

ISTBI Newsletter

April – June 2023





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> Problems with 'Pruning' Brain Connections Linked to Adolescent Mental Health Disorders

According to the World Health Organization (WHO), one in seven adolescents (aged 10-19) worldwide experiences mental health disorders. Depression, anxiety and behavioral disorders, such as attention deficit hyperactivity disorder (ADHD), are among the leading causes of illness and disability among adolescents, and it's common for adolescents to experience multiple mental health disorders.

Many mental health problems emerge during adolescence. Disorders such as depression and anxiety manifest as 'internalizing' symptoms, including low mood and worrying. Others, such as ADHD, manifest as 'externalizing' symptoms, including impulsive behaviour.

In a study published in Nature Medicine on 24 April 2023, researchers from the ISTBI identified a characteristic pattern of brain activity among these adolescents, termed as the 'neuropsychopathological factor', or NP factor for short.

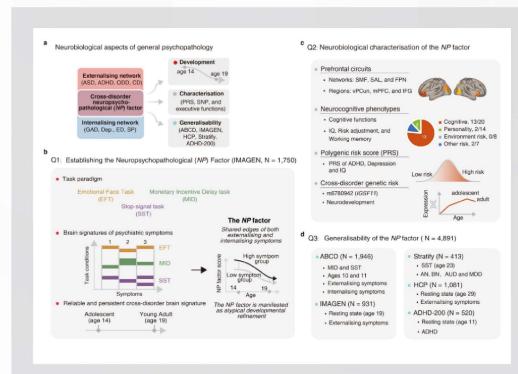
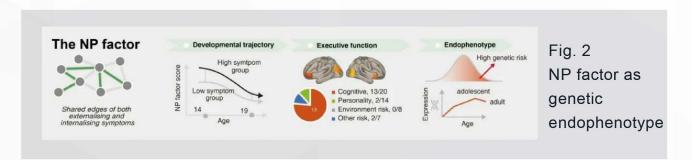


Fig. 1 Overview of research questions and analyses

The research team examined data from the 1,750 adolescents, aged 14 years, from the IMAGEN cohort, a European research project examining how biological, psychological, and environmental factors during adolescence may influence brain development and mental health. In particular, they examined imaging data from brain scans taken while participants took part in cognitive tasks, looking for patterns of brain connectivity - in other words, how different regions of the brain communicate with each other.

Adolescents who experienced mental health problems – regardless of whether their symptoms were internalizing or externalizing, or whether they experienced multiple disorders – showed similar patterns of brain activity. These patterns (NP factor) were largely apparent in frontal lobes, the area at the front of the brain responsible for executive function, which, among other functions, controls flexible thinking, self-control and emotional behaviour.



The researchers confirmed their findings by replicating them in 1,799 participants from the ABCD Study in the USA, a long-term study of brain development and child health, and by studying patients who had received psychiatric diagnoses.

When the team looked at genetic data from the IMAGEN cohort, they found that the NP factor was strongest in individuals who carried a particular variant of the gene IGSF11 that has been previously associated with multiple mental health disorders. This gene is known to play an important role in synaptic pruning, a process whereby unnecessary brain connections – synapses – are discarded. Problems with pruning may particularly affect the frontal lobes, since these regions are the last brain areas to complete development in adolescents and young adults.

The discovery of the NP factor could help identify young people who are at greatest risk of compounding mental health problems, enabling early intervention and risk reduction.

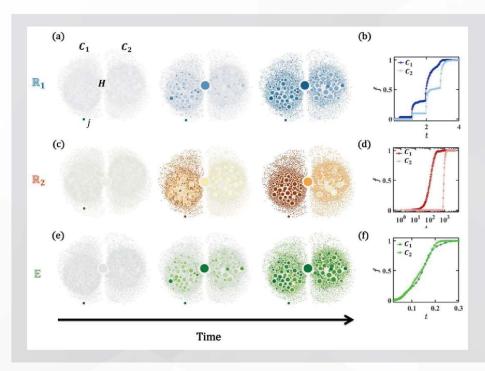


Fig. 1
Different spreading patterns is constructed with different dynamical

In contrast to traditional research that starts from theoretical systems composed of models and networks, big data and the rapid development of data analysis techniques have made it possible to reverse-analyze signal propagation from massive amounts of data. The critical issue is how to correctly restore the connection between units under an unknown system structure from time series data and then identify the path of signal propagation. From the most basic linear correlation to non-linear correlation, and then to the introduction of information flow and transfer entropy concepts, many time series analysis techniques have laid a solid foundation for analyzing signal propagation.

After reviewing a series of theoretical and numerical methods for analyzing unit dependency, the authors further introduce the latest progress in signal propagation analysis, including structure and functional network reconstruction represented by causal inference, information source localization based on time-varying network systems, unit connection inference, and signal processing and time series prediction methods driven by artificial intelligence. In the future, with the further enrichment of data, these analysis techniques will inevitably become important tools for deep analysis of signal propagation and promote a deeper understanding of various complex systems.

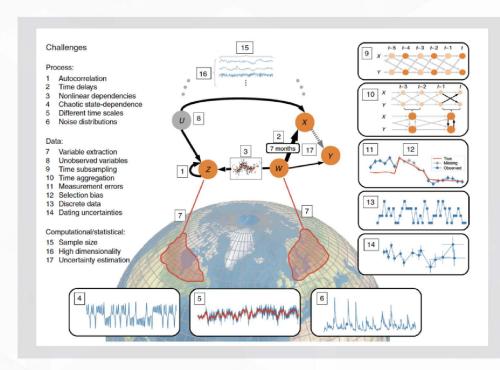


Fig. 2
Opportunities
and challenges
of causal network modeling of
the global
climate

Finally, the authors review the application of the aforementioned theories in fields such as epidemiology, social dynamics, neuroscience, power systems, and robotics, indicating that signal propagation research has broad application prospects. Taking neuroscience as an example, a large number of neural circuits constitute the most basic signal processing and transmission units in the brain. Under the unified integration of hierarchical networks, signals are transmitted in a certain direction to complete the execution of a brain task. The establishment of neural kinetic models and the collection and analysis of neural firing data help researchers understand neural signal transmission from different perspectives, which is conducive to a deep understanding of the brain and provides a theoretical basis for treating cognitive disorders and other neurological diseases.

This review not only helps to further promote the development of complex systems research but also provides a guide for future research.

» Full Article:

Ji, P., Ye, J., Mu, Y. et al. Signal propagation in complex networks. Phy Rep 1017, 1–96 (2023). https://doi.org/10.1016/j.physrep.2023.03.005

» Full Article:

Xie, C., Xiang, S., Shen, C. et al. A shared neural basis underlying psychiatric comorbidity. Nat Med 29, 1232-1242 (2023). https://doi.org/10.1038/s41591-023-02317-4

[About the Authors]





Dr. Xie has published several articles on the topic of reinforcement-related functional circuits underlying common mental disorders, including "Differentiating the distinct roles of neural networks in adolescent depression" (BP:CNNI, 2020), "A novel dual-pathway theory of alcohol abuse in adolescents" (Science

Advances, 2021), and "Identifying a shared general neural basis underlying comorbid psychopathology" (Nature Medicine, 2023).



A/Prof. Tianye Jia

A/Prof. Jia is supported by the National Science Fund for Excellent Young Scientists and Shanghai Pujiang Scholarship. He previously worked at the Institute of Psychiatry, Psychology and Neuroscience of King's College London (ranked 2nd for Psychology and Psychiatry world-wide). Jia's study focuses on

understanding the neurobiological bases for human behaviour and psychiatric disorders with large neuroimaging genetic data. Of over 50 publications, he has published articles as the first or corresponding author on flagship/top journals such as Nature Medicine, Nature Human Behaviour, PNAS, Nature Communications, Science Advances, Molecular Psychiatry, Biological Psychiatry and JAACAP.



Comprehensive Review of Signal Propagation in Complex

Signal propagation in complex networks plays a vital role in driving epidemics, promoting trust and moral behavior in social groups, enabling the development of misinformation detection algorithms, and supporting the cognitive abilities of the brain. The geometry of signal propagation is influenced by both network topology and diverse forms of nonlinear interactions between nodes. However, advances in this area are often system-dependent and have limited translational potential across domains. Given over two decades of research on this subject, there is an urgent need for a comprehensive review.

A research team, led by Prof. Peng Ji from the Institute of Science and Technology for Brain-Inspired Intelligence of Fudan University, reviewed the research progress of signal propagation in complex networks and its application in various fields in Physics Reports on 4 April 2023.

Signal propagation in complex systems can be taken as the continuous transmission of information, physical quantities, or even states between units. The dynamical model is the basic mathematical tool that specifically describes this interaction mechanism, and a concise but accurate dynamics model is the first step in understanding signal propagation. The authors introduce the construction methods and research progress of various common theoretical models that carry signal propagation phenomena, including epidemic models, Kuramoto models, diffusion models, cascading failure models, and models describing neuronal dynamics.

On the other hand, the underlying topologies determine many local properties of signal propagation such as direction and speed. The authors point out that, compared to traditional random networks, emerging network structures, such as time-varying and multilayer networks, have a more complex impact on the topological factors caused by signal propagation, but they also provide new ideas and methods for network regulation and intervention in the propagation process. Based on a general kinetic model, the corresponding theoretical framework successfully separates the factors of kinetics and topology, which is of great significance for deepening the understanding of the roles played by both in signal propagation.

[About the Authors]





Prof. Peng Ji received his Ph.D. in theoretical physics from Humboldt University of Berlin in 2015 with Professor Jurgen Kurths, and then worked at the Potsdam Institute for Climate Impact Research in Germany. He joined ISTBI at the end of 2016 as Young Principal Investigator and became Professor in 2021. He

has won many honorary titles such as Pujiang Talent (2017), Shanghai University Distinguished Professor-Oriental Scholar (2018), Oriental Scholar-Tracking Program (2021). His current research interests include human brain and zebrafish imaging analysis, neural network models, nonlinear dynamics analysis of complex networks, etc. He has published a series of articles in journals such as Nature Physics, Nature Communications, Physics Reports, Physical Review Letters as the first or corresponding author in recent years.



Effects of Urban Living Environments on Mental Health in Adults

An exponential rise in urban living has emerged over the past century. Over half of the world's population now lives in cities, and this proportion is much larger in industrialized countries. More and more people choose to live in urban areas to have better access to healthcare, education and work opportunities. However, urban dwellers are also faced with specific challenges, including exposure to pollutants, lack of green spaces and crowding. There is a long history of studies pointing to an association between urbanicity and mental health problems - particularly for anxiety and depression, the most prevalent mental health disorders. Obtaining comprehensive and detailed assessments of urbanicity is a challenge. Studies tend to focus on specific aspects of the urban environment, such as population density, socioeconomic conditions or access to green spaces. Yet such factors are inherently interconnected and need to be considered in the broader context of urban environments.

Prof. Gunter Schumann (ISTBI) worked with Dr. Jiayuan Xu (Tianjin Medical University General Hospital), Prof. Andre Marquand (Radboud University Medical Center) and their teams to account for this natural complexity by examining many factors related to urban living and modeling them as specific environmental profiles in a large population sample, the UK Biobank. Crucially, their study is unique in that they integrated these profiles with data on brain anatomy, genomics and mental health. Their findings suggest that different environmental profiles of urban living may influence specific psychiatric symptom groups through distinct neurobiological pathways (Fig. 1 and Fig.2).

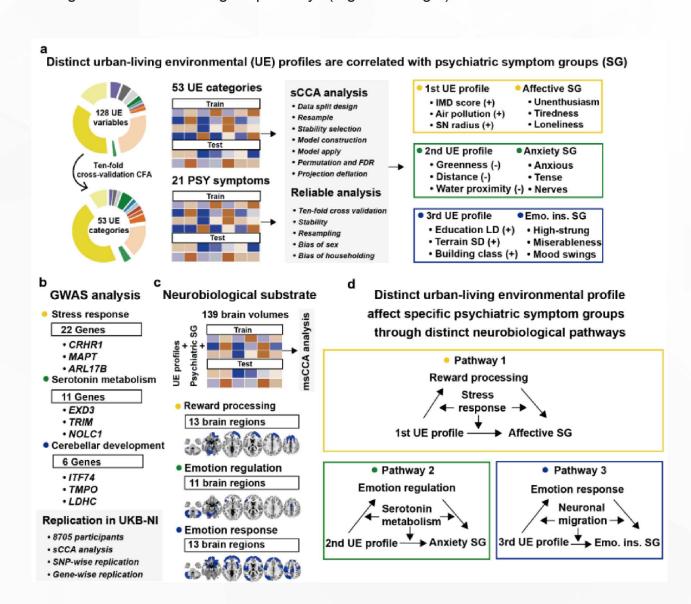


Fig. 1 Schematic summary of main findings



Fig. 2 Research philosophy

As the importance of this work in this field, Nature Medicine published a specific news and views on this work. They pointed out that "The study from Xu et al. marks an important step in untangling the links between urbanicity and mental health by taking into account the inherent complexity of urban environments. The authors' observation that different clusters of psychiatric symptoms were related to different urban environment profiles clearly demonstrates the need to comprehensively model the broader environment, including physical and social aspects. Furthermore, they provide a solid basis for further research on possible mechanisms underlying the urbanicity—mental health link by showing that the anatomy of specific brain regions was associated with this link. In addition, their findings suggest that this link may differ depending on one's genetic makeup."

This work was published in Nature Medicine on 15 June, 2023.

» Full Article:

Ji, P., Ye, J., Mu, Y. et al. Signal propagation in complex networks. Phy Rep 1017, 1–96 (2023). https://doi.org/10.1016/j.physrep.2023.03.005

[About the Authors]





Dr Xu's research focuses on MRI-based neuroimaging exposome-genomics and the underlying neurobiological mechanisms of Alzheimer's disease (AD) and major depressive disorder (MDD). These multidisciplinary studies based on big data have enhanced the understanding of the key influencing factors for

human brain structure and function, and are helpful for the development of new technologies for improving cognitive function and preventing and treating AD and MDD. She published the results as the first author in journals such as Nature Medicine, Nature Human Behavior, Molecular Psychiatry, and Brain, etc. Dr Xu aims to further explore the research on biomarkers supported by the etiological mechanism of MDD, so as to provide reliable biomarkers for the study of biological subtypes of MDD and the evaluation and prediction of clinical diagnosis and treatment.



Prof Gunter Schumann

Prof. Schumann is an internationally renowned scientist who is shaping and coordinating European and global mental health research on prediction and neurobiological characterization of mental disorders. He investigates biological mechanisms underlying reinforcement-related psychopathology and the

development of population neuroscience and precision medicine in Europe and globally. His interest lies in the identification of neurobehavioral phenotypes, for patient stratification. He conceived and is coordinating IMAGEN, one of the most comprehensive and successful imaging genetics studies to date involcing 18 European partners. He has been awarded a Horizon Europe Project 'environMENTAL', of which Fudan University is a partner, being one of the very few Horizon Europe partners in China.



A Phenome-wide Association and Mendelian Randomization Study for Alzheimer's Disease

Alzheimer's disease is the leading cause of dementia, but the environmental factors associated with the development of AD remain incompletely identified. This study explored the relationship between 4171 environmental factors and AD in a very comprehensive way using genetic and phenotypic data from 502,493 subjects in the UK Biobank. The investigators first used a phenotype-wide association analysis, which initially identified 84 environmental factors that were associated with AD.

Based on this, prospective cohort analysis and image association analysis were used to confirm that 39 of these environmental factors were significantly associated with the risk of developing Alzheimer's disease. A Mendelian randomization approach further demonstrated a causal effect of 21 of these factors in the development of AD.

These analyses suggest that people with higher education, larger body size, more non-adipose tissue, more computer use, and better baseline cognition have a lower risk of developing the disease, whereas overeating, excessive exercise, prolonged outdoor exposure, lipid metabolism disorders, and simvastatin use increase the risk of developing AD.

This study integrates genetic, clinical, and imaging data in a multidimensional manner, providing the first comprehensive and rigorous study of wide-area environmental factors and providing important targets and reliable evidence for AD prevention.

» Full Article:

Chen, S-D., Zhang, W., Li, Y-Z. et al. Signal propagation in complex networks. Phy Rep 1017, 1–96 (2023). https://doi.org/10.1016/j.biopsych.2022.08.002

[About the Authors]





Dr Li is interested in genetic and neural mechanisms of sleep disorder and the risk factors of psychiatric disorders and neurodegenerative disorders. She has published papers in Nature Aging, Molecular Psychiatry and Biological Psychiatry etc.

Collaboration and Exchange





ISTBI Delegation Visits the University of Sydney

On 9 - 11 May, 2023, a party of six from the ISTBI, led by Professor Jianfeng Feng, the Dean, visited the University of Sydney to discuss further development of academic collaboration. This is our first international delegation since the COVID - 19 pandemic hit, and also the first face-to-face interaction between the ISTBI and the University of Sydney since an MoU was signed four years ago.

The Fudan – Sydney Brain and Intelligence Science Alliance (BISA) was established between Fudan University and the University of Sydney in 2019 to raise research impact through brain and mind translational research, with both universities committing seed funding to support collaborative projects. Its goal is to train research leaders, advance technological innovation and scientific research and secure practical applications. For 2023, the strategic research themes are Cognitive Neuroscience and Brain Disorders, Computational Neuroscience and Neuroimaging and Digital Healthcare.

A hybrid workshop was organized on 11 May, bringing together academics with shared interest in brain and mind research to review the progress of BISA projects, identify collaboration opportunities, and build team synergy to bring the best out of the partnership.

Professor Sharon Naismith, BISA academic lead at the University of Sydney, kicked off the workshop by presenting an overview of the alliance's achievements.

BISA has launched two rounds of seed-fund programs, targeting multidisciplinary teams (Flagship Program) and early career researchers (Accelerator Program), which have supported 8 joint projects covering the areas of computing neuroscience, imaging, brain health, data analysis, etc., participated by senior researchers as well as ECRs and PhD students. BISA has organized 14 events, including forums,

workshops, symposia, and information sessions, attracting around 700 participants across academia, hospitals and industries. There was also a Research Mentoring Program to support research leadership development and ECR capacity building.

Despite of the disruptions caused by the pandemic, academic exchanges between the two universities have maintained active. Just as Mrs Amanda Sayan, Director of Partnerships at the University of Sydney's Office of Global Engagement, said, "...there is one thing that the pandemic hasn't changed us, that is the commitment from colleagues of both universities to working together to tackle brain and mind challenges. So, with masks on our face, we carried on."



Workshop Panel with BISA Project Leads

Collaboration and Exchange

During the visit, a series of meetings and lab visits were lined up with the Matilda Centre, Brain and Mind Centre, School of Medical Sciences, and School of Psychology to discuss future joint research opportunities.

Professor Maree Teeson, Centre Director of the Matilda Centre, Professor Ian Hickie, NHMRC Senior Principal Research Fellow and Translational Research Collective and Co-Director, Health and Policy of the Brain and Mind Centre, Professor Mary Collins, Fellow of the Royal Australian Chemical Institute and Head of the School of Medical Sciences, and Professor Damian Birney, Acting Head of the School of Psychology and their research teams hosted the delegation.



ISTBI Delegation at the Matilda Centre









Meeting at the Brain and Mind Centre

At the School of Medical Sciences

The partnership between Fudan and USyd continues to be strong and multidisciplinary, with a range of seed-fund programs, joint training programs, academic events, and mutual visits planned. For more information on the partnership or how to get involved, please contact:

- > Ms Jiayue Dai, Director of International Collaboration, Institute of Science and Technology for Brain-Inspired Intelligence, Fudan University: istbi_ic@fudan.edu.cn
- > Ms Xiaohui Fu, Partnerships Officer, Office of Global and Research Engagement, University of Sydney: xiaohui.fu@sydney.edu.au

Collaboration and Exchange







Newly Initiated! Bimonthly Fudan-Cambridge-Sydney Brain and Intelligence Science Young Scholar Symposia

Fudan University has signed agreements with both the University of Cambridge and the University of Sydney to promote the academic exchange, research collaboration and young scientist training. This year, we are bringing together the three prestigious universities to explore further opportunities for collaboration in the fields of Cognitive Neuroscience, Computational Neuroscience, Neural Engineering and Translational Research through a series of bimonthly symposia.

These bimonthly symposia, organised by and for early career researchers (ECRs), serve as a platform for ECRs to present their work and get feedback from their peers, and at the same time, as a hub to find potential international collaborators to start innovative research projects with.

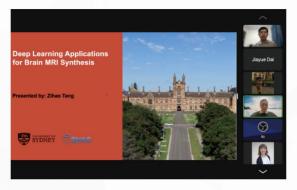
So far, two symposia have been held on 26 April and 15 June, involving 9 speakers with presentation topics ranging across computational psychiatry, apathy, age associated memory impairment, neuroimaging, learning algorithms for spiking neural networks, etc.







Symposia 1 (26 April, 2023)





Symposia 2 (15 June, 2023)

The 3rd symposium will be held on 7 September. Ph.D. students and ECRs from the three universities are welcome to sign up as Speaker for future symposia by contacting istbi_ic@fudan.edu.cn

» Upcoming Events:

Event	Date & Time	Venue
Shanghai-Edinburgh Ageing Workshop	11 August 15:00-18:00; 19:00-21:00 Shanghai	Zoom
Fudan-Cambridge-Sydney Brain and Intelligence Young Scholar Symposium	7 September 16:00-18:00 Shanghai time	Zoom ID: 830 2276 8856
Shanghai Forum	27 - 29 October	Shanghai (details to be announced)
Neurotechnology Innovation Forum	2 - 4 December	Shanghai (details to be announced)

Award and Honor



Professor Peng Ji's Group Awarded a Silver Medal in the International Exhibition of Inventions of Geneva

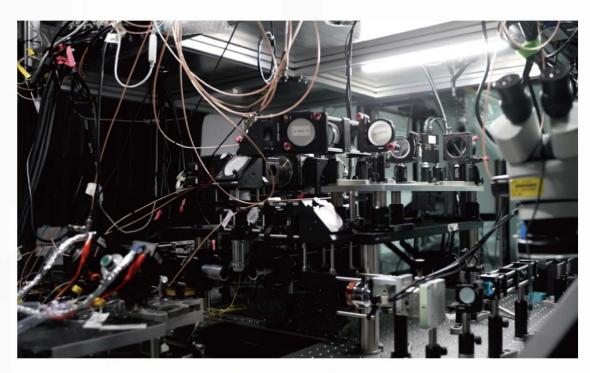


On 9 May, 2023, Professor Peng Ji's research team was awarded a Silver Medal in the International Exhibition of Inventions of Geneva for the invention 'Unified Platform for Imaging and Data Analysis of Zebrafish Whole Brain'.

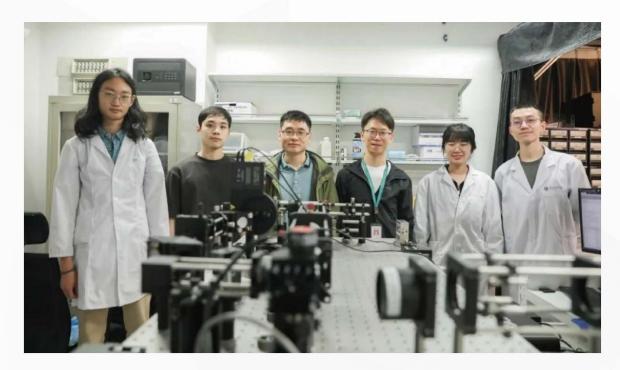
The platform consists of two parts:

- On the hardware side, the optical fluorescence microscope can not only dynamically present important information such as single-cell scale neural activity and neural structure of the whole brain, but also manipulate single neurons/clusters and provide a virtual reality environment to study zebrafish's sensory-motor transduction.
- On the software side, based on the received spatiotemporal signal activity, the system autonomously analyzes complex systems in real-time and reflects a variety of information such as neuron clustering and activated neuron types. Additionally, it conducts analysis such as neuron network reconstruction and information channel identification in the background.

The related research provides important data support for unraveling the mysteries of the brain.



The Unified Platform



Professor Peng Ji's Team

Join Us



We are recruiting young scholars who would like to take up a postdoc position in Shanghai and have a strong interest in the following research areas:

- 1. Cognition and Neuromodulation
- 2. Bioinformatics and Neuroscience
- 3. Whole-brain Computation and Digital Brain
- 4. Brain-inspired Intelligence Technology and Application
- 5. Neuroimaging and Translational Medicine

» Requirements

- 1. Under the age of 35
- 2.PhD degree in relevant fields of the aforementioned research areas, including but not limited to Mathematics, Statistics, Neuroscience, Bioinformatics, Artificial Intelligence, Biomedical Engineering, Clinical Neuroscience, etc.
- 3.Haven't returned/come to China or haven't been (back) in China for more than 1 year

» Benefits

- 1.Salary: ≈ 450k CNY/per annum (≈ 64k USD/per annum), for 3 years
- 2.One-off relocation fee
- 3. Potential opportunities to apply for national fellowship programs
- 4. Given preference to application for Teaching and Research Positions at Fudan University, with the same competence and eligibility

> How to Apply

Please contact istbi_ic@fudan.edu.cn



1.Fudan Fellow Program 2023

Fudan Fellow Program welcomes outstanding scholars from around the world to Shanghai for on-campus academic interaction with the Fudan community.

» Eligibility

Applicants should be citizens of a foreign country and have a good command of Chinese or English. Those who have previously been accepted into this program may not apply for the same category again. There are four categories:

- 1. Honorary Fudan Scholar: Applicants who have won the Nobel Prize, Turing Award, Fields Medal, or other similar awards;
- 2. Distinguished Fudan Scholar: Applicants who are academicians from a country (region) or top scholars with equivalent academic honors, or scholars recommended as having the potential to win the Nobel Prize, Turing Award, Fields Medal and other similar awards.
- 3. Fudan Scholar: Applicants who are full-time Chair Professors or Full Professors (tenure-track) of higher education and research institutions, and have outstanding scientific research potential;
- 4. Fudan Fellow: Applicants who are assistant professors or above in higher education or research institutions, or postdoctoral scholars from top universities with outstanding research potential, who are active and innovative thinkers and have an ongoing research project;
- 5. Applicants with experience working in government or international organizations, well-known enterprises, high-end think tanks or media organizations, with the ability to conduct higher academic communication and scientific and policy research, are recommended to apply for the appropriate category based on their personal circumstances.

» Program

1. Schedule: Honorary Fudan Scholars are invited to campus for no less than 1 week. Distinguished Fudan Scholars are invited to campus for no less than 2 weeks.

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Fudan Scholars and Fudan Fellows are invited to the Fudan campus for 60 days, exceptionally no shorter than 30 days and no longer than 90 days. All are required to visit Fudan University in person.

- 2. Activities: Every four weeks on campus, fellows are asked to give at least one lecture, either to students or fellow researchers, or to host workshops and seminars.
- 3. Publications: Fellows are encouraged to publish papers after the visit under the title of Fudan Scholar/Fudan Fellow. A copy of the publication shall be presented to and kept by Fudan University.

» Allowances & Services

1.International round-trip airfare allowance: The program provides an airfare allowance of up to RMB 35,000 for each Honorary Fudan Scholar/Distinguished Fudan Scholar/Fudan Scholar and up to RMB 10,000 for each Fudan Fellow, with actual travel expenses. The maximum Economy and Business Class allowances are as follows:

Region	The Maximum Allowance for Economy Class (RMB)	The Maximum Allowance for Business Class (RMB)
Aisa	3000	10000
Europe	8000	25000
North America	8000	35000
South America	15000	50000
Africa	8000	25000
Oceania	8000	30000

2. Stipends:

For Honorary Fudan Scholar: 1600 RMB/day * number of visiting days (tax included) For Distinguished Fudan Scholar: 1600 RMB/day * number of visiting days (tax included)

For Fudan Scholar: 1000 RMB/day * number of visiting days (tax included) For Fudan Fellow: 300 RMB/day * number of visiting days (tax included)

3. Services:

Designated facilities and offices are provided by the invitation platform or institution during the visit.

Application

All applications must be in English. An application form and a research proposal form are required. For different categories of applications:

- 1. Honorary Fudan Scholar: Application Form and Curriculum vitae;
- 2. Distinguished Fudan Scholar: Application Form and Curriculum vitae;
- 3. Fudan Scholar: Application Form, Curriculum vitae, and Research Proposal;
- 4. Fudan Fellow: Application Form, Curriculum vitae, Research Proposal and 2 Recommendation Letters.

How to apply

Please contact istbi ic@fudan.edu.cn

2. Fudan Brain and Intelligence Fellowship for Sabbatical Leave

The Fudan Brain and Intelligence Fellowship for Sabbatical Leave has been opened to invite oversea scientists in relevant disciplines to carry out academic activities at our institute during their Sabbatical Leaves.

» Requirements:

- 1.Fellows should be Assistant Professor or above.
- 2. Fellows should conduct research in the following areas and relevant ones:
- (1)Cognitive Neuroscience
- (2) Neuromodulation, Digital Healthcare and Neural Engineering
- (3)Bioinformatics and Neuroscience
- (4) Virtual Brain and Digital Brain Modelling
- (5)Brain-inspired Intelligence Technology and Application
- (6) Neuroimaging and Translational Medicine
- 3. Fellowship supports visits for up to 12 months, and potentially for up to 24 months.

Join Us

» Responsibilities:

- 1.Co-supervise young scholars (postgraduate students, postdoctoral fellows, and early-career researchers) on their research projects and provide constructive feedback.
- 2. Give lectures, or either take lead / participate in organizing an academic event, such as workshop, symposium, conference, etc.

» Scope of the Fellowship:

- 1.One-time travel expenses to and from China.
- 2.Stipends commensurate with experience: no less than CNY 1000 yuan * number of days visiting (tax included).

» How to apply

Please contact istbi_ic@fudan.edu.cn