senior UM Reporter Ku Weng Hin, Senior UM Reporter Connie Ren · Photo / Jack Ho, with some provided by the interviewee

海貝在一般人眼中，只是海生螺類的堅硬保護外層，但在楊斌教授這位歷史學家的眼中，這小小的一顆毫不起眼的海貝，卻可窺視出一段鮮為人知的全球史。

三千年歷史的海貝

澳門大學歷史系主任楊斌教授的辦公室，擺放著從各地購買或搜集的歷史珍品，當中有殷商時期的青銅貝和不同年代的瓷器和書畫等。在他眾多的藏品中，最不顯眼的應是那幾顆散在青花瓷盤子裡的海貝，但它們卻是所有藏品中年代最久遠——足足有三千年歷史。

訪問一開始，楊教授向記者展示了他書桌上這些珍珠白色、大小幾乎一樣的海貝。每個海貝的表面上都有一條長長的齒槽，背面稍微突起。「我研究這些海貝足足18年了，這些全都是來自數千年前的古物，十分珍貴，在古代貿易市場佔舉足輕重的地位，對全球貿易也有著重要的意義。」

楊教授在其2021年出版的中文版著作《海貝與貝幣：鮮為人知的全球史》從全球史的角度探討貝幣的起源、演變、價值等，溝通中國史跟世界史，探索既有地方特色又有全球性的貝幣世界，為讀者描繪了一幅浩瀚的貨幣史畫卷。

該書分析了從新石器時期到20世紀中期在印度、東南亞、先秦中國、古代雲南、西非、太平洋諸島和北美長期存在使用的海貝和貝幣，試圖打通中國史和世界史，對於經濟史、貨幣史、海洋史和全球史均有相當的突破，獲得社科文獻出版社的「2021年度十大好書」、《中華讀書報》的「2021年度不容錯過的20種歷史好書」、《新京報》的「2021年度閱讀推薦」及國家圖書館第17屆文津圖書獎的「推薦圖書」。楊教授說：「在250多種海貝當中，只有俗名『貝齒』的貨貝以及少量的環紋貨貝被選中作為貨幣，因為海貝成年後大小都一樣，長約1.5厘米至2厘米，寬約0.8厘米，就像在流水線上生產出來，這是它在印度和西非成為貨幣的主因。而且海貝只重約1克，非常輕巧和易攜，堅硬不易腐蝕，在交易中可稱、可量、可數，是成為小額交易媒介的不二選擇。」

一顆海貝連繫中外

楊教授來自浙江，上世紀90年代於中國人民大學攻讀本科及碩士學位，2004年在美國波士頓東北大學完成博士學位。先後在中國人民大學和新加坡國立大學任教，2017年加入澳大，2021年7月出任歷史系主任。他醉心中國史、全球史、海洋史和科技醫療史的研究，是西冷印社社員，亦是澳大唯一一名該社社員。

楊教授是最早提倡並實踐從邊疆看中國的學者之一，他在攻讀博士學位期間已開始將研究的目光投向雲南，更決定把雲南歷史作為其博士論文的研究課題。在雲南進行田野調查期間，他更了解到貝幣在古代已經在內陸雲南使用，回美後即告訴導師這個發現，「我的導師也跟我說起西非貝幣的歷史，引起了我對貝幣的興趣。之後就開始深入研究，後

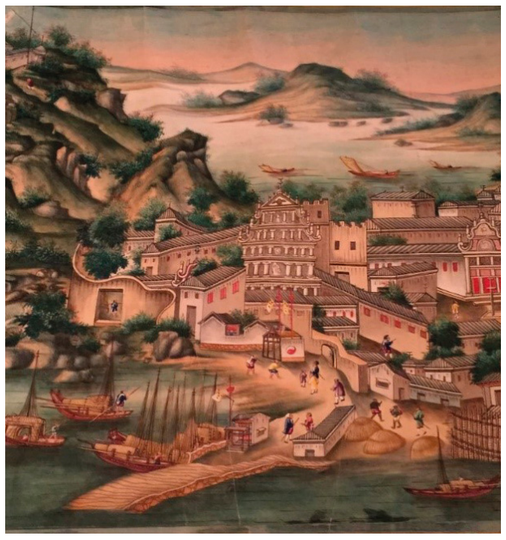
楊斌教授的著作《海貝與貝幣：鮮為人知的全球史》
Cowrie Shells and Cowrie Money: A Global History by Prof Yang Bin

連繫中外歷史的海貝
Cowrie shells that connect Chinese history with world history

來還寫了三篇關於雲南、殷墟以及整個亞洲海貝興衰的論文，本以為我的觀點全都寫在文章裡了，但後來我又有很多新發現，於是又撰寫了《海貝與貝幣：鮮為人知的全球史》一書加以詳述。」

目前學術界大多把中國史與世界史分開來研究，楊教授希望透過他的書，把中國史跟世界史兩個學科互相融通，「中國是在世界之中，而不是在世界之外。」他的著作從馬爾代夫開始應用貝幣寫起，按時間順序描述海貝作為貝幣在不同地區的應用，他同時儘量強調貝幣跨地區的聯繫、發展和脈絡，配以各地有關貝幣的考古紀錄、人物遊記、法典等，用地方材料講述全球故事。

楊教授還在著作中提出了和很多學者不一樣的觀點，是其著作的一大亮點。「中國學術界很多學者認為，海貝是中國最早的貨幣，是最早使用海貝作為貨幣的國家。但我指出了海貝在古代的中國並非貨幣，只是『貨幣候選物』。『貨幣候選物』是指可能成為貨幣的東西，包括最終可能沒有成為貨幣的東西。過去人們分不清貴重物品和貨幣之間的關係，認為貨幣就等於財富和有價值的東西。海貝來自遙遠的印度洋，運輸不便，供應也不穩，所以它在古代中國沒有成為貨幣。」他還以珍貴的鑽石比喻為古時的海貝，「雖然可以用鑽石換取貨幣，但人們不用鑽石消費，所以海貝和鑽石一樣都不是貨幣。」



清代澳門山水長卷，收藏於新加坡國立大學博物館。

A landscape scroll of Macao from the Qing dynasty in the National University of Singapore Museum

與澳門的歷史因緣

2017年春，身處新加坡的楊教授正在撰寫一本講述國學大師饒宗頤教授在新加坡大學任教經歷的書，他搜集資料期間，偶然在新加坡國立大學博物館李光前藏品館看到了正展出一幅長318厘米，寬30厘米的清代澳門山水長卷。此卷未曾被收錄於有關澳門地圖或繪畫的任何著錄，為楊教授首次發現，是目前發現關於澳門地貌、風光和民居的最大型中國山水畫和地誌畫。

楊教授在這之前從未研究過澳門歷史，但他當時即將到澳大任教，意外發現了這幅畫，也許正是他要跟澳門開始一段歷史因緣的契機。

「這幅山水長卷的顏色豔麗，氣魄宏大，我想研究它到底畫了甚麼。」楊教授到澳門後這幾年來，陸續走遍了澳門每座山和街道，大致確認了圖上所畫的澳門地形。他結合同時代的文獻，對其主題、內容和特點加以比較分析。此長卷是受到西洋畫法影響的中國畫家所作的傳統山水長卷，時間約為乾隆早期或中期（18世紀中期），是目前發現最大的一幅澳門地誌畫，也是中國視野下以澳門為主題的一幅最早最大的中國傳統山水畫，生動展現了清代主權和治權下澳門華洋交錯安居樂業的「盛治」。楊教授將這發現寫成文章〈「百里江山」——新發現的一幅新加坡藏澳門山水長卷初探〉，刊登於澳門文化局主辦、澳大澳門研究中心編輯的《文化雜誌》。他說：「在研究長卷時，我受到啟發，正準備撰寫一本專著，探討18世紀不同視野下的澳門形象。」

研究歷史自得其樂

在重述整個學習和研究歷史的過程裡，楊教授形容自己年少時開始學歷史純粹是因緣際會。後來遠赴海外升學，既是時代所向，也是志向所趨，「研究歷史是一件很自得其樂的事，即使我從事學術研究這麼多年，今時今日每當我找到一些文獻能證明到自己的觀點，仍會十分興奮。自娛自樂是人生的最高境界，也是我研究歷史的動力。」

楊斌教授的辦公室放滿他的珍藏

Prof Yang Bin and his many collectables in his office

To ordinary people, a cowrie shell is merely the hard protective outer layer of a marine mollusc. But in the eyes of historian Yang Bin, this small, unassuming sea shell can provide a glimpse into a piece of global history that not many people know of.

3,000-Year-Old Cowrie Shells

Yang Bin is head of the Department of History of the University of Macau (UM). In his office, one can find antiques that he has collected from around the world. They include bronze cowries from the Shang dynasty and porcelain, calligraphy works, and paintings from different eras. Among these collectables, the cowrie shells displayed on a celadon plate are the most inconspicuous, but also the oldest — they are 3,000 years old.

At the beginning of the interview, Prof Yang handed us the cowrie shells so that we could observe them closely. Pearl white in colour and of similar size, the shells have a long 'teeth mark' on the surface and are slightly convex on the back. 'I have been studying these cowrie shells for 18 years. These shells are valuable antiques from thousands of years ago. They played a critical role in the ancient trade market and were of significant value to global trade,' says Prof Yang.

In his book *Cowrie Shells and Cowrie Money: A Global History*, published in 2021, Prof Yang explores the origins, evolution, and values of cowrie money from the perspective of global history. By bridging the gap between Chinese history and world history, Prof Yang paints a vast picture of monetary history with both local and global characteristics.

The book analyses cowrie shells and cowrie/shell money used in India, Southeast Asia, pre-Qin China, ancient Yunnan, west Africa, the Pacific islands, and North America from the Neolithic period to the mid-20th century. The book makes breakthroughs in economic history, monetary history, maritime history, and world history, and was ranked among the 'Top Ten Books of 2021' by Social Sciences Academic Press (China), the 'Top 20 History Books of 2021' by *China Reading Weekly*, the 'Recommended Books of 2021' by *The Beijing News*, and 'Recommended Books' by the 17th Wenjin Book Award of the National Library of China.

楊斌教授以「印度洋來的『寶貝』」為題演講，介紹海貝和貝幣的歷史。
Prof Yang Bin gives a talk titled '"Treasured Shells" from the Indian Ocean: Cowries in Early China'

'Of the more than 250 species of cowries, only Monetaria moneta, commonly known as "money cowry", and a small number of Monetaria annulus, commonly known as "ring cowrie", were selected to be cowrie money,' says Prof Yang. 'When the cowries are fully grown, their shells are of similar size, about 1.5 to 2 cm in length and 0.8 cm in width, as if they are manufactured in assembly lines, which is also the main reason why they became currency in India and West Africa. Moreover, weighing only about 1 gram each, the cowrie shells are light, portable, and difficult to break. They can be easily weighed, measured, and counted, making them an excellent choice as a medium of exchange for small transactions.'

A Sea Shell Linking Chinese History and World History

Born in Zhejiang province, Prof Yang completed his bachelor's and master's degrees at the Renmin University of China in the 1990s and his PhD at Northeastern University in Boston in 2004. He taught at the Renmin University of China and the National University of Singapore before joining UM in 2017, and he became the head of the Department of History in July 2021. Prof Yang is passionate about the study of Chinese history, global history, maritime history, and the history of science and medicine. He is also the only member of the Xiling Seal Art Society at UM.

As one of the first scholars to advocate studying China from its border areas, Prof Yang began to study the history of Yunnan province during his doctoral studies, and chose it as the topic of his doctoral thesis. During his fieldwork in Yunnan, Prof Yang learned about the use of cowrie money in inland Yunnan in ancient times. He then told his supervisor about his findings upon returning to the United States. 'My supervisor mentioned to me the history of cowrie money in West Africa and it provoked my interest in studying cowrie money. Later, I began to conduct in-depth studies on this topic and wrote three articles about the rise and fall of cowrie money in Yunnan, Yinxu, and Asia, respectively,' says Prof Yang. 'I thought I had put all my points in the articles, but then I made so many new discoveries that I wrote another book, *Cowrie Shells and Cowrie Money: A Global History*, to analyse them in detail.'

While most scholars separate Chinese history from world history, Prof Yang hopes to provide a link between the two disciplines: 'China is within the world, not outside of it,' he says. Prof Yang's book begins with the first use of cowrie shells as currency in the Maldives before chronologically analysing the circulation of cowrie money in different regions. Supported by archaeological records, travelogues, and codices from around the world, the book highlights the inter-regional connections, developments, and contexts of cowry money in order to tell a global story from local perspectives.

In addition, Prof Yang presents a different perspective from that of many scholars in his book, which he considers one of the highlights. 'While many scholars in academia in China consider cowrie shells as the earliest money in China and China as the first country to use cowrie shells as currency, I point out that cowrie shells were only a "money candidate" in ancient China, but not a currency. "Money candidate" refers to items with the potential to be used as currency, including items that did not really become currency,' says Prof Yang. 'Previously, people did not distinguish between valuables and currency, thinking currency was equivalent to wealth and something of value. Cowrie shells came from the remote Indian Ocean, so they were difficult to transport and the supply was unstable. For this reason, they did not become currency in ancient China.' He also compares cowrie shells in ancient China to diamonds: 'Although diamonds can be exchanged for money, people did not use them for consumption. In the same sense, cowrie shells did not become currency in ancient China.'

Historical Encounter with Macao

In spring of 2017, Prof Yang was in Singapore, writing a book about the sinology master Prof Jao Tsung-I's experiences as a faculty member at the University of Singapore. During the data collection process, he came across a 318 cm long, 30 cm wide landscape scroll of Macao from the Qing dynasty on display as part of the Lee Kong Chian Collection in the National University of Singapore Museum. Prof Yang identified the scroll, which was not included in any Macao map collections or paintings. It is the largest existing Chinese landscape painting of the topography, scenery, and dwellings of Macao.

At that time, Prof Yang had never studied the history of Macao. The fateful encounter with the painting occurred just before he began working at UM, which presented him a unique opportunity to form a relationship with Macao. 'I was determined to study what was painted in this landscape scroll with bright colours and grandeur,' says Prof Yang, who has walked almost every hill and street in Macao in the years since his arrival, generally confirming the topography of Macao as drawn on the map. Taking into consideration the literature from the same period and having conducted a comparative analysis of the painting's subject matter, content, and characteristics, Prof Yang has concluded that this traditional landscape scroll was painted by a Chinese artist influenced by Western painting methods and dated the painting to around the early or mid-Qianlong period (mid-18th century). In addition to being the largest known topographical painting of Macao, the landscape scroll is also the largest and the earliest traditional Chinese landscape painting of Macao from a Chinese perspective, which vividly depicts the well-being of both Chinese and foreigners in Macao living in a 'golden age' under the sovereignty and governance of the Qing dynasty. Prof Yang later presented this discovery in his article titled '"A Hundred Miles of Rivers and Mountains" — A First Look at a Newly Discovered Macao Landscape Scroll from Singapore.' The article was published in the Chinese edition of *Review of Culture*, a journal produced by the Cultural Affairs Bureau of Macao and edited by UM's Centre for Macau Studies. 'Inspired by the landscape scroll, I am going to write a book about Macao's image in the 18th century from various perspectives,' he says.

Finding Pleasure in History Research

Recounting his experiences of learning and researching history, Prof Yang says that it was purely by chance that he started to study history when he was young and he went overseas to pursue further studies both because of the times and because of his aspirations. 'I find it a pleasure to conduct research in history. Even after all these years, I still get very excited when I find pieces of evidence that can prove my point of view,' says Prof Yang. 'I believe the ultimate goal of life is to enjoy oneself, and this is what drives me to do research in history.'

Rostam J. Neuwirth：AI時代的法律挑戰

Rostam J. Neuwirth: Legal Challenges in the Era of Artificial Intelligence

文/余偉業、實習生宋祉慧．圖/何杰平、校園記者楊海彤．英文翻譯 / 蘇恩霆
Text / Kelvin U, Intern Chloe Sung．Photo / Jack Ho, UM Reporter Rainny Yang．English Translation / Anthony Sou

澳門大學環球法律學系主任Rostam J. Neuwirth教授研究當代全球治理議題，專注探索法律與科技和語言的關係。他的新著剖釋了AI時代帶來的挑戰，起了拋磚引玉的效果，引發跨學科、跨地域的辯證。

填補AI法律空隙

「當某天Siri能完全按我們人類的方式從情感、智力和精神層面去體驗世界、與我們互動，甚至影響我們的行為時，法律上該如何監管？」這是Rostam J. Neuwirth教授多年潛心鑽研的問題。

人工智能（Artificial Intelligence，簡稱AI）技術發展迅速，早已超越時空界限，既可為善，亦可為惡，對監管機關帶來前所未有的挑戰。Neuwirth教授表示，我們即將走進AI無所不在的未來，任何人都能輕易使用AI，但目前監管AI的法律還是圍繞數據庫、個人資料保護、自動駕駛、算法交易等方面的規定，並非專門就AI對社會帶來的整體影響而起草，因此法律需要與時俱進，適應時代的變革。

歐盟委員會2021年5月提出《人工智能法案》（AI Act），是全球首個AI法律框架，規管企業和政府如何使用人工智能技術。Neuwirth教授隨即對此長達108頁的法案進行剖析，「制訂AI法案就如燙手山芋，牽涉很多深層次、法律以外的問題，例如人類認知、科學倫理等。」他指法案也將對AI產業及市場發展影響深遠。

有見及此，專注當代全球法律研究近30年的Neuwirth教授決心在法案通過前，以法律觀點分析AI應用場景的潛在風險，並把研究成果出版成書，以引起國際學術界討論。他在短短一年內完成學術專著《歐盟人工智能法案：監管潛意識人工智能系統》，2022年8月獲英國著名國際出版社Routledge出版。該專著拋磚引玉式地引起專家學者、政策制訂者、業界和公民開展一場跨學科、跨地域的辯證。

思考如何監管AI

Neuwirth教授的學術專著主要思考如何監管，甚至禁止使用控制潛意識的AI技術，這也是歐盟《AI法案》的關鍵議題之一。他指出，AI目前與腦機接口、功能磁共振成像、機器人與大數據等各項技術深度融合，已被允許通過間諜軟件進行「讀心」和「造夢工程」或透過低於感覺閾限的外界刺激，不知不覺操控人們的思想，從而干預行為。「未來的AI應用場景包羅萬象，我們要提防思想和行為被操縱，設置法律防線。」

制定AI法律框架還涉及計算機科學、神經系統科學、社會學、政治學、市場營銷和心理學等領域。Neuwirth教授撰寫學術專著期間，透過澳大人文社科高等研究院的跨學科平台與校內不同領域的專家對話，集思廣益。「我有幸在這裡從同事身上瞭解到其它領域對AI的觀點。規範AI應用領域的開發和使用無法單打獨鬥，畢竟大家都坐在同一條船上。」

挑戰法律二元論

人工智能這一概念，恰好是Neuwirth教授於其另一部學術專著《矛盾修辭時代的法律：語言、邏輯和法律之間的通感》（Routledge出版）描述的「矛盾修辭」（Oxymoron）的例子，即機器應否被視定為擁有人類智慧，這是一個邏輯自相矛盾的表述。Neuwirth教授指出，從孫子兵法的「置之死地而後生」到莎士比亞的「尊貴的惡棍」，矛盾修辭是日常話語的組成部分，「然而，我們甚少察覺這些廣泛使用的修辭方式是如何潛移默化地影響我們的思想。」

據Neuwirth教授的觀察，由矛盾命題組成的概念不斷繁衍，如從「發展」到「可持續發展」，即「變」與「不變」之概念同時存在。在法律領域，矛盾修辭案件（如以「真假貨Real fakes」來形容原廠夜間生產的假冒品）難以通過法律推理來明晰對立術語或概念之間的界限，因此需要尋找更適當的語言來交流資訊，使律師、其他行業人員及普羅大眾有更一致的認知，「從認知語言學上，倘若兩個相反或對立的命題能夠結合，並與現實匹配，法律就必須適應這種狀況。」他的觀點挑戰了法律傳統的二元論思想，即人們對正義與非正義、合法與非法、正確和錯誤的感知。

除了在法學、語言學上見解獨到，Neuwirth教授還對世貿組織和區域貿易法、跨國法、金磚國家

《歐盟人工智能法案：監管潛意識人工智能系統》
The EU Artificial Intelligence Act: Regulating Subliminal AI Systems

Rostam J. Neuwirth教授與學生交流
Prof Rostam J. Neuwirth exchanges ideas with students

商法、創意經濟中的知識產權法、全球正義與創意經濟、歐盟貿易法等深有研究，至今出版了3部專著、3部合編書籍和37篇書籍章節，以及發表了44篇學術文章，由《國際經濟法雜誌》《國際法律符號學雜誌》《歐洲發展研究雜誌》《國際文化政策雜誌》等具國際影響力的學術期刊刊登。

法律視野放眼世界

Neuwirth教授早於20年前在意大利歐洲大學學院攻讀博士時開始思考矛盾修飾的概念。當時他從文化產業層面探討國際貿易法的監管挑戰。成長於奧地利的Neuwirth教授自幼受當地深厚的創作文化薰陶，認為文化是精神上的滿足，產業則是物質上的追求，兩者維度不一卻被綑綁一起，這挑戰了法律在傳統上把文化與經濟視為兩個獨立領域的邏輯，這種情況在涉及國際貿易法規時尤其明顯。

Neuwirth教授在奧地利格拉茨大學求學時的法律視野已經放眼世界。他在大學本科期間到法國奧弗涅大學留學，擴寬視野，為學習環球法律奠下基礎。其後負笈加拿大蒙特利爾麥基爾大學攻讀法學碩士，鑽研當地的國際案例，其中美國訴加拿大期刊進口措施案（Canada Periodicals Case）成為他博士論文的研究案例。

學有所成後，他返回奧地利，擔任該國外交部國際法局歐洲法處的法律顧問，其後前往印度，先後於西孟加拉邦國立法學大學（NUJS）和希達亞圖拉國立法律大學（HNLU）執教，並藉此探索印度文化。2007年，Neuwirth教授加入澳大法學院，主要負責研究生課程，兼教授本科生通識課程。他經常與來自美國、法國、德國、古巴、莫桑比克、佛得角、菲律賓、中國內地和澳門等地的學生分享其成長經歷和國際觀。

「我欣賞澳大多元文化的學習環境。這裡的學生勤奮有禮、充滿好奇心、思想開放，塑造了良好的學術氛圍。」身為環球法律學系主任，Neuwirth教授強調思維格局決定學術高度，「我們要放眼世界，研究國際關注的當代法律議題。在全球化格局下，國與國之間的經濟、文化、生態等相互依存，思考問題時更需從環球視野出發。」

培育法律專才

周遊列國大半生的Neuwirth教授在澳門定居15年後在這裡組織家庭，育有兩名子女。這些年來，Neuwirth教授一直經歷和見證著澳大和澳門的發展。

Neuwirth教授表示，澳門法律制度獨特，擁有優良的基因，在「一國兩制」框架下運作和發展，澳門作為一個特區既能參與世貿組織，亦可融入橫琴粵澳深度合作區和粵港澳大灣區的發展，「澳門的主要挑戰是法律框架的一致性和政策的連貫性，法律領域的教育工作者亦需要適應這種變化。」

Neuwirth教授認為，環球法律學系的內涵兼容並蓄：即在對待全球治理的問題時要多角度前瞻思考，在「矛盾修辭」無處不在的時代下，事物大都具有多面性，因此需要透過比較研究和跨學科方法，以包容方式理解和處理不同法律學科之間，乃至中國、區域和全球法律之間動態關係的變化，從而培育能貫徹法治精神、充分理解當地需求的法律專才，應對當前與未來的挑戰。

如今是迅速向前發展的時代，隨著中國的國際地位不斷提升，Neuwirth教授相信：「法律界的前景將會更加寬廣，中國正需要一群熟悉全球環境的法律人才，我們培育的畢業生正好滿足需求。」

Rostam J. Neuwirth, head of the Department of Global Legal Studies at the University of Macau (UM), is a legal scholar who engages in research on a variety of contemporary global governance issues focusing on the various links between law, language, and technology. In his most recent book, he sheds light on the challenges posed by the era of artificial intelligence (AI) in an effort to stimulate a transdisciplinary and transnational debate among readers.

Filling the Gap of AI Regulation

If Siri is one day able to perceive the world the way humans do on an emotional, intellectual, and spiritual level, and develops the capacity to influence our behaviour through interactions, how should the AI technology be regulated? Prof Neuwirth has studied this issue in recent years.

AI technology has developed rapidly in recent years. Transcending the boundaries of time and space, the technology can be used for both good and evil purposes and therefore poses an unprecedented challenge to regulators. According to Prof Neuwirth, while we will soon enter a future in which AI is everywhere and easy enough to use, the current laws governing AI were drafted to address more specific issues such as databases, personal data protection, autonomous driving, and algorithmic trading and are not adequate to cover the overall impact of AI on society as a whole. Therefore, in order to regulate AI, future legislation must keep up with the times and adapt to the changes.

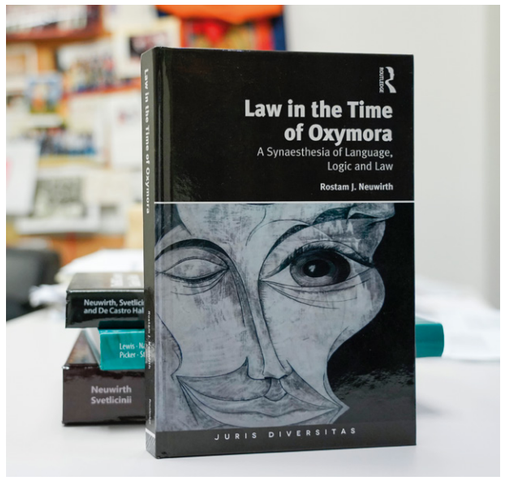
In May 2021, the European Commission proposed the AI Act, which introduced the world's first legal framework for AI to regulate the use of smart technologies by businesses and governments. Prof Neuwirth spared no time in studying the 108-page-long regulation, knowing it would have a significant influence on the AI industry and related market development. 'The formulation of the AI Act is a very complicated process as it involves many deep issues beyond the law, such as human cognition and ethical issues in science,' says Prof Neuwirth.

With over 30 years of experience in contemporary global legal research, Prof Neuwirth was determined to analyse the potential risks of AI applications from a legal perspective before the law was passed. Hoping to influence international academia, he compiled his findings in the monograph *The EU Artificial Intelligence Act: Regulating Subliminal AI Systems* in just one year. Published by Routledge, an internationally renowned British company, the book aims to stimulate a transdisciplinary and transnational debate between students, academics, practitioners, policymakers, and citizens.

How to Regulate AI

In his book, Prof Neuwirth focuses on how to regulate and prohibit the use of AI systems that deploy subliminal techniques. This is also one of the key topics proposed in the AI Act of the European Commission. According to Prof Neuwirth, the convergence of AI with various related technologies,

Rostam J. Neuwirth教授多門法律課程
Prof Rostam J. Neuwirth teaches various courses in law



《矛盾修辭時代的法律：語言、邏輯和法律之間的通感》
Law in the Time of Oxymora: A Synaesthesia in Language, Logic and Law

such as brain–computer interfaces, functional magnetic resonance imaging, robotics, and big data, allows for 'mind reading' or 'dream hacking' through brain spyware, while external stimuli received below the threshold of awareness can secretly manipulate the human mind and alter human behaviour. 'AI will be used in many different scenarios in the future. We must guard against the possibility of the manipulation of thought and behaviour through legal means,' says Prof Neuwirth.

The formulation of a legal framework for AI also involves disciplines such as computer science, neuroscience, sociology, political science, marketing, and psychology. In the process of writing his book, Prof Neuwirth took advantage of the interdisciplinary platform provided by UM's Institute of Advanced Studies in Humanities and Social Sciences to exchange ideas with experts from different disciplines at the university. 'I was lucky to be able to learn about the different perspectives of my colleagues towards AI through the institute. One person cannot really cover all the challenges facing the regulation of AI development and application. We are all in the same boat,' says Prof Neuwirth.

Challenging Dualism in Law

AI is an oxymoron or a 'contradiction in terms' as described by Prof Neuwirth in his 2018 book *Law in the Time of Oxymora: A Synaesthesia in Language, Logic and Law* (published by Routledge), since there remain serious doubts whether machines can be considered 'intelligent'. Other examples of oxymora include 'Death brings life' from The Art of War and 'honourable villain' from Shakespeare's Romeo and Juliet. Prof Neuwirth points out that oxymora are an integral part of everyday discourse, but people are rarely aware of the subtle influence that these widely used forms of rhetoric may have on their thinking.

From Prof Neuwirth's observation, there have been a growing number of concepts consisting of such opposite propositions, such as the way that 'sustainable development' denotes change and not-change at the same time. In the legal field, the boundaries between opposing terms or concepts are difficult to clarify through legal reasoning in cases involving oxymora (e.g. the use of the term 'real fakes' to describe counterfeit products produced during night shifts in the original factories). Therefore, there is a need to find a more appropriate language for communication, which will help to create common understanding between lawyers and members of other professions as well as citizens in general. 'From the perspective of cognitive linguistics, if two opposite propositions can be combined into a concept that is matched in reality, the law must adapt to the situation,' says Prof Neuwirth. This view challenges the legal tradition of dualism, or the way people perceive the difference between justice and injustice, lawful and unlawful, and right and wrong.

In addition to insight into law and linguistics, Prof Neuwirth has a wealth of knowledge about legal topics such as the World Trade Organization (WTO) and regional trade law, transnational law, business law in the BRICS countries, intellectual property law and the creative economy, global justice and the creative economy, and European Union trade law. He has published three monographs, three co-edited books, 37 book chapters, as well as 44 academic articles in internationally influential journals such as the *Journal of International Economic Law*, the *International Journal for the Semiotics of Law*, the *European Journal of Development Research*, and the *International Journal of Cultural Policy*.

Studying Law from a Global Perspective

Prof Neuwirth became interested in oxymora 20 years ago when he was still a PhD student at the European University Institute in Italy. At that time, he explored the regulatory challenges facing international trade law in the context of the cultural industries. Growing up in Austria, Prof Neuwirth was nurtured by the region's rich creative culture. In his opinion, while culture is a spiritual fulfillment and industry is a material pursuit, the two things can be bundled together into the 'cultural industry', which challenges the logic of the legal tradition that treats culture and the economy as two separate domains, especially when it comes to the regulation of international trade.

Prof Neuwirth understood law as a global science when he was an undergraduate student at the University of Graz in Austria. During this period, he also studied at the University of Auvergne in France to broaden his horizons, which laid the foundation for his future global legal studies. After graduation, he went on to study for a master's degree in law at McGill University in Montreal, Canada, where he researched international cases in the country, including the Canada Periodicals Case, which he used as an example in his doctoral thesis.

After completing his studies, Prof Neuwirth returned to Austria and worked as a legal adviser in the Department of European Law of the International Law Bureau of the Austrian Federal Ministry for Foreign Affairs. He later moved to India to teach at the West Bengal National University of Juridical Sciences in Kolkata and the Hidayatullah National Law University in Raipur, where he also explored Indian culture. He joined UM's Faculty of Law (FLL) in 2007, and is currently responsible for postgraduate studies as well as general education for undergraduate students. He regularly shares his experiences and international perspective with students from different countries and regions, including the United States, France, Germany, Cuba, Mozambique, Cape Verde, the Philippines, mainland China, and Macao.

'I appreciate the multicultural environment here at UM. The students are usually very hardworking and polite. They are also curious and open-minded and this helps to create a good learning atmosphere,' says Prof Neuwirth. He believes that broadening perspectives is the key to academic excellence. 'We need to broaden our horizons and study contemporary legal issues of international concern. In the context of globalisation where countries are interdependent on one another economically, culturally, and ecologically, it is even more important to look at issues from a global perspective,' he says.

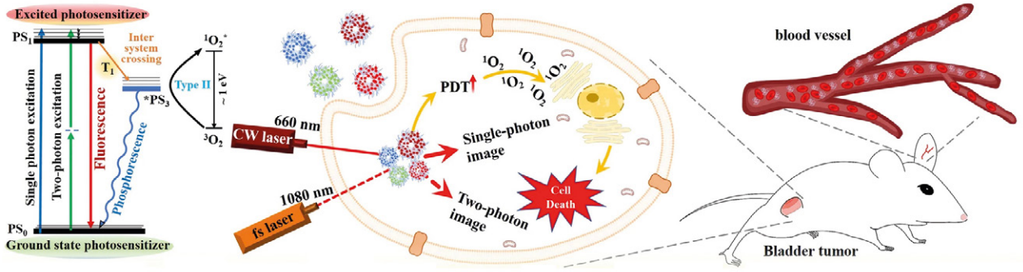
Nurturing Legal Professionals

Prof Neuwirth travelled around the world for most of his life, and he chose to start a family in Macao after living here for 15 years. He is now the father of two children. Over the years, Prof Neuwirth has witnessed the growth of the university and Macao in leaps and bounds.

Prof Neuwirth says that Macao is unique from a legal perspective because its legal system has been influenced by different legal families. Operating and developing under the 'One Country, Two Systems' framework, Macao, due its status as a special administrative region, can participate in the WTO and at the same time join the development of the Guangdong-Macao In-depth Cooperation Zone in Hengqin and the Guangdong-Hong Kong-Macao Greater Bay Area. 'It is necessary for Macao to develop a consistent legal framework and a coherent policy to avoid contradictions, which is a major challenge facing all legal systems in the present era. I think legal educators in particular have to adapt to this changing environment,' says Prof Neuwirth.

As head of the Department of Global Legal Studies, Prof Neuwirth stresses that the essence of global legal studies is inclusivity, which means to think ahead from multiple perspectives when dealing with issues of global governance. In the time of oxymora, many things are often multifaceted, and there is a need to adopt comparative and interdisciplinary methodologies to understand and deal with dynamic changes between different legal disciplines. This is especially true of the changes between domestic, regional and global law, so as to nurture legal professionals who can uphold the spirit of the rule of law and understand local needs to meet the challenges of the future.

In these rapidly evolving times, and with China's rising international status, Prof Neuwirth believes that the legal profession will become even more important and law graduates of UM will be able to meet China's demand for legal professionals who are familiar with the global aspects of law.



PSMA納米粒子可用於摧殘實體腫瘤和醫學影像掃描

PSMA nanoparticles can be used to destroy solid tumours and for medical imaging

近紅外納米海綿載藥助腫瘤治療

Near-infrared Nanosponge for Tumour Drug Delivery and Treatment

文、圖 / 劉子銘 · 中文翻譯 / 葉浩男

Text & Photo / Liu Tzu-Ming · Chinese Translation / Davis Ip

很多科技背後都運用了近紅外有機分子。我與研究團隊最近與多間院校的研究人員合作，開發了一種近紅外有機納米海綿和裝載有機近紅外染料的方法，有望改進癌症光動力治療和醫學成像技術。

近紅外有機分子應用廣泛

近紅外光是指介乎可見光和中紅外光之間的電磁波。近紅外有機分子經過激活後能吸收、反射或釋放近紅外光，在短距離無線通訊、遙距溫度感知、太陽能發電等領域廣泛使用。此外，近紅外有機分子細小，容易進入生物體內和細胞，因此常用於癌症診療和醫學成像。

屬於「染料」的近紅外有機分子可以作為「光敏劑」在癌症的光動力療法使用。光敏劑被注射到患者體內會在癌細胞中積聚。醫療人員其後會向癌細胞的位置發射特定波長的光線，從而激活光敏劑，產生帶有毒性的活性氧，藉此消滅癌細胞。

掃描醫學影像時，醫療人員經常用近紅外有機染料作為熒光標記物。熒光標記物進入患者體內後，會聚集在目標分子並發出熒光。進行電腦斷層掃描時，一些染料也會被用作「造影劑」來提升影像的對比度，從而更清晰地顯示患者的血管和器官結構。

以納米粒子裝載近紅外染料

近紅外有機染料在醫學的應用仍面對不少限制。首先，很多染料會在生物體內產生毒性或引起免疫反應（即生物相容性低）。此外，染料大多較難在水中溶解（即疏水性強、親水性低）。解決方法之一是合成生物相容性較高、疏水性較低的「近紅外有機納米粒子」，以它們作為載體裝載這些近紅外有機染料，將染料送達目標位置。

然而，由於每種染料的分子結構都不同，裝載它們的納米粒子通常要量身定製，費時費力。另一方面，合成納米粒子和裝載染料的過程相當繁複，合成的條件很嚴格，以一般的技術大規模生產時，很難確保不同批次的產品保持相同的性質。因此，研究團隊希望針對一些能裝載不同染料的納米粒子，開發出簡單的染料裝載方法。

合成新的納米海綿

我們研究團隊運用了簡稱PSMA的聚（苯乙烯－馬來酸），合成出一種近紅外有機納米粒子。這種粒子是一種納米海綿聚合物，能夠透過吸附作用裝載多種近紅外有機染料。我們用新合成的PSMA納米粒子裝載了10種染料，部分染料來自市面，部分由我們新合成出來。新的染料包括用於製作有機發光二極管的424、製作有機太陽能電池的YI-1、YI-3和YI-8，以及製作染料敏化太陽能電池的ADF-1-3和DTDPTID。結果顯示，相比傳統的載體，PSMA納米粒子可以裝載更多染料，對細胞的毒性也較低。

癌症光動力治療

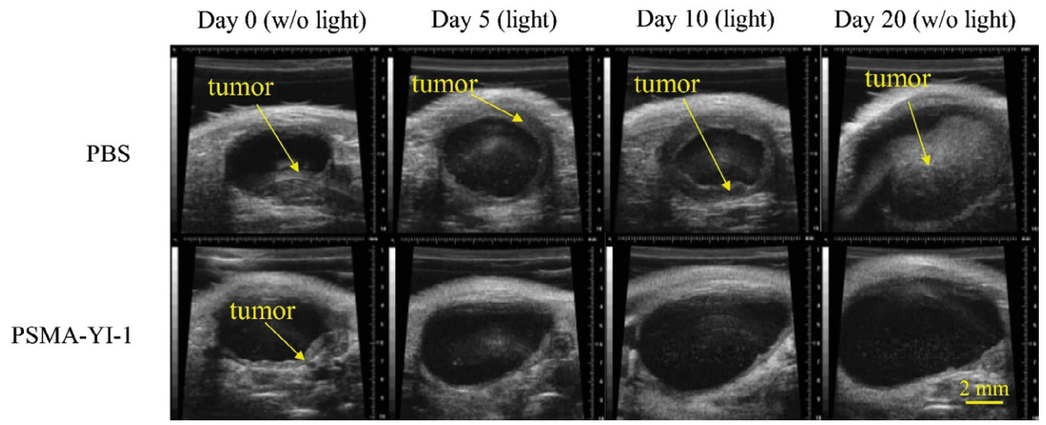
PSMA納米粒子能在光動力治療時摧殘實體腫瘤。我們在一組有膀胱癌的實驗組小鼠身上，注射裝載了YI-1染料的PSMA納米粒子，然後每5日用808 nm鐳射或660nm鐳射進行一次光動力治療，每次30分鐘。兩輪治療後，小鼠的腫瘤明顯縮小，用808 nm鐳射進行治療時效果尤其顯著，癌細胞活性下降超過50%。與此同時，沒有使用PSMA納米粒子治療的對照組小鼠的腫瘤不斷增大，到了第20日幾乎佔據整個膀胱。解剖了實驗組小鼠後，發現牠們的心、肝、脾、肺、腎都沒有明顯損傷或炎症，可見裝載了YI-1染料的PSMA納米粒子沒有產生全身性的毒性，是有效、可靠的光敏劑。

此外，為了驗證PSMA粒子用於醫學成像時的效能，我們將三種染料分別裝載到PSMA粒子，再將粒子放到有MB49膀胱癌細胞的小鼠身上。透過單光子發射斷層掃描，24小時後觀察到三種染料均發出了熒光信號，呈現腫瘤位置。因此，我們相信不同強烈特性的紅外光有機染料有望取代目前常用的一些小分子染料，帶來新的免疫熒光染色技術。

我們也以裝載了染料的PSMA納米粒子作為造影劑，對小鼠進行體外和體內的多光子激光掃描。結果顯示，PSMA納米粒子的生物相容性高、疏水性低，毋需穿越細胞膜（學界稱之為胞吞作用）就能進入小鼠的細胞並發出熒光信號。我們也將PSMA納米粒子注射到小鼠的尾靜脈，其後發現粒子能通過血液循環流動到小鼠耳朵的血管。由此可見，PSMA納米粒子可作為多光子造影劑，用於深層組織的醫學成像。

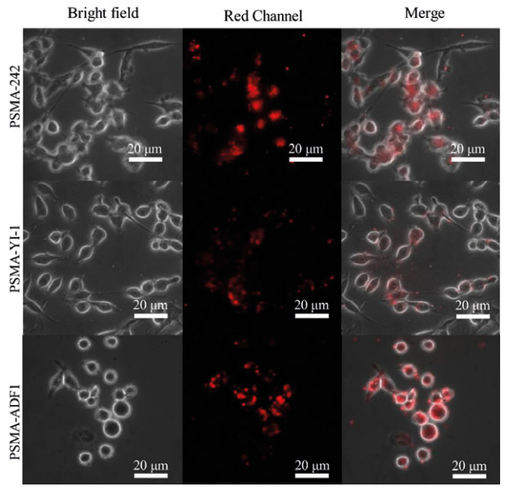
改進化療方案

透過以上研究，研究團隊證實了PSMA納米海綿可以裝載多種有機近紅外染料，用於光動力治療和醫學成像。這項發現為有機光電材料在生物醫學治療的應用提供了新的視角，成果已獲《納米生物技術雜誌》刊登。我們相信，這種納米粒子也可加載額外的癌症化療藥物，降低化療所需的藥物劑量，因此我們將來可能會朝著這個方向繼續探究，進一步了解近紅外有機分子的潛能。



經過多次使用裝載了YI-1染料的PSMA納米粒子的光動力治療後，實驗組小鼠（下方）的膀胱腫瘤在20日間大幅縮小，沒有接受治療的對照組小鼠（上方）的膀胱腫瘤則顯著增大。

After rounds of photodynamic treatment with PSMA nanoparticles loaded with the dye YI-1, the bladder tumours in the laboratory mice (bottom) shrank significantly within 20 days, while the bladder tumours in the untreated control group of mice (top) enlarged significantly.



這張熒光圖像呈現了小鼠體內被裝載了242、YI-1、ADF1這三種染料的PSMA納米粒子所標記的癌細胞

This fluorescence image shows cancer cells in mice labelled with PSMA nanoparticles loaded with three dyes: 242, YI-1 and ADF1

Organic near-infrared (NIR) molecules are used in many technologies. In recent years, my research team and I have worked with researchers from various institutions to develop an NIR organic nanosponge and a method for loading NIR organic dyes that promise to improve photodynamic cancer therapy and medical imaging.

Wide Applications of Organic NIR Molecules

NIR light is electromagnetic radiation that has longer wavelengths than visible light and shorter wavelengths than mid-infrared light. When organic NIR molecules are activated, they can absorb, reflect, or emit NIR light. Such materials are widely used in short-range wireless communications, remote temperature sensing, and solar power generation. Moreover, because organic NIR molecules are so tiny, they can easily penetrate our bodies and cells. This makes them useful for cancer diagnosis and medical imaging.

One type of NIR organic molecules, known as 'dyes', can be used as photosensitisers in photodynamic therapy (PDT) for cancer. In PDT, doctors inject photosensitisers into the patient's body, wait for them to accumulate in tumour tissue, and then shine a light of a specific wavelength on the areas to be treated to activate the photosensitisers and generate an active form of oxygen that can destroy the cancer cells nearby.

In addition, organic NIR dyes are often used as fluorescent markers in the canning of medical images. In the patient's body, the fluorescent marker accumulates in the target molecules and emits fluorescent light. Some dyes are also used as contrast agents in computed tomography to increase the contrast of the image, giving a clearer picture of the patient's blood vessels and organ structures.

Loading Nanoparticles with NIR Dyes

The use of organic NIR dyes in the field of medicine still faces some limitations. First, many dyes are toxic in living organisms or can cause immune reactions, a property known as low biocompatibility. Secondly, most dyes are poorly soluble in water, which means they are hydrophobic and not hydrophilic. One solution is to create organic NIR nanoparticles that are more biocompatible and less hydrophobic and that can carry organic NIR dyes to their targets.

However, because the molecular structure of every dye is different, the nanoparticles that carry the dye, known as carriers, often have to be tailor-made and they are time-consuming to produce. In addition, the process of synthesising the nanoparticles and loading them with dyes is complex and demands stringent conditions. Therefore, it is difficult to ensure that different batches of carriers have the same properties in large-scale production with conventional techniques. Our team, therefore, aims to develop a simple method to load multiple types of dyes onto the same nanoparticle.

Creating a New Nanosponge

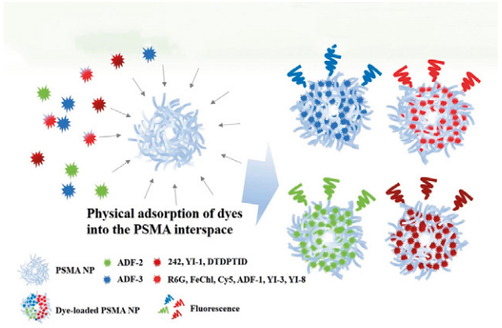
Our team has used poly (styrene-alt-maleic acid), or PSMA, to synthesise a NIR organic nanoparticle, which is a nanopolymer that can carry a wide range of organic NIR dyes. We loaded onto the new PSMA nanoparticles ten dyes, some of which are commercially available and were newly synthesised by us. The new dyes include 424 for the production of organic light-emitting diodes, YI-1, YI-3 and YI-8 for the production of organic solar cells, and ADF-1-3 and DTDPTID for the production of dye-sensitised solar cells. The results show that the PSMA nanoparticles can carry more dyes and are less toxic to the cells than conventional carriers.

Photodynamic Therapy for Cancer

Furthermore, PSMA nanoparticles can be used to destroy solid tumours in PDT. Our team injected PSMA nanoparticles loaded with the YI-1 dye into a group of laboratory mice with bladder cancer. After that, we treated them through PDT with an 808 nm laser or a 660 nm laser for 30 minutes every five days. After two rounds of treatment, the tumours in the mice were significantly reduced in size, especially in those treated with the 808 nm laser, with their cancer cell activities decreasing by more than 50 per cent. At the same time, the tumours in the control group, which were not treated with PSMA nanoparticles, continued to grow and occupied almost the entire bladder by Day 20. Autopsy of the mice revealed that no significant damage or inflammation was found in their hearts, livers, spleens, lungs, or kidneys. This indicates that the PSMA nanoparticles loaded with the dye YI-1 do not produce systemic toxicity, and thus can be an effective and reliable photosensitiser.

To test the effectiveness of the PSMA particles for medical imaging, our team loaded each of three dyes onto PSMA particles and injected them into mice with MB49 bladder cancer cells. Using single photon emission tomography, we found that after 24 hours, all three dyes emitted a fluorescent signal indicating the locations of the tumours. Therefore, we believe that organic NIR dyes with different intensity properties could replace some of the currently used low molecular weight dyes, which will lead to new immunofluorescent staining techniques.

Our team also performed *in vitro* and *in vivo* multiphoton laser scans on mice using PSMA nanoparticles with the dye as a contrast agent. The results showed that PSMA nanoparticles are highly biocompatible, have low hydrophobicity, and do not need to cross the cell membrane (called cytokinesis) to enter mouse cells and emit fluorescent signals. We also injected PSMA nanoparticles into the tail vein of mice and found that the particles could flow through the bloodstream to the blood vessels in the ears of the mice. This shows that PSMA nanoparticles can be used as multiphoton contrast agents for medical imaging of deep tissue.



PSMA納米粒子可以裝載各種近紅外有機染料

PSMA nanoparticles can be loaded with a variety of organic NIR dyes

Towards Better Chemotherapy

Through these studies, our team has shown that PSMA nanoparticles can be loaded with a variety of organic NIR dyes for PDT and medical imaging. This discovery offers a new perspective on the use of organic optoelectronic materials for biomedical therapeutic applications and has been published in the *Journal of Nanobiotechnology*. We believe that such nanoparticles could also be loaded with additional drugs for cancer chemotherapy to reduce the required dose of chemotherapy. Our research team will continue to work in this direction to further identify the huge potential of NIR organic molecules.

劉子銘是澳大健康科學學院副教授，擁有台灣大學光電工程學博士學位，研究聚焦生命科學，使用超快鐳射技術探索納米光子學研究癌症生物學，以及創造光的新診斷和治療用途。

Liu Tzu-Ming is an associate professor in the Faculty of Health Sciences at UM. He holds a PhD in optoelectronic engineering from the University of Taiwan. His studies focus on life sciences, the use of ultrafast laser technology to explore of nanophotonics to study cancer biology, and the development of new diagnostic and therapeutic applications of light.

「學術研究」為投稿欄目，內容僅代表作者個人意見。

Articles in the Academic Research column were submitted by UM scholars. The views expressed are solely those of the author(s).

疫情下內地有關線上教育的輿論

Public Opinion on Online Education in Mainland China during the Pandemic

文 / 周明明 · 圖 / 編輯部，部分由作者提供 · 中文翻譯 / 葉浩男
Text / Zhou Mingming · Photo / Editorial Board, with some provided by the author · Chinese Translation / Davis Ip

線上教育從前並非主流的教育方式。不過，隨著新型冠狀病毒疫情肆虐，不同年級的老師和學生都要迅速適應線上教育。據我們所知，我們是首個研究疫情前、疫情初期和往後疫情期內地線上教育輿論並提出改善線上教育建議的團隊。

分析關於線上教育的微博帖文

有關研究由筆者與廣州數說故事資料智慧中心總監牟昊合作開展，基於數說故事資料智慧中心提供的社交媒體數據，我們收集了2019年中至2020年底新浪微博上發佈有關線上教育的帖文，並借助於數說故事資料智慧中心提供的演算法模型對數據進行輿情分析。

依據發帖時間，微博數據分為三個階段：1）疫情前（2019年7月1日至2020年1月9日）；2)疫情初期（2020年1月10日至2020年4月30日）；3）疫情後期（2020年5月1日至2020年11月30日）。在這三個階段之間有兩件較為重要的事件：2020年1月，新型冠狀病毒肺炎在內地迅速蔓延。有鑑於此，中央政府宣佈各年級的教育活動改為線上進行。另外，在2020年5月初，中央政府宣佈在疫情防控阻擊戰取得重大戰略成果，各地學校陸續恢復面授。

我們收集了這些微博帖文內容和發帖者的個人資訊，如性別等。為了比較三個階段的帖文，我們運用了變換器的雙向編碼器表示法（英文簡稱BERT）作情感分析，即透過這種技術來自動判斷帖文的不同情感類別，分別是正面（標示為+1）、中性（標示為0）和負面（標示為-1）。我們還使用了隱含狄利克雷分佈（英文簡稱：LDA）模型來識別非結構化文本數據所屬的主題。

我們發現，有關線上教育的微博帖文在疫情初期急劇增加，2020年3月達到高峰，當時內地的學校和教育機構全面暫停面授、轉為在線教學，該月在微博錄得430,566則相關帖文，比我們的研究範圍的第一個月（2019年7月，33,415則帖文）高出10倍以上，也比最後一個月（2020年11月，9,366則帖文）高出40多倍。由此可見，2020年1月開始的緊急情況引起了民眾對線上教育的極大關注，這在女性群體中表現尤其明顯。

事實上，疫情初期激增的相關帖文的確來自女性用戶居多。在第一和第三階段，多數男性和女性用戶似乎都對線上教育持中性態度。疫情前的帖文中有79.03%是中性，只有4.67%是負面。然而，疫情初期的帖文中有51.63%為負面，中性帖文的比例降至33.04%。在第三階段，9.27%女性用戶持負面觀點，仍然高於第一階段的3.26%，反映疫情較易使女性對線上教育產生持久的負面看法。

疫情初期，線上教育是暫停面授教學後唯一的替代方案。當時，微博用戶在對線上教育普遍持負面看法。過往一項針對內地公眾對特定線上教育平台滿意度的研究也有類似結論。不過，這點卻與另一些針對中國公眾對大規模開放線上課堂（慕課）等在線學習模式的態度的研究形成鮮明的對比。這點反映出，當公眾在被要求、而非主動參與線上教育活動時，對線上教育較易有負面看法。

有關線上教育帖文主題的類型

另一方面，我們的分析顯示，疫情前的帖文主題可分為兩類、疫情初期的帖文主題可分為4類，而疫情後期的帖文主題可分為7類。疫情前，首要的帖文主題類別主要針對線上教育的目的和功能，討論語氣正面，但疫情初期的帖文主題主要是表達對學校、教師、學生和課程安排的憂慮。疫情後期的相關帖文數量則有所減少，但主題卻更趨多樣。

據我們所知，我們這項分析是首個有關這個時期內地有關線上教育的輿論的研究項目，結果已獲《教育技術研究與發展》（Educational Technology Research and Development）刊登。該期刊是教育領域內唯一完全專注於教育技術研究和開發的學術期刊，2021影響因子達5.58，在全球國際教育技術期刊中排名第6。

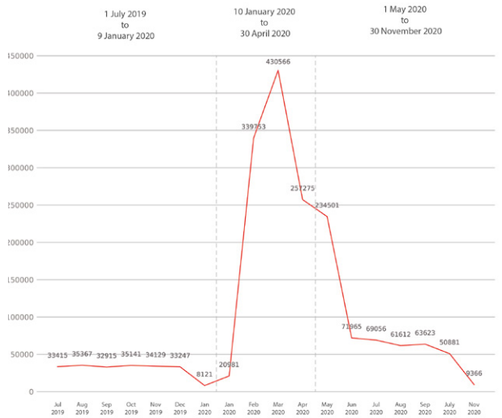
我們的數據顯示，疫情初期的微博帖文頻繁出現「困倦」和「焦慮」等關鍵詞。線上教育通常要求學習者高度自律和有自我指導的意識，但當線上學習並非出於主動時，學習者較難達到這種預期。因此，我們在認同線上教育益處的同時，也應該提醒人們需要以更多不同的形式開展線上教育活動，才能使時間較長的課程在屏幕上也能盡展效益。

The emergence of the COVID-19 pandemic has forced teachers and students at all levels of education to quickly move to online classes, which have traditionally been seen as an alternative route in education. To our knowledge, our study is the first attempt to analyse public opinion about online education before, during, and after the outbreak in mainland China. In the study, we have also made recommendations for improving online education.

Analysing Microblogs about Online Education

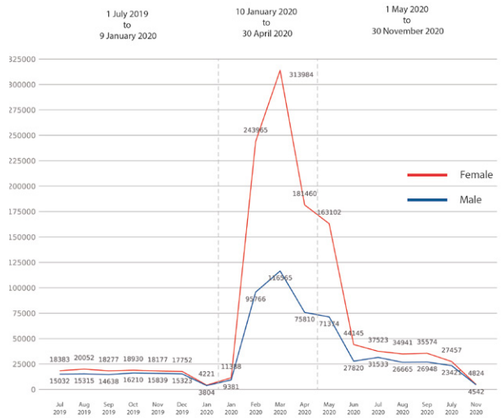
The study was conducted by Prof Zhou Mingming and Mou Hao, director of DataStory, a big data company based in Guangzhou. With the help of DataStory, we collected microblogs about online education published on Sina Weibo between mid-2019 and late 2020 and conducted sentiment and content analyses of the data.

These microblogs were divided into three time periods: 1) Pre-pandemic Period (1 July 2019 to 9 January 2020); 2) Mid-pandemic Period (10 January 2020 to 30 April 2020); and 3) Post-pandemic Period (1 May 2020 to 30 November 2020). The three periods were delineated by two key events: 1) In January 2020, COVID-19 rapidly spread across mainland China within weeks. In recognition of the situation, the Chinese central government recommended the use of distance learning for all grade levels across the country; 2) In early May 2020, the Chinese central government concluded that mainland China had achieved a major strategic success in combating COVID-19, and schools



在三個時間階段有關線上教育的微博帖文數量

The total number of microblogs about online education during the three periods



在三個時間階段有關線上教育的微博帖文數量(按用戶性別劃分)

The total number of microblogs about online education during the three periods (by gender)

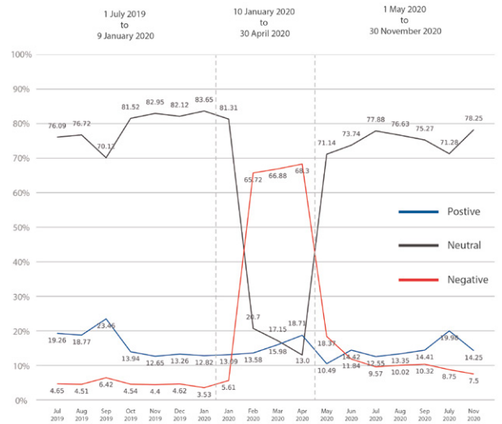
were reopened to resume face-to-face teaching.

In addition to the content of the microblogs, we also collected the profiles of their creators, including their gender. To compare the microblogs from the three time periods, we used Bidirectional Encoder Representations from Transformers (BERT) for sentiment analysis. Specifically, we used this machine learning technique to automatically classify the microblogs into three sentiment categories: positive, negative, and neutral. Each microblog was tagged with a numerical sentiment value of +1, 0, or -1 to indicate positive, neutral, or negative polarity. For content analysis, we used the Latent Dirichlet Allocation (LDA) algorithm to identify the topics to which a piece of unstructured text data belongs.

We found that the number of microblogs about online education increased dramatically during the Mid-pandemic Period, peaking at 430,566 microblogs in March 2020, when schools and other educational institutions in mainland China completely suspended face-to-face classes and switched to online learning. This number is over ten times higher than that from the first month of our study (33,415 in July 2019) and over 40 times higher than that from the last month of our study (9,366 in November 2020). This indicates that the emergencies that started in January 2020 caused a lot of concern about online education among the population, especially among women.

Indeed, the dramatic increase in the number of microblogs about online education during the Mid-pandemic Period came mainly from female users. In the first and third periods, most male and female users seemed to be equally indifferent to online education. Before the pandemic, 79.03 per cent of microblogs in the study were classified as neutral towards online education, and only 4.67 per cent of them were negative. However, in the Mid-pandemic Period, only 33.04 per cent of the posts were classified as neutral, and 51.63 per cent of them were negative. Moreover, the proportion of female users who held negative views was much higher in the third period (9.27 per cent) than that in the first period (3.26 per cent). This implies that the pandemic has had a lasting negative impact on women's attitudes towards online education.

During the Mid-pandemic Period when online education was the only alternative to face-to-face teaching, Weibo users generally held negative attitudes towards online education. This is consistent with a study of Chinese users' satisfaction with selected online education platforms during the pandemic, but contrasts with previous studies



在三個時間階段有關線上教育的微博帖文的情感值的變化

Changes in sentiment scores of microblogs about online education during the three periods

that examined public attitudes in mainland China towards online learning models such as Massive Open Online Courses (MOOCs). This shows that the public would likely take a negative stance if they participate in online education involuntarily.

Topic Clusters of Microblogs about Online Education

Meanwhile, we found that the optimal number of topic clusters was 2 in the Pre-pandemic Period dataset, 4 in the Mid-pandemic Period dataset, and 7 in the Post-pandemic Period dataset. In the Pre-pandemic Period, the first group of topics was primarily about the purposes and functions of online education, expressed in a positive tone. During the Mid-pandemic Period, the topics mainly reflected concerns about schools, teachers, students, and curriculum. In the Post-pandemic Period, the topics that appeared on Weibo were even more diverse, although the number of microblogs about online education decreased.

To our knowledge, our study is the first attempt to analyse public opinion about online education in mainland China during this period. The results have been published in *Educational Technology Research and Development*, the only peer-reviewed journal in the field of education that focuses exclusively on the research and development of educational technology. The journal is ranked sixth among international journals of educational technology, with an Impact Factor of 5.58 in 2021.

According to our datasets, 'sleepy' and 'anxious' emerged as frequent keywords in microblogs during the Mid-pandemic Period. Online education often requires learners to be highly self-disciplined and self-directed, but it can be difficult for learners to meet this expectation when online learning is not voluntary. While we acknowledge the benefits of online education, a greater variety of online activities is needed to maximise the value of learning through the screen during long hours of online sessions.

周明明副教授是澳大教育學院代副院長(科研)及教育研究中心主任,並負責國家教育部普通高校人文社會科學重點研究基地在澳大的建設。主要研究方向為教育心理學與現代科技的跨學科研究,包括社交媒體與在線教育的結合、教育大數據挖掘、數字科技在高等教育課堂中的應用,以及如何利用新科技手段測量傳統教育及心理學的重要概念。在學術期刊與國際會議中發表了80餘篇論文和學術報告。

Zhou Mingming is an associate professor and the interim associate dean (research) at the UM Faculty of Education (FED), where she also serves as the director of the Educational Research Centre. At UM, Prof Zhou is responsible for the management of the key research base of humanities and social sciences of the Ministry of Education. Her studies focus on interdisciplinary research of educational psychology and computing technology, including the integration of social media and online education, educational data mining, the use of digital technology in higher education, and how to innovate traditional measures of key concepts in education and psychology. She has published and presented over 80 papers in academic journals and international conferences.

「學術研究」為投稿欄目,內容僅代表作者個人意見。

Articles in the Academic Research column were submitted by UM scholars. The views expressed are solely those of the author(s).

生活即學習，學習即生活：探究澳門大學的住宿式書院教育

Living is Learning, Learning is Living: Exploring Residential College Life at the University of Macau

文 / 梁美兒．圖 / 蔡繼有書院提供．中文翻譯 / 葉浩男
Text / Janny Leung．Photo / Choi Kai Yau College．Chinese Translation / Davis Ip

在當下的大數據時代，我們應該如何衡量大學之大？面對各大排名機構收集和羅列的海量數據，我們如何才能評估一所大學有否履行使命？

甚麼才是好的大學教育？

增進知識、轉化科技、進而造福社會，這些當然是大學的重要任務，但我們切勿忘記大學最根本的使命是作育英才。大學時期是學生人生成長的關鍵階段，他們的大學又是否能提供一個令他們有深有啟發的蛻變性學習經歷？全球各項大學排名的不少量化指標都是用來衡量大學能否提供這類培育學生茁壯成長、積厚成器的平台。

甚麼才是好的大學教育？40多年前我剛讀大學，印象最深刻的是我的大學提供了包羅萬象的課程，數百門選修課包括了一些我從未接觸的語言（如烏爾都語等），以及我聞所未聞的學科（如景觀建築和分形幾何等），範圍之廣令人驚嘆。此外，我的教授都對他們的學術領域充滿熱情，令人振奮。我在大學生涯汲取了新的技能和專業知識，當然令我非常興奮，但如果要數我在大學最寶貴的收穫，卻莫過於是我的個人發展，包括學懂反思自己的人生和願景、從更廣闊的角度認知世界、認識自己對社會的責任。這些個人成長的根基主要源於我在住宿式書院的經歷。

書院生活中成長

回想在大學那些年，不同年級的同學在書院裡的食堂激烈辯論、暢所欲言，辯題跨越我們各自的學科領域，無所不談，至今記憶猶新。同樣難忘的是，當我的室友遇到挫折，我曾通宵達旦安慰她們，而我有需要時，他們也會伸出援手，令我感激不已。面對一些我們當時認為不公正的處事方式，我們會集思廣益，齊心與大學的行政主管和院長們周旋。另外，我和同學在校際比賽前曾奔走每座宿舍每條走廊，逐個房間拍門招募隊員。在各種各樣的書院經歷中，歡聲和淚水不斷交織。我們學懂了團隊精神和同理心、培養出誠信和品格，成為了有能力回饋社會的成年人。

梁美兒教授首次出席蔡繼有書院晚宴
Prof Janny Leung's first Formal Hall Dinner at CKYC

蔡繼有書院非洲鼓隊
CKYC's African Drum Ensemble

蔡繼有書院和澳門嘉諾撒聖心中學的學生在路環淨灘
Students of CKYC and Sacred Heart Canossian College Macau clean up a beach in Coloane

澳大的「四位一體」教育模式

好的大學使學生收獲到豐富的知識和鍛煉出專業的技能，也為他們提供一些開拓視野、建立價值觀的變革式體驗，讓他們成長、發展才華、展翅飛翔。澳門大學深明大學教育是品學兼重、兩者相輔相成的原則。在「四位一體」的教育模式下，澳大學生一方面積累學科知識，同時修讀通識教育課程。他們的學習不局限於課室，也從實習和社區服務中獲取學習經驗。

作為該教育模式的重要一環，澳大的住宿式書院提供了一個重要的綜合平台，讓學生將他們所有的學習經驗轉化為個人成長。在澳大，書院和學院齊心協力支持學生精進學術，同時協助他們培養一系列軟技能和正面的人生態度。這些軟技能可歸納為七項勝任力，分別是公民責任心、全球競爭力、知識整合能力、團隊協作、服務與領導、文化參與和健康生活。

蔡繼有書院的宗旨

澳大在2010年起試行住宿式書院制度，2014年遷入現校園後全面啟動10所書院，也正式展開了「生活即學習，學習即生活」的體驗式教育模式。當時，蔡繼有書院創院院長龐百騰教授和書院捐贈人蔡冠深博士提出書院的三大宗旨，好比鼎之三足。第一個宗旨是「敏於思、慎於行」，也是我們的院訓。我們的書院鼓勵學生自我挑戰、擁抱新想法和直陳己見，並在行動時求取平衡和關顧他人所需。我們書院有幾個較有特色的傳統活動，包括非洲鼓和啦啦隊活動，無不展示出學生的好奇心和創造力。

書院第二個宗旨是鼓勵學生成為有國際視野的公民。因此，我們與不少內地和海外書院結為夥伴，開展互訪和聯合考察。參與這些活動的學生都認為自己從中獲益良多、開闊視野，並且積累了寶貴的多元文化團隊合作經驗。

書院第三個宗旨是關愛社群，例如我們與岩沙小學合作讓書院學生到該小學作服務學習和義教。我們的學生也積極在澳門參與志願和社區服務。我們也會鼓勵書院學生自主組織他們的住宿生活。

孕育人才的環境

作為院長，每當我看到一些數年前還是害羞的少年新生如今已經轉變為充滿自信的學長，並且積極建言、為院生創造更有意義的體驗，我都深感欣慰。書院和學生能夠一齊成長、過程之中互勵互勉、彼此支持，令我鼓舞不已。我們在書院致力營造有利孕育人才的環境，協助學生有更豐盛的生活和發展。希望學生體驗在書院的學習生活後，都會意識到人生每個經歷都有學習的價值、都是成長的機遇。求知之心不應隨大學畢業而消散，願「生活即學習，學習即生活」的心態長伴他們一生。

In this age of Big Data, how do we measure the greatness of a university? From the multitude of data amassed and tabulated by the ranking agencies, how can we assess if a university fulfils its mission?

What is a Good University Education?

Undoubtedly, universities play a pivotal role in the advancement of knowledge, the technology transfer for the betterment of society. But we must not forget that the education of students is still a core function of a university. Even among all the quantitative

measures used by the well-known university ranking systems, a large percentage of the measures relate to the transformational experience that the university provides in this critical development period as the students develop into adulthood.

What makes a good university education? I look back at my own university experience more than 40 years ago. True, I was amazed by the wealth of knowledge among the hundreds of courses on offer, from languages (e.g., Urdu) that I had never heard of, to topics that I did not know existed as a line of investigation (e.g. landscape architecture, fractal geometry). I was energised by the passion of the professors for their chosen research areas. I was thrilled to acquire new skills and deepen my expertise. Yet what was most valuable to me was my development as a person. During my university days, I learned to reflect on my own goals and aspirations, to gain a broader perspective on the world, and to comprehend my connection and responsibility to my community and society. What was essential to my growth and maturity was my experience at my residential colleges.

Life in College

I remember the most heated intellectual arguments among friends from different years in the Dining Hall, over topics beyond any of our own major disciplines. I remember staying up all night to console and support roommates going through difficult times and being appreciative when they return the favour.

蔡繼有書院奪得2020/2021學年「十大書院聯合會院長盃」總冠軍

CKYC won the overall championship in the CICA Masters' Cup for the 2020/2021 academic year

I remember banding together to brainstorm how we can argue with the university administration to change procedures that were unjust (as they appeared to us at that time). I remember knocking on every door in each corridor and entryway to recruit team members for intercollege competition. Somehow through all the running around, the tears and laughter, I learned teamwork and empathy, I developed integrity, and I became an adult ready to contribute back to society.

UM's '4-in-1' Model

A good university education provides the student with both an enrichment of their knowledge and skills and a transformational experience for their maturity and growth. The University of Macau (UM) is fully cognizant of this duality in university education. Its '4-in-1' model clearly highlights that students should acquire discipline-specific expertise and also general knowledge, and that learning is done not only in the classroom but also through experience via internships, service learning, and community engagement.

The residential colleges at UM play a critical role as an integrative platform for students to assimilate all their learning experiences into their own personal growth. Working hand-in-hand with the faculties, the residential colleges support the students in their academic pursuits and also develop their soft skills and attitudes, as encapsulated into seven competencies: Responsible Citizenship, Global Competitiveness, Knowledge Integration, Teamwork and Collaboration, Service and Leadership, Cultural Engagement, Healthy Lifestyle.

Mission of the College

The residential college (RC) system began at UM on a trial basis in 2010. In 2014, the university inaugurated its 10 RCs upon relocation to the current campus, officially launching its experiential learning model guided by the education philosophy that 'Education is not preparation for life. Education is life itself'. Since the establishment of Choi Kai Yau College (CKYC) in 2014, our Founding Master Prof David Pong and our College Donor Dr Jonathan Choi have formulated the CKYC Tripod as the college's educational goal. The first tenet of the CKYC Tripod is our motto: 'Dare to Think, Care to Act'. We encourage students to challenge themselves to open up to new ideas, to stand up and speak out, yet be balanced and mindful of others in their actions. The students' curiosity and creativity have been channelled into several unique

梁美兒教授在大學接觸划艇運動並加入校隊。圖為她33年後與劍橋大學克萊爾學堂師生一同划艇。

Prof Janny Leung rows for Clare Hall at the University of Cambridge, 33 years after she joined a rowing team at university to learn a new sport.

college traditions such as our African Drum team, our cheerleading team, etc.

The second tenet of the CKYC Tripod is 'Citizenship with Global Awareness'. CKYC has established partnerships with colleges across mainland China and overseas. All the students who have participated in the mutual exchange visits and joint study tours have expressed appreciation of the broadening of their perspectives and valuable multi-cultural teamwork experiences.

The third tenet of the CKYC Tripod is a 'Caring Community'. The college's partnership with Bia Sha Primary School provides students with service-learning experiences. Our students also engage in charity work and community services in Macao. Within the college, we encourage self-governance in the organisation of hostel life.

A Living Learning Community

For me, it is most heart-warming when confident upper-year students – shy teenagers just a couple of years ago – approach me with eager ideas for how CKYC can provide a more meaningful experience for newly-admitted students. It is gratifying that the college and the students can support each other as we grow together.

At CKYC, we strive to provide a nurturing milieu for the students' enrichment and development. Through their college experiences, we hope students will realise that every activity is a learning experience, and learning does not end with the completion of their university degree, but is a mindset that will stay with them for the rest of their lives.

梁美兒教授是澳大蔡繼有書院院長，分別於哈佛大學、牛津大學和麻省理工學院取得學士、碩士和博士學位，在運輸和優化研究方面卓有成就。過去數十年來大多數時間在書院制大學學習和任職，堅信書院為學生提供的學習環境有其深遠的意義。

Prof Janny Leung is the college master of Choi Kai Yau College at UM. She obtained an SB degree in Applied Mathematics from Harvard University, an MA in Mathematics from the University of Oxford, and a PhD from the Massachusetts Institute of Technology. She is a renowned researcher in transportation and optimisation. Having studied and worked in collegiate universities for most of her career, she is a strong believer in the value of the learning environment that a college can provide.

澳大於2010年引入住宿式書院系統。書院作為多元文化與多元學科融會貫通的知識整合學習平台，致力培養學生具有公民責任心、全球競爭力、知識整合能力、團隊協作、服務與領導、文化參與和健康生活的七項勝任力。

UM launched its residential college (RC) system in 2010 to create a multicultural and multidisciplinary learning platform for knowledge integration. RC education aims to cultivate seven competencies of students, namely responsible citizenship, global competitiveness, knowledge integration, teamwork and collaboration, service and leadership, cultural engagement, and healthy lifestyle.

住宿式書院系統網站

Website of the Residential College System

呂志和書院的實踐：體育在教育中發揮的角色

Lui Che Woo College: The Role of Sports in Residential College Education

文 / 藍志雄、周國暉、孫斯斯、李永康．圖 / 呂志和書院提供．中文翻譯 / 葉浩男

Text / Desmond Lam Chee Shiong, Chao Kuok Fai , Sun Sisi, Ivan Lei Weng Hong．Photo / Lui Che Woo College．Chinese Translation / Davis Ip

澳門大學呂志和書院致力成為學生的家。這種精神深植於書院的文化，也體現在「我們是一家」的書院格言。書院推崇卓越學術、重視領導才能、崇尚多元，以各項活動啟導學生提升信心、志向和競爭力。在呂志和書院眾多的教育項目中，體育活動是關鍵的一環。

體育的正面影響

住宿式書院是澳大實踐全人教育書院理念的重要平台。書院關顧學生身心健康，每位教職員有如學生的家長般用心將書院打造成一個「大家庭」，協助我們的「孩子」（學生）在個人成長、學術和專業發展發揮傑出表現，使他們具備有助成為傑出領袖的素養。

書院旨在協助學生發展七大勝任力，當中至少三項能藉體育活動提升，分別是健康生活、服務與領導和團隊協作。一些研究顯示，體育活動不單有利於大學生的學術表現，也對他們往後的人生有所裨益。此外，有針對大學生的研究發現，體育活動對學術表現有正面影響，包括在小組研習項目發揮更好的合作精神，以及取得更佳的成績。

體育活動對大學生的身心發展相當有益，而恒常運動有利學生訓練較強的集中力、自信和自我認同，這些都是精神和情緒能力方面的重要「資本」。參與體育運動的學生有較強的自我控制能力，身心抗壓能力也較強。此外，學生參加體育活動不時遇到挫折，這些歷練也能使人意志更堅定、更有決心，鍛煉更堅韌的性格，對他們（尤其是疫情期間）的心智發展大有益處，這正是「但凡不能殺死你的，都能使你更強大」這句格言的含義。

體育有助培養不同技能

呂志和書院重視體育，鼓勵學生強身健體。學生每年積極參加澳大十大書院聯合會的年度比賽，包括籃球、足球、啦啦隊、羽毛球和乒乓球等項目。我們為體育活動投入大量資源，擁有合資格的教練和優良的體育設備，也為書院體育隊伍提供品格方面的引導。我們每個學期都舉辦林林總總的體育活動，遍及各類專業訓練和餘暇體驗，由學生按興趣選擇。在過去學年的呂志和書院體育日，吸引超過100名學生參加，除了參與籃球和羽毛球等熱門項目競賽，也體驗了網球、健球、壁球、躲避球和慢跑等項目。此外，不少學生也參加了由銀河娛樂集團資助的迷你馬拉松。

籃球、足球和啦啦隊等團體活動尤其有助學生發展互動技能、團隊建立能力和領導才能，並有助他們建立分析和策略性思考能力。在這些隊際體育活動中，同輩的互動無疑是課堂以外一個交流資訊和分享知識的絕佳平台，也能讓學生從中發展出日後能應用於職場的社交技巧。

師生參加健球活動

Students and college staff play Kin-Ball

書院籃球隊在院際比賽奪冠

The college's basketball team wins the championship in an inter-college competition

師生參加2021銀河娛樂澳門國際馬拉松

Students and college staff join the 2021 Galaxy Entertainment Macao International Marathon

師生在啦啦隊比賽合照

Students and college teaching staff in a cheerleading competition

恆常運動，特別是參與團體競賽，無疑是積極的精神能量泉源。這些活動能提升學生對書院和大學的歸屬感，以及培養作為負責任公民應有的價值觀。體育活動也有助書院教職員與學生在較輕鬆的環境下互動，強化學生與書院的聯繫。書院的教職員常與學生參與各類體育活動，不但一同訓練，也會在院際比賽時為他們熱烈打氣。同時，我們也會悉心指引學生在學習和參與活動中取得平衡。

未來計劃

體育活動在大學和住宿式書院教育擔當重要角色。體育不僅能令一個人有更堅強的品格、有益身心，還能使人在課堂外學到受用一生的技能。我們希望將來推出高爾夫球、欖球、排球、健球等更多體育項目，也計劃邀請出色的教練，藉以提升現有體育活動的水平。這些舉措正源於我們的願景——孕育具競爭力和放眼全球的新一代領袖之才。

Lui Che Woo College (LCWC) at the University of Macau (UM) strives to become a place students can call home. This is reflected in the culture of the residential college (RC) and the college motto 'We Are Family!' LCWC also values academic excellence, leadership development, and diversity, offering various programmes to enhance students' confidence, conviction, and competitiveness. Among these programmes are sports activities, which play a pivotal role in RC education at our college.

Positive Impact of Sports

The RCs at UM are important platforms upon which the university realises its visions for whole-person education. At LCWC, we are dedicated to whole-person education and care about the physical, mental, and emotional well-being of our students. Just like the parents of a typical family, LCWC staff are committed to creating a home where 'our children' (students) can thrive personally, academically, and professionally, as well as acquire important qualities they need to become successful leaders.

LCWC's emphasis of sports is consistent with at least three of the seven competencies advocated by the university's RC education model, namely Healthy Lifestyle, Service and Leadership, and Teamwork

and Collaboration. Previous research has shown that students' engagement in sports during their university years can promote their success not only in school, but also in later life. Studies on university students have also found that engagement in sports will create a positive impact on their academic outcomes, such as better teamwork in group projects and higher grades.

Playing sports also has many positive effects on university students, not only on their body, but also on their mind. Regular participation in sports helps to strengthen a student's mental and emotional capital, including concentration, self-confidence, and self-esteem. Students can develop a stronger internal locus of control and a greater tolerance to both physical and mental stress. In addition, as failures in sports activities and competitions are not uncommon, students can cultivate perseverance and determination through frequent sports training and competitions. All of this helps to strengthen the resilience of students, which is crucial to their mental development, especially during the epidemic – 'What doesn't kill you makes you stronger.'

Developing Multiple Skills through Sports

Sports involvement is highly encouraged and valued at LCWC. Every year, students are recruited for the annual inter-college competitions held by the UM Committee on Inter-College Affairs, where they compete with members of other RCs in sports such as basketball, football, cheerleading, badminton, and table tennis. LCWC not only provides ample resources, including qualified coaches and sports equipment, for students with an interest in sports, but also offers moral guidance for members of the college sports teams. In addition, each semester our college organises a wide range of sports activities, including professional training and recreational games, which students can choose to participate in freely based on their interests. In the previous academic year, more than 100 LCWC students joined the college's Sports Day. During the event, in addition to popular sports such as basketball, badminton, table tennis, and football, the college staff and student leaders organised activities of tennis, Kin-Ball, squash, dodgeball, and jogging. In addition, many LCWC students participated in a mini-marathon sponsored by the Galaxy Entertainment Group.

Team sports, including basketball, football, and cheerleading, provide opportunities for students to foster interaction, teamwork, leadership skills, as well as analytical and strategic thinking skills. In addition, interaction with peers through team sports often leads to the sharing of useful information and knowledge outside the classroom, which can cultivate social skills indispensable to students in their professional careers in the future.

Regular participation in sports, especially team sports, is also a fruitful source of positive mental energy. It can not only strengthen students' sense of belonging and contribution to their RCs and the university, but also instil the value of responsible citizenship in them. Sports activities also provide a platform for college staff and students to interact in an informal setting. Indeed, LCWC staff and affiliates often engage with students during sporting activities. They train together with the students and passionately cheer for them at inter-college competitions. The college also provides guidance for students to balance the time between sports with academic activities.

Future Plans

Sports play an important role in university and RC education. They not only build a person's character, but also bring physical and mental benefits, helping students develop valuable lifelong skills beyond the classroom. In the future, LCWC hopes to expand its sports programmes to include other sports such as golf, cricket, volleyball, and Kin-Ball. In addition, the college will boost its existing sports programmes by recruiting well-qualified coaches. In alignment with our mission statement, these initiatives will help us nurture the next generation of globally-minded and competitive leaders.

網球訓練

A tennis training session

乒乓球訓練

A table tennis training session

藍志雄教授是澳大呂志和書院院長，研究領域包括跨文化決策、酒店營銷和博彩消費，論文見於《Journal of Product Innovation Management》《Journal of Business Research》《Journal of International Marketing》和《Annals of Tourism Research》等學術期刊，另有兩部專著。他熱衷參與羽毛球、乒乓球和高爾夫球等運動。

Prof Desmond Lam Chee Shiong is the college master of Lui Che Woo College (LCWC) at UM. His research interests include cross-cultural decision-making, hospitality marketing, and gambling consumption. His publications have appeared in leading international journals such as the *Journal of Product Innovation Management*, *Journal of Business Research*, *Journal of International Marketing*, and *Annals of Tourism Research*. He is also the author of two books. His favourite sports include badminton, table tennis, and golf.

周國暉教授是澳大呂志和書院副院長，負責書院學生生活及其學術發展的事務。他於曼徹斯特大學獲得數學博士學位，研究領域涵蓋數論、表示論、非交換幾何學，曾在台灣中山大學、中國科學院、復旦大學和上海大學擔任多個學術職務。

Prof Chao Kuok Fai is the associate college master of LCWC at UM and is responsible for affairs related to students' life and academic development. He received his PhD in mathematics at the University of Manchester. His research interests include number theory, representation theory, and non-commutative geometry. He has held academic positions at Sun Yat-Sen University in Taiwan, the Chinese Academy of Sciences, Fudan University, and Shanghai University.

孫斯斯博士是澳大呂志和書院駐院導師，於蒙特利爾大學取得法學博士學位。著有多篇關於書院教育的論文，曾應美國學生人事管理者協會2019年會議邀請作相關演講。她也是中國政法大學中加法律研究中心的研究員，持有中國律師執業證。

Dr Sun Sisi is a resident fellow of LCWC at UM. She holds a doctoral degree in law from the University of Montreal, Canada. She is the author of a number of academic papers on RC education and was invited to speak at the 2019 National Association of Student Personnel Administrators Student Affairs Conference in Los Angeles. She is also a researcher at the Sino-Canadian Law Research Center at the China University of Political Science and Law and a registered lawyer in China.

李永康是澳大呂志和書院駐院導師，致力發展書院的體育活動和其它項目，曾在美國學習和工作10多年，期間恒常參與遠足、游泳和羽毛球等運動。他相信體育對學生的心理健康、學業和社交至關重要。

Ivan Lei Weng Hong is a resident fellow of LCWC at UM. He has been involved in the development of sports activities and programmes in the college. Before joining UM, Lei studied and worked for over a decade in the United States, where he regularly participated in sports such as hiking, swimming, and badminton. He believes that sport is vital to the mental health, academic performance, and social well-being of students.

「書院發展」為投稿欄目，內容僅代表作者個人意見。

RC Development is a submission column. The views expressed are solely those of the author(s).

澳大於2010年引入住宿式書院系統。書院作為多元文化與多元學科融會貫通的知識整合學習平台，致力培養學生具有公民責任心、全球競爭力、知識整合能力、團隊協作、服務與領導、文化參與和健康生活的七項勝任力。

UM launched its residential college (RC) system in 2010 to create a multicultural and multidisciplinary learning platform for knowledge integration. RC education aims to cultivate seven competencies of students, namely responsible citizenship, global competitiveness, knowledge integration, teamwork and collaboration, service and leadership, cultural engagement, and healthy lifestyle.

住宿式書院系統網站

Website of the Residential College System

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