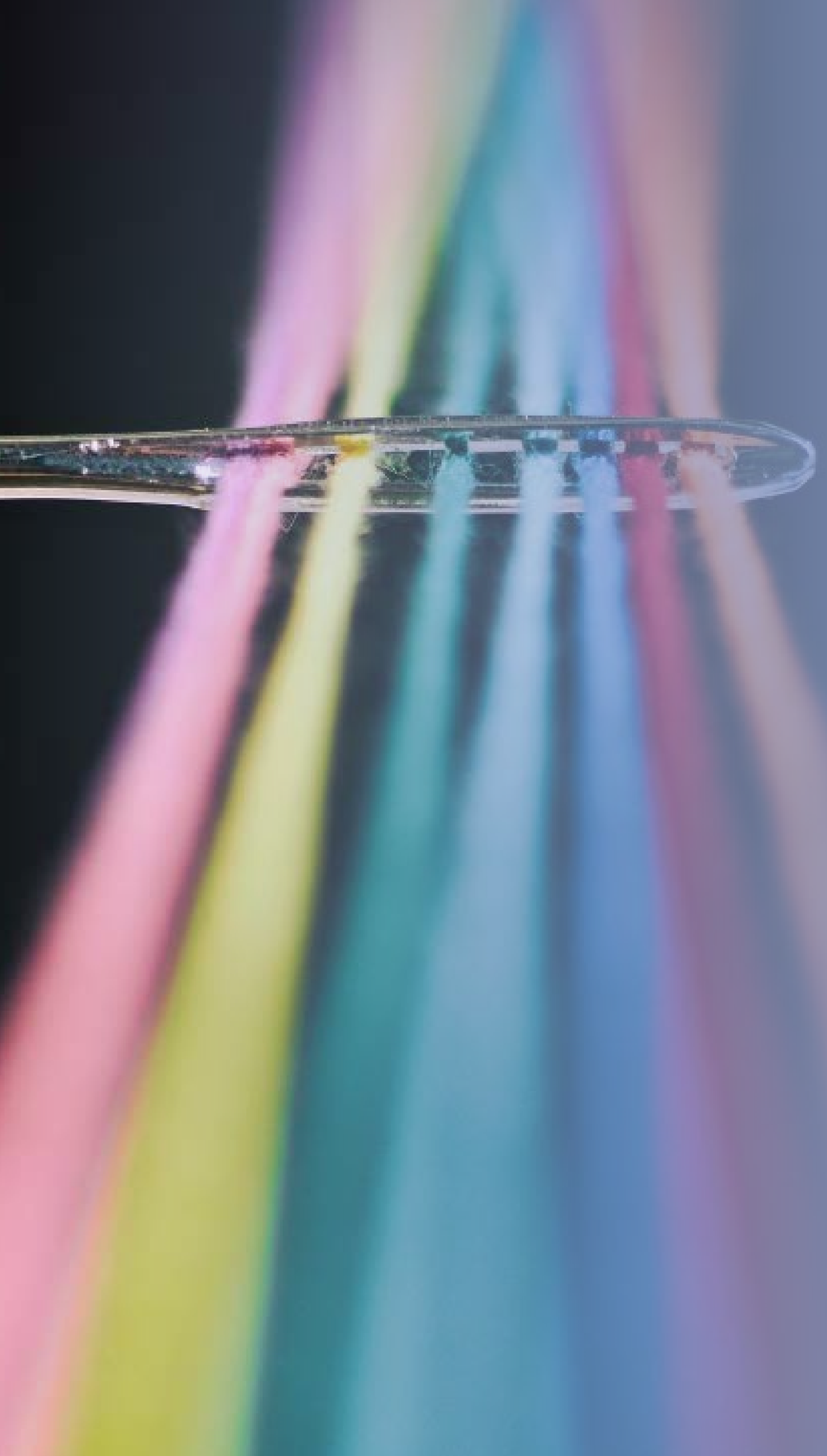
2022 Centre for Sleep and Cognition

Annual report

NUS National University of Singapore

CENTRE for SLEEP & COGNITION



Director's Message

"When the going gets tough, the tough get going"

One of the first thoughts that come to mind about the past year is the winding down of COVID-19 pandemic, and the return of face-to-face interactions. However, along with the restoration of some of life's accustomed ingredients were dramatic upheavals in global geopolitics and economics, whose impact is likely to grow. In such challenging times, well-grounded teams have an outsized advantage and often emerge stronger. The Centre can be proud of being in that position. Our relentless focus on building deep capabilities has always been integral to our identity and this year, it enabled us to shift into a higher gear in scientific capability and reputation despite global headwinds. On the sleep front, we have one of the most capable teams in the world in the sleep wearable technology space. We have led in evaluating the robustness of sleep measurement outside a sleep lab and recommending the duration of monitoring necessary to obtain a reliable assay of sleep variability. We are beginning to mine global sleep data.

Our teams are acknowledged for our understanding of the cognitive benefits of daytime napping in adolescents and young adults. The combination of our edge in trustworthy long-term sleep assessment as well as being able to study different sleep schedules in laboratory or quasi-laboratory settings has given June Lo and myself a leg-up on assessing sleep variability, which is emerging as a facet of sleep that may rival duration in its impact on health and wellbeing. I had the opportunity to contribute an invited piece to Annual Reviews in Psychology on Sleep and Cognition.

Thomas Yeo and Helen Zhou are well entrenched as thought leaders in human brain imaging. Thomas made several notable contributions to how the field thinks about biases in Big Data in Neuroimaging, having contributed to two mega collection efforts. He also developed a framework to translate insights gathered from such large datasets to making inferences about phenotypes collected from smaller ones. His work on the Schaefer brain atlas crossed a 1000 citation threshold. Helen's work on neurodegenerative disorders garnered her two highly prestigious invitations to speak: at the International Society for Magnetic Resonance in Medicine and a keynote at the Organization for Human Brain Mapping.

The PIs of the Centre have collaborated on within-Centre initiatives like using AI to improve the inference of blood pressure from photoplethysmography (PPG) signals and developing our own models for asessing 'Brain Age'. School of Medicine/NUHS signature studies like GUSTO, SG70, SINGER and the Queenstown Health District project, also benefit from our participation. Our industry partnerships with Oura Health and Nestle have done well. NeuroBit, a spinoff company started by former postdoc Amiya Patanaik is into its fifth year. Seizing opportunities to ride meteoric growth in mental health concerns, Julian Lim will be taking the knowledge and skills garnered in his time at our Centre into a new private venture.

Our Centre seminars, started during COVID-19 lockdowns have grown from strength to strength becoming a venue attracting the best sleep and brain imaging scientists in the world. This has benefited our students and staff who continue to excel. Having long envied the intellectual environment of European and North American universities, we can now realistically boast that under our canopy, a scientist will not only receive top-notch scientific training, he/she will imbibe a collegial ethos and collaborative mindset that rivals that of any top group in the world. The future is unpredictable but the one thing I can sleep securely on each night, is the conviction that whatever it throws at us, the Centre of Sleep and Cognition is well positioned for. We are creative, have indomitable spirit, and we will keep going.

Prof. Michael Chee

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SLEEP & COGNITION LABORATORY

Prof. Michael Chee
Principal Investigator

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep.

Robert Frost's haunting words penned after a sleepless winter night, enshrine the devotion of a lone wagon driver to completing his task and have inspired many for over a century.

Frost had reportedly laboured through the night writing a long poem. The memorable short poem about a snowy evening and the little horse only emerged at daybreak. It was as if he had a hallucination, and in just "a few minutes without strain." Perhaps a case of concentrated memory replay?

The SCL certainly has more miles to go in delivering on our promise to transform thoughtful sleep science into public good. However, we are well on our way. Following on our work to validate the use of Oura rings in multi-night sleep studies, we systematically determined how long sleep should be observed to make accurate estimates of sleep variability at weekly and monthly observation frames. We tracked how students slept and work patterns morphed as COVID-19 re-opening unfolded and added to our trove of work on napping by reporting on how it can boost learning of a prior knowledge structure. Our meta-analysis on the effects of napping on cognition proved of interest to both scientists and finance writers.

Using data from several editions of our Need for Sleep studies resulted in uncovering how developmental cortical thinning and sleep EEG changes might be connected to cognitive maturation in adolescents. This will be useful when assessing how sleep patterns might affect the trajectory of brain and cognitive development in larger, longitudinal datasets like GUSTO.

The multi-week, objective sleep tracking protocols we developed have been incorporated into four studies: the SG70 longitudinal aging study, one evaluating the effects of student sleep schedules on glucose levels throughout the day and over a fortnight, a third study evaluating two types of night shifts in medical residents, and finally, a Nestle funded work evaluating the effect of novel food supplement on sleep, cognition and blood glucose. We also worked with HPB to assess a sleep intervention that used objectively tracked and rewarded participants who met specific sleep goals.

The easing of mobility and travel restrictions allowed our young scientists to attend ESRS and interact with their peers. At the same time, they have also been able to interact with international opinion leaders in Sleep science through our regular virtual Centre seminars.

In 2023, we expect to initiate a NUS wide sleep phenotyping project that will examine the effects of sleep on student learning habits and vice versa. Clearly the SCL's horse is galloping along nicely, without needing to defer sleep!

Meta-Analysis of Studies on Naps and Cognition

Naps are periods of sleep taken outside the main nighttime sleep period and while they are common in children and in some societies, they are frowned upon for adults in many 'advanced' societies despite their cognitive benefits.

We synthesized contemporary empirical evidence on the impact of afternoon naps on human cognition. We did this by evaluating how age, or the duration or timing of the naps influence cognition in 60 experimental studies on healthy people. Qualifying experiments compared cognitive performance between a group that took a nap and a group that stayed awake in the same period.

The overall benefit of naps were significant across different cognitive tests. Effects were the strongest for vigilance and memory. Naps ranging from 30 min –120 min, and between 12 noon to 4pm showed benefits. Effect sizes across cognitive domains were small to medium, which is fairly good for health behaviours. The work was published in Sleep Medicine Reviews and caught the interest of the Times (UK) and a branch of the Financial Times.

Work Location Impacts Sleep and Physical Activity

Wearable and mobile tracking revealed changes in sleep, physical activity, and wellbeing during COVID-19 lockdown and reopening .

Changes were strongly related to how much people went back to in-person work versus remained working from home. Those going back to work both slept and got up earlier and were more physically active than those who stayed at home.

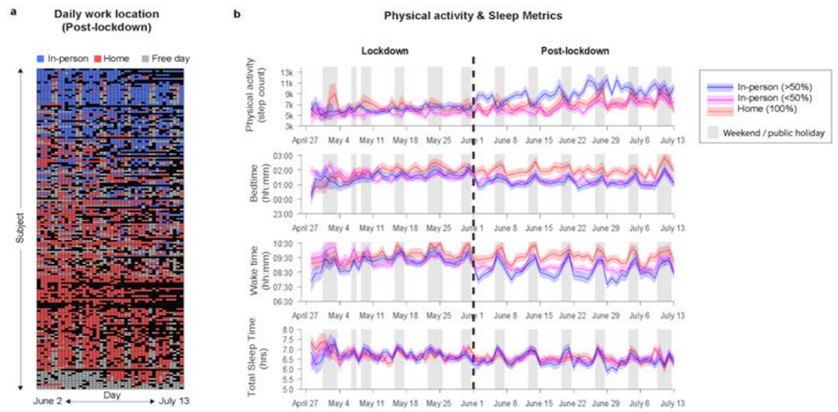


Fig 1. (A) Daily records of work arrangements (in-person vs WFH); each row represents a different person and each column a different day; some transitioned to going back to work; others consistently worked from home (B) Post-lockdown changes in physical activity, bedtime, wake time, and total sleep time were larger for those returning to in-person work. This work appeared in Sleep.

Naps Boost Learning of Structured Knowledge

Organizing knowledge into a framework helps one learn and adapt to revisions in learned material. Sleep aids the formation and transformation memories. Our study combined the two strategies to boost learning outcomes.

The provision of a prior learning framework with which to remember a sequence of pictures was in of itself advantageous to learning. Additionally, adolescent participants who were allowed to nap on multiple consecutive days showed an advantage in learning over those who did not nap, even when the material was subsequently altered and later expanded.

Sleep spindles, a readily recognizable electrophysiological feature, were more abundant in those who evidenced better learning outcomes.

This work was also published in Sleep and is the second installment of a trio of works the lab has on how having prior cognitive structures helps with learning.

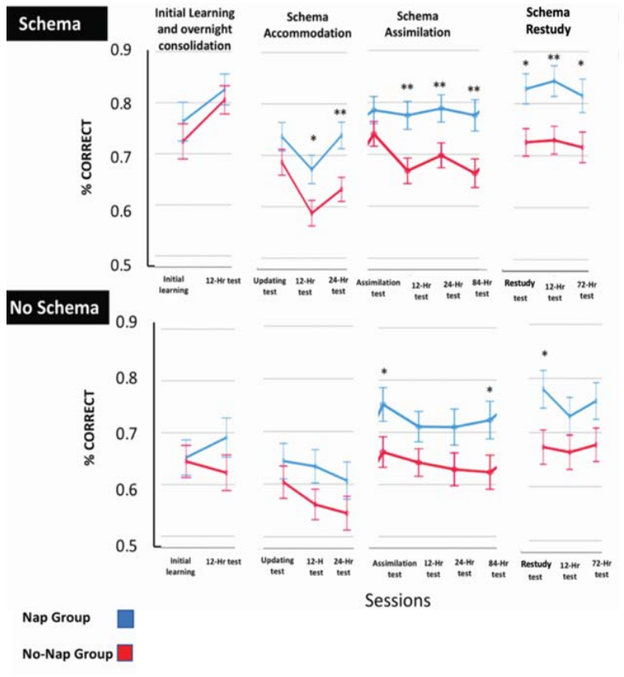


Fig 2. Memory benefits of midday naps were particularly strong for materials that fit an existing knowledge structure (schema).

SLEEP and HEALTH LABORATORY

Assistant Prof. June Lo
Principal Investigator

All of us have experienced and are familiar with the immediate consequences of sleep deprivation. Pulling an all-nighter or simply sleeping too little for a night causes us to become sleepier, slower, less sharp, and crankier the following day. Yet, for various reasons, many of us still do not obtain sufficient sleep.

Given the escalating prevalence of sleep curtailment in many modern societies and the unanimous reports of its diverse negative consequences, such as impaired attention in students and increased risks for dementia in older adults, the team at the Sleep and Health Laboratory has been characterizing the contribution of sleep to cognitive, physical, and psychological well-being in various age groups. We have also been studying factors that lead to voluntary sleep curtailment. Our hopes are to improve sleep health, and thereby enhance brain and cognitive functions as well as psychological well-being. We envision our research leading to better identification of individuals at risk for short and poor sleep, and providing novel and practical ways to maximise cognitive potential and improve quality of life across the lifespan.

Sleep Variability - Is There an Optimal Sleep Schedule?

When faced with limited sleep opportunities, some people cope by sleeping more whenever they can, thereby increasing the day-to-day variability in their sleep; whereas others stick to a fixed bedtime and wake time, for a more regular, albeit restricted, sleep schedule. This project aims to investigate whether a variable or a stable short sleep schedule will be more effective in minimizing the neurobehavioural and metabolic deficits caused by recurrent sleep restriction.

In this ongoing 16-day study, we will be comparing day-to-day cognitive, mood, brain, and glucose metabolic outcomes among participants who are given 6 hours to sleep every weeknight and those who are given 4 to 8 hours to sleep on weeknights.

Tracking Development of Sleep and Neuropsychological Functions in School-Age Children

The features of sleep that contribute to optimal cognitive outcomes in school-age children remain uncertain, particularly in the long run. With polysomnography, this study examines the features of sleep macro- and micro-structure that contribute to cognitive and psychosocial development among school-aged children.

Cognitive performance, resilience, dishonest behavior, and internalizing and externalizing behaviors will be assessed at baseline as well as 1-year follow up.

Parent- and School-Related Factors of Short Sleep in School-Age Children

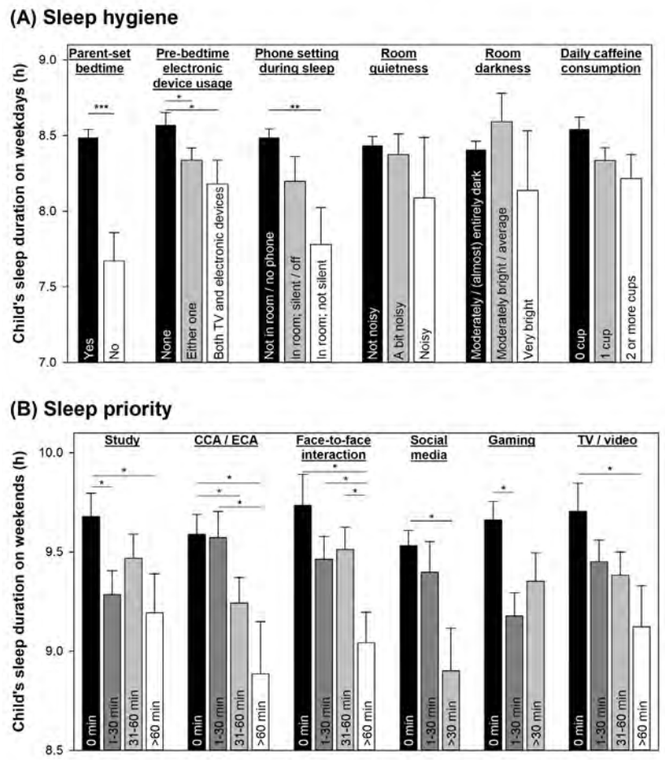


Figure 1. (A) Effects of different sleep hygiene practices on children's sleep duration on weekdays. Darker bars indicate better sleep hygiene practices. (B) Effects of parents' sleep priority on children's sleep duration on weekends. Darker bars indicate higher prioritisation of children's sleep over other activities (i.e. parents allowed their children to sacrifice fewer minutes of sleep for other activities). Error bars represent standard error. * $p < .05$; ** $p < .01$; *** $p < .001$.

Our recent survey in Singapore showed that on weekdays, 64.5% of school-aged children slept less than the minimum recommended duration of 9 h. Although this percentage decreased to 19.5% on weekends, the high prevalence was alarming. Short sleep in this age group was driven by multiple school- and parent-related factors, which interestingly, differed for weekdays and weekends.

Short sleep on weekdays was associated with earlier school start times, and poorer ability of the parents to enforce sleep hygiene, i.e., no parent-set bedtimes and allowing their child to engage in pre-bedtime usage of electronic devices (Figure 1A). In contrast, short sleep on weekends was associated with parents' prioritization of other activities over their child's sleep, including studying, co-/extra-curricular activities, face-to-face interactions with family and friends, social media, gaming, and watching TV/videos (Figure 1B). To understand whether factors of short sleep in school-age children differ across cultures, and if similar differential weekday-weekend patterns exist, we are extending this investigation to a cross-cultural comparison with children in the U.S. and China.

Assistant Prof. Julian Lim
Principal Investigator

In 2022, the Awake Lab has continued to focus its efforts on understanding how being mindful can have a positive effect on well-being and thriving. Having identified improvements in sleep as an important pathway for these gains, we are particularly eager to delve deeper into this area to more comprehensively understand the relationships between mindfulness, sleep, and daily functioning.

In line with these goals, we extended our partnership with MindFi this year to conduct an efficacy trial of their wellness app, studying 200 volunteers who used the app regularly for a period of 5 weeks and measuring changes in their stress, sleep, and well-being. We also explored partnerships with Bonfire Health, a local start-up aiming to use AI-based approaches to detect workplace stress and offer targeted interventions. These industry tie-ups have been useful for us to gauge the translational value of our research, and we are excited to foster these and other new relationships in the coming years.

With regard to our core interest in mindfulness-based therapy for sleep, our efforts in the lab have been geared towards greater mechanistic understanding to improve the translational value of these treatments. We have continued to explore the impact of mindfulness meditation on brain activity during sleep, misperception of sleep and wake states, and resting-state functional configurations at rest. Our interests also extend to whether meditation might have an impact on increasing the restorative effects on daytime naps. All these studies are being carried out with an eye to increasing the real-world impact of mindfulness-based sleep treatments as they start to gain more traction as a therapeutic option for those with insomnia and other sleep difficulties.

Mindfulness Based Treatment for Insomnia Reduces Discrepancies Between Objective & Subjective Measures

Sleep discrepancies - a mismatch between objective and subjective sleep times - are common among patients with insomnia and other sleep disturbances, and may contribute to the maintenance of their problems. Our graduate student, Noof Shaif, conducted a reanalysis of the Mindfulness as Sleep Therapy (MIST) dataset to investigate whether Mindfulness Based Treatment for Insomnia (MBTI) might reduce this discrepancy relative to a control condition (the sleep hygiene, education, and exercise programme group; SHEEP). In this study, subjective sleep parameters were measured using sleep diaries, and objective parameters measured using polysomnography (PSG) and actigraphy.

The main finding of this work, published in the Journal of Sleep Research, was that MBTI significantly reduced the discrepancy for sleep onset latency (SOL), or the time taken to fall asleep, for both PSG (Figure 1a) and actigraphy (Figure 1b). SHEEP reduced this discrepancy for actigraphic measures only. In contrast, there was no significant change in discrepancy for wake time during the night in either group. Interestingly, we found that the increases in behaviourally measured trait mindfulness were correlated with reductions in SOL discrepancy, which in turn were correlated with improvements in sleep quality.

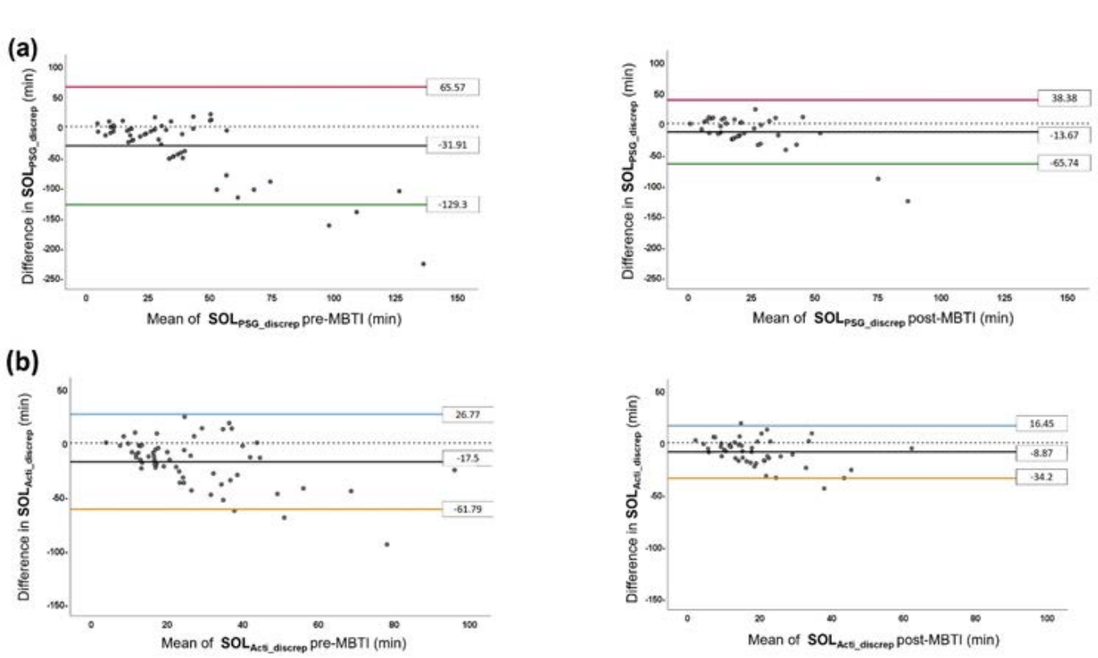


Figure 1. Bland–Altman plots presenting the discrepancy and the agreement limits pre- versus post-MBTI intervention
(a) SOLPSG_discrep, (b) SOLActi_discrep. Black lines represent the means of SOLPSG_discrep and SOLActi_discrep, and red/green and blue/orange lines denote the upper and lower agreement limits. MBTI, mindfulness-based therapy for insomnia; SOLPSG_discrep, the discrepancy between PSG-recorded and self-reported sleep onset latency; SOLActi_discrep, the discrepancy between actigraphy-recorded and self-reported sleep onset latency.

Eyeblinks as an Online Measure of Sustained Attention

Aaron Ang conducted a pilot study measuring eyeblink rate during an auditory psychomotor vigilance task. Average eye blink rates 10 seconds prior to target onset were significantly lower preceding trials with faster response. This pilot demonstrated that attention could potentially be measured in real-time using recent eye blink rate as an index (Figure 2).

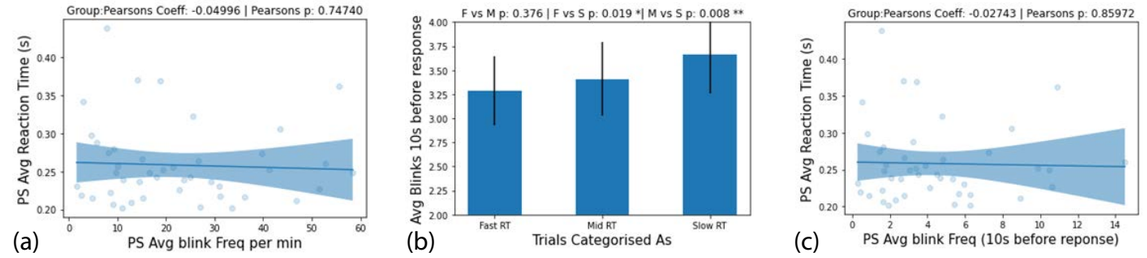


Figure 2. Eye blink rate as a function of audio PVT reaction time. (a) Average blink rate during entire task and (c) time windows 10s prior to target onset, as a function of average reaction time for all participants. No significant correlation was found, suggesting that blink rate is not an accurate predictor of attention across participants. (b) Within-subjects analysis, where trials for all participants were broken down into tertiles by reaction time. Trials with slowest reaction time had significantly higher blink rates 10 seconds before target onset as compared to trials with mid- and fast reaction time. Error bars are standard error of mean.

Drift Diffusion Model (Ddm) Metrics Predict Vulnerability to Recurrent Two-Week Sleep Restriction in Adolescents

In collaboration with Dr. June Lo, we published this reanalysis in a tribute issue of Sleep Advances for Dr. David Dinges Festschrift. We found a novel interaction, with baseline performance metrics more accurate at predicting PVT performance during the first week of sleep curtailment, and DDM metrics more accurate at predicting PVT performance on the second week.

Multimodal Neuroimaging Laboratory

Associate Prof. Helen Zhou
Principal Investigator

In 2022, our members at the Multimodal Neuroimaging in Neuropsychiatric Disorders Lab (MNL) finally returned to the office. We had our first lab meeting and lab party without masks in three years. Our monthly brainstorming sessions have also gained more momentum. We can see everyone's smiling faces and the sparkles in their eyes!

This year, our lab had high international visibility. In June, I gave a keynote lecture on brain network phenotypes in neurological disorders at the Annual Meeting of the Organization for Human Brain Mapping (OHBM, see interview). I was also invited to give a plenary talk on "Ideas ahead of their time – resting state functional MRI" at the Annual Meeting of the International Society for Magnetic Resonance in Medicine (ISMRM). We are also proud that young scientists from the lab continue to gain recognition from the international community. Four research works were selected for oral presentations at international conferences. Two out of these four projects are based on Singapore datasets: the Growing Up in Singapore Towards healthy Outcomes (GUSTO) study and the Memory, Aging, and Cognition (MACC) study.

As we continue to understand brain network phenotypes and search for early imaging biomarkers in disease, our lab has made good progress on several fronts. Our work in eLife shows the stage-dependent influence of brain networks on memory from preclinical to dementia stages of Alzheimer's disease. Replicated in two cohorts, our study advances the hypothetical Alzheimer's disease biomarker model. We were involved in two large-scale studies published in Nature and Translational Psychiatry. Moreover, our group completed several machine learning projects on image segmentation, classification, and outcome prediction in stroke, schizophrenia, and dementia. For example, the work on an interpretable deep learning model to predict individualized longitudinal brain atrophy and cognitive decline by our Ph.D. student, Yu Xiao, has won the highly competitive Abstract Merit Award at OHBM 2022.

In parallel, 2022 has been a productive year for us in terms of recruitment and imaging. Our focus was on "Aging". In collaboration with other labs from CSC, NUSmed, and NUHS, we collected brain scans from >200 at risk elderly for SINGER, a multidomain lifestyle intervention to reduce cognitive decline and physical frailty. With the vision to map lifespan brain trajectory and enhance human potential, ~300 SG70 participants and ~100 young and middle-aged participants have joined our multidisciplinary study.

As the pandemic is winding down, the team expects the coming year to be even better!

Stage-Dependent Influence of Neurodegeneration on Memory across Alzheimer's Disease Continuum

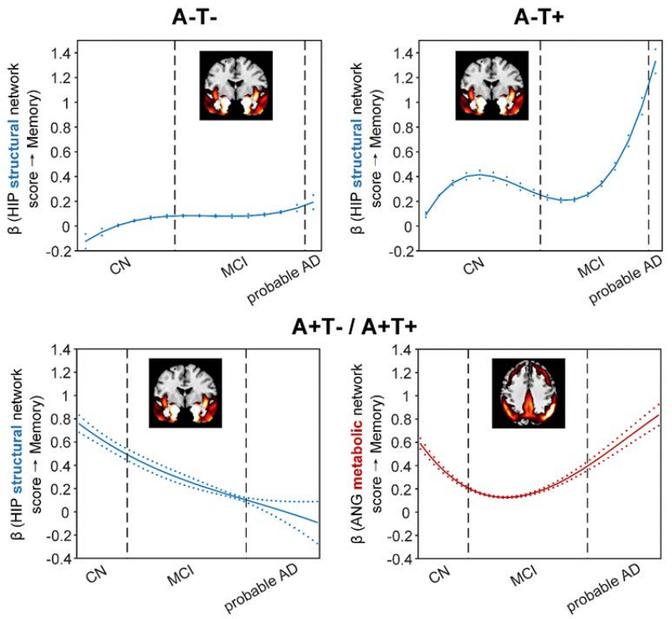


Figure 1. Stage-dependent association of brain hippocampal structural network with memory performance in different pathology groups.

In this study, we characterized how network-based structural and metabolic imaging biomarkers are associated with memory performance in 1280 individuals with or without amyloid pathology from cognitively normal to dementia stages.

Our findings provide first evidence that both the hippocampal structural network and the default mode metabolic network contribute to memory performance in the amyloid-positive cognitively normal individuals, while the metabolic network dominates the memory-network associations in the late dementia stage. This will pave the way for precise stratification and intervention strategies to slow down memory decline. We are working on further examining the AD hypothetical biomarker model longitudinally.

This study is published in eLife.

Classification and Prediction in Neuropsychiatric Disorders

Classification and prediction in neuropsychiatric disorders

Our PhD student Yu Xiao developed an efficient and interpretable graph convolutional network model to predict individualized, longitudinal regional atrophy and cognitive decline in the AD spectrum. Importantly, our approach was validated in two independent datasets (ADNI and MACC from Singapore) indicating its generalizability. This work was presented as Oral in OHBM 2022 and received the abstract merit award. Moreover, our PhD student Mengjiao Hu developed a deep feature approach based on naive 3D convolutional neural network models for schizophrenia identification, which also provides relevant neurobiological interpretations. This study is published in Schizophrenia Research.

Cerebrovascular MR marker segmentation using deep learning

Our PhD student Yilei Wu proposed a deeply supervised 3D neural network to perform white matter hyperintensity (WMH) segmentation in fluid attenuation inversion recovery magnetic resonance images. Published by Medical Imaging with Deep Learning (MIDL), this method achieved competitive performance on the independent Singapore dataset from MACC, outperforming other state-of-the-art methods. His work also ranked 4th in the "Ischemic Stroke Lesion Segmentation Challenge 2022" at the medical image computing and computer assisted intervention (MICCAI) conference. We are currently in collaboration with NUH clinicians to apply his approach to predict clinical outcomes.

Variations in Cortical Functional Gradients Relate to Dimensions of Psychopathology in Preschool Children

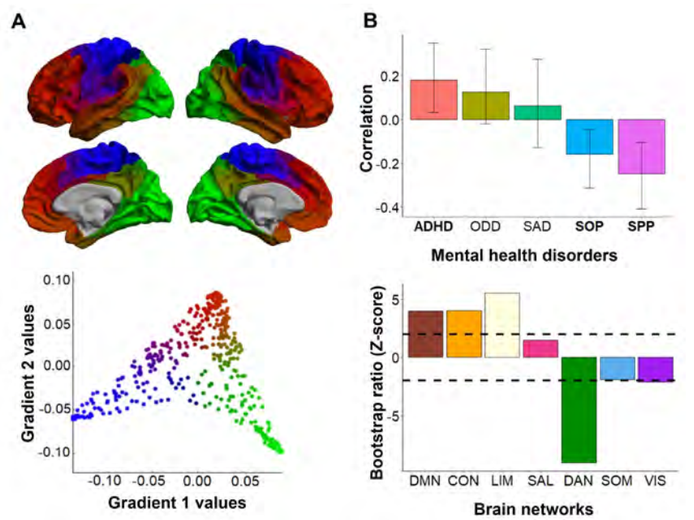


Figure 2. Variations in cortical functional gradients relate to dimensions of psychopathology in preschool children

While brain functional hierarchy has been established in healthy adults, few are looking at its development in preschool children as well as its relevance in mental health. Utilizing data from the longitudinal Growing Up in Singapore Towards healthy Outcomes (GUSTO) dataset, we revealed for the first time that the principal axis that explained the most variation of functional connectivity in preschool children separated the two unimodal networks. Importantly, we discovered a diverging pattern differentiating ADHD and phobic disorders that manifested in the second functional gradient between unimodal and transmodal regions. Our results provided valuable insights into the relationship between functional neuroarchitecture and mental health in this understudied cohort. This study was presented as Oral in OHBM 2022 and the manuscript is under review.

Computational Brain Imaging Group

Associate Prof Thomas Yeo
Principal Investigator

2022 has been a good year for the Computational Brain Imaging Group (CBIG). With the loosening of pandemic restrictions, group members are now mostly back at the office and enjoying face to face interactions with each other. Our weekly "brain tea" has also been revived with much enthusiasm.

A core philosophy of CBIG is slow science, which emphasizes quality rather than quantity. One effect of this philosophy is that research in our group takes multiple years to be published, but is widely recognized to be of great depth, even yielding memes on social media. Consequently, our research has lasting impact regardless of the publication venues. One salient example is the widespread adoption of our functional brain atlases in the past decade. This year, our 2018 Schaefer atlas crossed the landmark threshold of 1000 citations.

A common theme across our publications this year is "big data". We were involved in two large-scale studies published in Nature and led several studies published in high-profile venues. Our study in Nature Neuroscience shows how AI models trained from large datasets can be translated to predict new phenotypes in small datasets. At the same time, potential biases of AI models remain a significant concern across many fields. Our study in Science Advances shows that biases towards minority population remains an important open problem in neuroimaging. You can find more details in the following pages.

Finally, I am proud that our young scientists are gaining recognition from the international community. Dr. Csaba Orban gave an invited talk at Dartmouth, while Dr. Ruby Kong was invited to present at Cornell and Monash University.

Shared & Unique Brain Network Features Predict Cognition, Personality & Mental Health

Previous studies have found that resting-state and task-state functional connectivity can predict specific traits at the individual level. In this study, we find that predictive network features are distinct across cognition, personality, and mental health. Although tasks are known to modulate the functional connectome, predictive network features are similar between resting and task states. Overall, our findings reveal shared brain network features that account for individual variation within broad domains of behavior.

This study was published in Nature Communications.

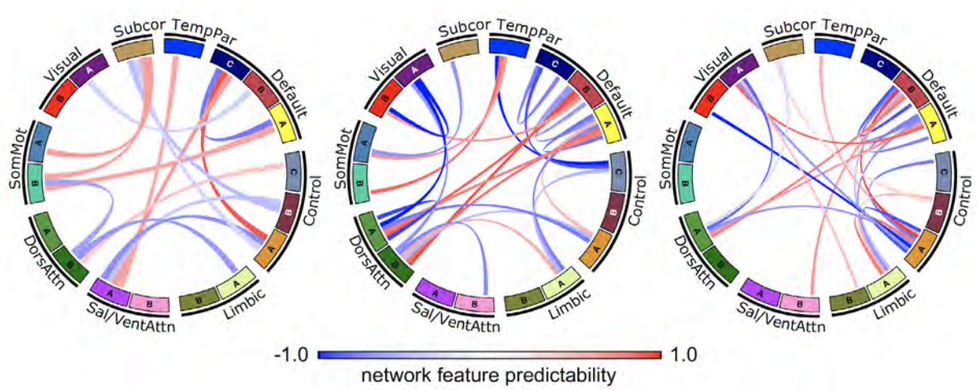


Figure 1. Predictive network features are distinct across the behavioral domains of cognition, personality and mental health.

Piggybacking on Big Data

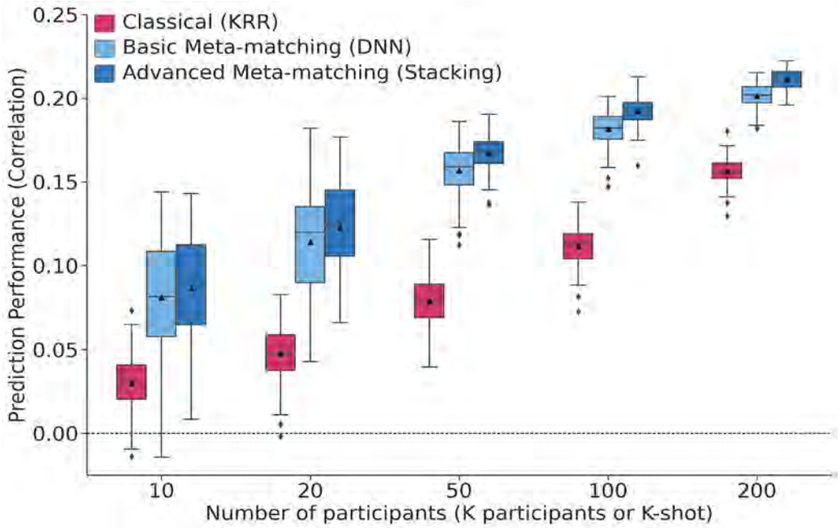


Figure 2. Our meta-matching algorithms (blue) achieved dramatic improvements over traditional machine learning (red).

Individual-level prediction is a fundamental goal in systems neuroscience and is critical for precision medicine. However, most prediction studies are underpowered, including less than a few hundred participants. A recent Nature study suggests the need for thousands of participants, but small-scale datasets are often unavoidable when studying rare clinical populations or when addressing focused neuroscience topics. We propose a simple "meta-matching" framework to effectively translate predictive models from large-scale datasets to predict new phenotypes in small-scale studies. We show that meta-matching can greatly boost the prediction of new phenotypes, achieving 100% to 400% improvements in many scenarios. We are working with multiple groups from Singapore and overseas to apply our approach to their data.

This study was published in Nature Neuroscience. Commentary on our study here.

Cross-Racial Generalization Failure in Functional Connectivity Prediction of Phenotypes

Algorithmic biases favoring majority populations pose a key challenge for precision medicine.

In this study, we find similar biases in models predicting behavioral phenotypes based on resting-state fMRI. More specifically, models trained from a heterogeneous population will yield better prediction performance for the majority group than the minority group.

Overall, the results point to the need for caution and further research regarding the application of current brain-behavior prediction models in minority populations.

This study was published in Science Advances.

CSC Seminars

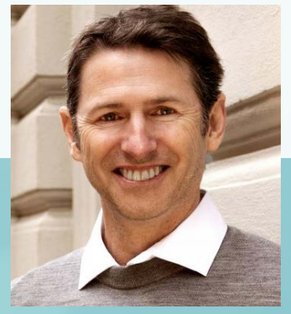
CSC Seminars attract some of the most sought after scientists in Sleep, Cognitive Neuroscience and Brain Mapping.

Sleep on it to ditch or deepen distress:
Why insomnia is the primary modifiable risk for emotional disorders

Eus Van Someren, Ph.D.
Prof at VU University, Head of Sleep and Cognition Department, Netherlands Institute for Neuroscience, The Netherlands

Exploring the links between insomnia and anxiety in school-aged children, one study at a time.

Michael Gradisar, Ph.D.
Professor of Clinical Child Psychology, Flinders University in Adelaide, Australia

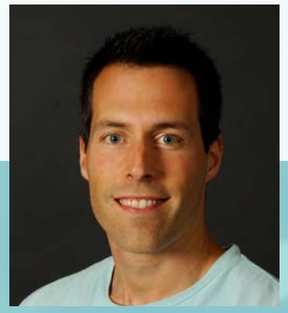


Sleepy, surly, spacey, sedentary, sugared-up, scary on the road, somatic/sore, and a bit less smart: The causal impact of short sleep in adolescents

Dean Beebe, Ph.D.
Professor, University of Cincinnati College of Medicine Director at Cincinnati Children's Hospital Medical Center, USA

Cognitive assessments in the COVID-19 era: On smartphones, websites, and other zoomsday scenarios

Jason Hassenstab, Ph.D.
A/Professor of Neurology and of Psychological and Brain Sciences , Director of the Cognitive Technology Research Laboratory Washington University in St. Louis, USA



Sleep is not a waste of time!

Jean-Philippe Chaput, Ph.D.
Senior Research Scientist, the Children's Hospital of Eastern Ontario Research Institute, Canada
Associate Professor of Pediatrics, University of Ottawa, Canada

Interindividual variability of brain phenotypes – towards population neuroimaging

Svenja Caspers, M.D., Ph.D.
Professor of Anatomy and Director of the Institute for Anatomy, University of Düsseldorf, Germany

CSC Seminars

Brain dynamics and flexible behaviors

Lucina Qazi Uddin, Ph.D.

Prof of Pyschiatry and Biobehavioral Sciences,
University of California Los Angeles, USA

Functional parcellation of the human subcortex

Andrew Zalesky, Ph.D.

Associate Professor, Faculty of Engineering and Medicine,
University of Melbourne, Australia

International Speakers at the CSC Seminars

Aurélie Stephan
Lausanne U

Daniel Buysse
U of Pittsburgh

Christian Webb
Harvard Med Sch

Jiahui Guo
Dartmouth College, US

Mac Shine
U of Sydney

Patricia Silveira
McGill U

James Cole
UCL,

Sara Mednick
UC Irvine

Sofie Valk
Forschungszentrum Jülich

Casey Paquola
Forschungszentrum Jülich

Joshua Gooley
Duke-NUS

Chao-Gan Yan
Chinese Academy of Sciences

Jean-Philippe Chaput
U of Ottawa

Karli Montague-Cardoso
Nature Portfolio

Partnerships

SG70

The CSC faculty is leading the brain health and digital phenotyping part of the SG70 study – a NUSmed flagship research programme. The SG70 cohort is part of the continuation of the Singapore Chinese Health Study led by Prof Koh Woon Puay.

Since the launch of the study in December 2021, about 300 subjects have been recruited and participated in the multi-dimensional aspects of the research, including neuropsychological assessments, brain imaging and digital tracking technology. Findings from the cohort have potentially significant contributions towards promoting healthy longevity in ageing Singaporeans.

HPB

The Health Promotion Board (HPB) is a statutory board under the Ministry of Health, with goals to promote healthy living in Singapore. In an effort to tailor its health promotion policies and programmes, HPB launched the "Health Insights Singapore (hiSG)" population health study four years ago, to better understand health behaviours of Singapore residents using wearable technology. The data from this project provide longitudinal insights into sleep behaviors of a large cohort of working adults.

In 2020-2021, we tracked how COVID-19 restrictions affected sleep and physical activity patterns in different groups of individuals. This year, we formulated guidelines for minimum data requirements for reliable sleep estimation using consumer sleep trackers. The publication in SLEEP Advances can be read here. Furthermore, we completed a large-scale intervention study to encourage healthy sleeping habits in short sleepers of this cohort. The Sleep and Cognition Lab looks forward to continued collaborations with HPB.

ENIGMA

Together with Dr. Jimmy Lee from the Institute of Mental Health Singapore, Prof. Michael Chee, and A/P Helen Zhou have been invited to join the ENIGMA clinical high-risk working group. This working group investigates structural brain alterations in those at clinical high risk for psychosis.

Two papers have been published using the ENIGMA data, the largest existing clinical high risk for psychosis datasets around the world (>1000 patients), one in JAMA Psychiatry 2021 and another in Translational Psychiatry 2022. Moreover, the Singapore team is working on a secondary proposal investigating structural covariance network topology in the clinical high risk.

SINGER

The CSC (A/P Zhou and A/P Yeo) partners with the Memory, Ageing, and Cognition Centre of NUHS (A/P Christopher Chen) to conduct the first multi-lifestyle SINgapore GERiatric intervention (SINGER) to reduce cognitive decline and physical frailty in elderly at risk for dementia.

Funded by the large collaborative grant from National Medical Research Council (2020-2024, led by A/P Chen), the CSC team seeks to answer questions that may be unique to Singapore/ Asian phenotypes with respect to vascular cognitive impairment by leveraging on high-resolution Magnetic Resonance Imaging.

To date, we have collected MRI scans from over 200 participants. The proposed study and its associated neuroimaging component will pave the way for robust and explainable personalized preventive medicine.

Partnerships

NUHS

The National University Health System (NUHS) is one of three public healthcare clusters in Singapore, and an integrated Academic Health System and Regional Health System. Members of NUHS comprise tertiary, acute and community hospitals, national specialty centres, polyclinics, a medical centre as well as academic health sciences institutions.

This year, the Sleep and Cognition Laboratory has embarked on a study to understand the impact of different rotating shift schedules, among Postgraduate Year 1 (PGY1) doctors at NUHS. The traditional "on-call" schedules require junior doctors to go through frequent 24-30 h overnight shifts. NUHS has implemented an alternative "float" schedule in several departments, where overnight shifts are less frequent but are concentrated in a week of consecutive 12-h night shifts, known as "night-float". Using state of the art wearable and mobile technology, we aim to understand the sleep patterns, metabolic response, and well-being of the doctors, and hope to provide insights to guide scheduling within NUHS for the betterment of present and future doctors.

PNC

A/P Thomas Yeo has initiated a new collaboration with Professor Raquel Gur and A/Prof Theodore Satterthwaite from the University of Pennsylvania to apply computational techniques developed by his group to the Philadelphia Neurodevelopmental Cohort (PNC).

It is widely believed that the balance of excitation and inhibitory neural activity is critical for healthy brain function. Disruption to the excitation-inhibition (E/I) balance is thought to play an important role in the onset of psychiatric disorders. However, the E/I balance is typically measured in animals with invasive techniques and cannot be easily investigated in human participants.

A/Prof Yeo and his PhD student Shaoshi Zhang recently developed a biophysical model that allows the estimation of E/I balance in human participants using just functional MRI data. It is widely believed that the E/I balance is heterogeneous across the cortex and decreases during development as the result of the maturing GABAergic inhibitory circuitry. They are currently investigating whether their model can detect reduction in E/I balance during development and whether E/I balance can be a sensitive marker of healthy development.

OURA

Oura Health is a Finnish health technology company that created the Oura Ring, a wearable sleep and activity tracker that leverages on multisensor measurements to deliver personalized health insights.

Wearable technologies such as the Oura Ring allow scalable measurement of sleep across multiple nights and large populations, allowing the characterization ofsleep patterns and targeted intervention studies. e.

The Sleep and Cognition Lab began our involvement with Oura Health in Dec 2019 to conduct a multi-night validation study on adolescents using Oura Rings and polysomnographic recordings. A second validation study on adults in a home-based setting was conducted between Dec 2020 -Apr 2021, and these results were used to improve Oura's sleep algorithms. The results of this study were published in the journal Nature and Science of Sleep. This year, we continued to conduct further studies to expand Oura's range of functions and accuracy in measurement. In addition to conducting validation studies, the Sleep and Cognition lab is collaborating with Oura to analyze large scale trends in sleep behavior from Oura's global user base.

POND

A/P Helen Zhou's team is collaborating with the Progression of Neurodegenerative Disease (POND) group at University College London on modelling the progression of neuroimaging biomarkers of Alzheimer's disease using machine learning approach. The approach can simultaneoulsly discover progression trajectories and subtypes with clinical relevance.

MCGILL

A/P Helen Zhou's team has initiated two projects with McGill University examining the effects of tau and amyloid-beta on functional connectivity, as well as its associations with mild behavioral symptoms and cognitive impairments in preclinical and prodromal AD.

Achievements

Impact & Exposure

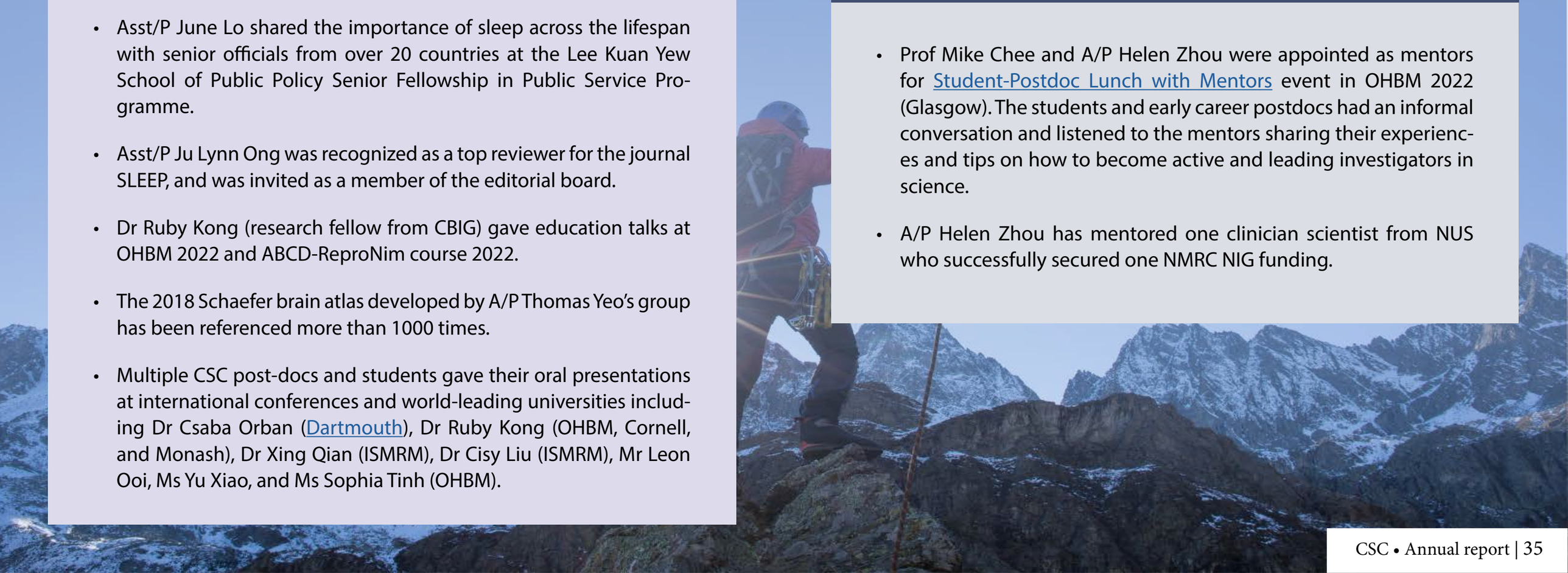
- Asst/P Julian Lim and his post-doc Aaron Ang were featured on an upcoming documentary on mental wellness, providing their insights on meditation and sleep.
- A/P Thomas Yeo is listed as a Clarivate Highly Cited Researcher for a fourth consecutive year.
- A/P Helen Zhou gave a keynote lecture "Differential Brain Network Phenotypes in Neurological Disorders: A Longitudinal Perspective" in OHBM 2022. She also gave a plenary talk in Ideas Ahead of Their Time at ISMRM 2022.
- Asst/P June Lo shared the importance of sleep across the lifespan with senior officials from over 20 countries at the Lee Kuan Yew School of Public Policy Senior Fellowship in Public Service Programme.
- Asst/P Ju Lynn Ong was recognized as a top reviewer for the journal SLEEP, and was invited as a member of the editorial board.
- Dr Ruby Kong (research fellow from CBIG) gave education talks at OHBM 2022 and ABCD-ReproNim course 2022.
- The 2018 Schaefer brain atlas developed by A/P Thomas Yeo's group has been referenced more than 1000 times.
- Multiple CSC post-docs and students gave their oral presentations at international conferences and world-leading universities including Dr Csaba Orban (Dartmouth), Dr Ruby Kong (OHBM, Cornell, and Monash), Dr Xing Qian (ISMRM), Dr Cisy Liu (ISMRM), Mr Leon Ooi, Ms Yu Xiao, and Ms Sophia Tinh (OHBM).

Awards

- PhD student Xiao Yu from A/P Helen Zhou's lab received a OHBM Merit Abstract Award based on her oral presentation on brain connectome-based prediction of future cognition and atrophy using machine learning.

Outreach & Membership

- Prof Mike Chee and A/P Helen Zhou were appointed as mentors for Student-Postdoc Lunch with Mentors event in OHBM 2022 (Glasgow). The students and early career postdocs had an informal conversation and listened to the mentors sharing their experiences and tips on how to become active and leading investigators in science.
- A/P Helen Zhou has mentored one clinician scientist from NUS who successfully secured one NMRC NIG funding.



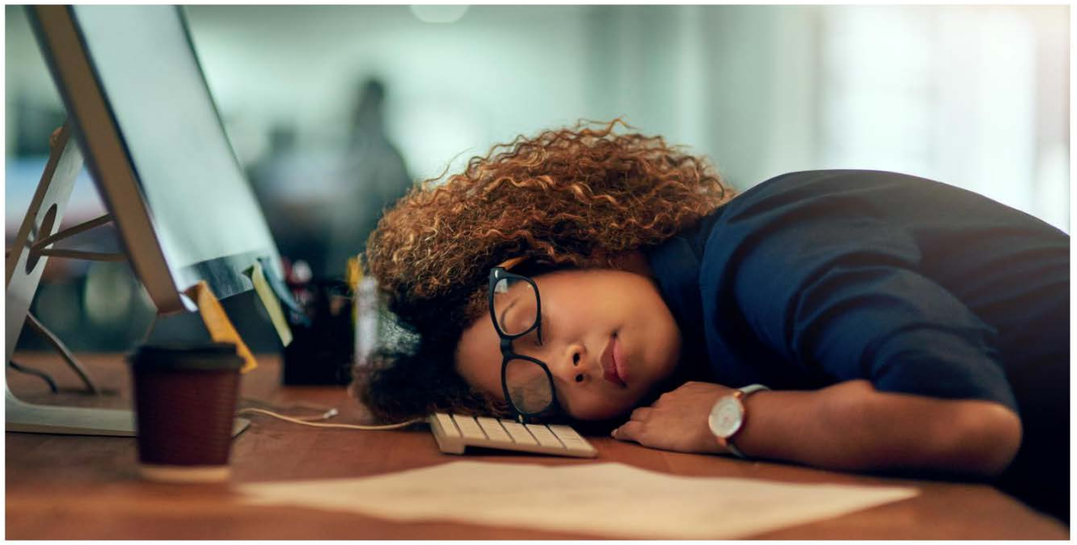
Community Impact

(Left) The Sleep & Health Lab has created an informative guide to explain to Singapore parents about healthy sleeping habits for school age children (7 to 12 years old). This 12-page document goes over facts regarding sleep problems in the country and ways to improve a child's sleep.

(Bottom) Prof. Michael Chee was interviewed in a Straits Times podcast with Joyce Teo talking about the extent to which we can intervene with improving sleep: speaking about a mix of personal measures we can take as well as some structural measures that society at large should take to ensure that we achieve better health and wellbeing.

SCIENCE

Have a nap at work, it's good for business



Researchers found that a snooze produced a moderate improvement in cognition

A meta analysis on napping and cognition by Dr. Ruth Leong from Prof. Chee's group was covered in several news outlets.

Tan Sri Dr Lim Wee Chai, the Executive Chairman and Founder of Top Glove Corporation Berhad and his entourage visited our sleep lab in August.

Featured Postdocs

Dr Xing Qian is a senior research fellow in the Multimodal Neuroimaging laboratory. She completed her PhD in neuromodulation at Tsinghua University before joining A/P Helen Zhou's lab in 2016.

What is your area of research?

I am interested in understanding the organization of brain functional and structural networks and how it changes in both neuropsychiatric disorders such as ADHD and AD, and the typical developing brain to support cognitive development.

Why is this work important?

The brain is the human body's most complex and mysterious organ. Yet an inconvenient truth is that 20% of the world's population suffer from various brain disorders which are mostly incurable and bring chronic suffering to millions worldwide. To this end, non-invasive neuroimaging techniques are a powerful tool. Unraveling fundamental organizational principles and cognitive relevance of macroscale brain structural and functional networks in humans has been and will continue to be crucial for understanding human behavior and brain disorders.

What inspired you to choose this field of study?

During my PhD, I dealt with many Parkinson' disease patients when collecting data; witnessing them battling their suffering touched me and strengthened my faith to do instructive research on the brain. At that time, I was mainly analyzing the time-domain local field potential from deep brain of humans, which is spatially limited and may not be adequate for my research questions. Then I noticed fMRI techniques, which provide richer spatial information of brain activity. So I turned to the neuroimaging field for my postdoctoral study.

Why did you choose to do your postdoc here?

After deciding to make the switch, I searched for neuroimaging labs in Singapore. Immediately Helen's work captured my attention, as it fits my goals very well. My impression of Helen as a nice and patient leader when we first met further convinced me that her lab was exactly what I was looking for. It now appears that I made the right choice. I have learned a lot here and I quite like the lab environment where everyone can help and learn from one another.

What are the long-term goals of your research?

I seek to answer fundamental questions about brain and cognition, e.g. how our brain works, by investigating the interactions among brain networks, behavior and diseases. I am also keen to develop non-invasive biomarkers for intervention and treatment that tackle brain disorders.

What are some of the best experiences that you have had in the lab?

I have met many nice colleagues, with whom I enjoy chatting and learning a lot from. When I first joined, I was naive to the field of neuroimaging and had so many questions that I didn't know where to start. Helen and my fellow postdocs have been very patient with me and kindly offered their knowledge and experiences. Without their help I would not have learned and adapted so quickly. I am very grateful.

What are some hobbies that you do in your spare time?

In my spare time, I like cooking, baking, and playing with my kids.

Dr. Chun Siong Soon is a senior research fellow in the Sleep and Cognition Laboratory. He completed his PhD in Psychology at Technische Universität München before rejoining Prof. Michael Chee's lab in 2009

What is your area of research?

I'm using multimodal neuroimaging and physiological assessments to study neural and physiological changes during transitions between states of consciousness. My other focus is developing digital phenotyping techniques to track sleep, cognitive performance and mental wellbeing with wearables and smartphone technology.

Why is this work important?

Consciousness and lack thereof during sleep are both central to the human experience. Despite huge advances, knowledge gaps remain about why and how the central and autonomic nervous systems coordinate transitions between arousal states. These impact various common measures of brain function, e.g., microsleep and associated shifts in heart rate and respiration contribute to multiphasic BOLD changes, thereby modulating functional connectivity measures.

Each hour of conscious functionality requires the support of 20-30min of sleep. Insufficient sleep incurs transient and long-term health and economic costs, at personal and societal levels. The pervasiveness of mobile information technology contributes to worldwide sleep loss, but can also help us find the balance between our conscious and unconscious states for optimal mental health and productivity.

What inspired you to choose this field of study?

Consciousness has always been the ultimate philosophical and scientific mystery for me. Understanding consciousness entails grasping the function and nature of unconscious sleep. It was somewhat serendipitous that I could marry this interest with an important concern in the neuroimaging community.

I am excited by the potential of digital phenotyping in transforming the healthcare landscape, by promoting healthy lifestyle and detecting health issues. To bring about just a few more minutes of sleep across the population would already be very substantial in utilitarian terms.

Why did you choose to do your postdoc here?

Maybe I'm just a creature of habit ;-p More importantly, we have a supportive leadership, availability of resources and talented people to work with, all the important ingredients for research excellence.

What are the long-term goals of your research?

Helping everyone improve sleep quality and quantity, so that I can enjoy more of it without guilt. Sweet dreams are made of these.

What are some of the best experiences that you have had in the lab?

Unconstrained intellectual discussions over compounds of elements 168. Conferences and retreats set the best stages. Too many over the years… but yet not quite enough.

What are some hobbies that you do in your spare time?

Spare time? What's that? Is it edible? One serving, lots of chilli.
Ok, fine, I do yoga. Some…times…

Dr. Heidi Foo is a research fellow in the Computational Brain Imaging Group. She completed her PhD in Psychiatry at the University of New South Wales before joining A/P Thomas Yeo's lab.

What is your area of research?
I am studying the contributions of genetics and environmental factors, as well as brain diseases to the architecture of functional brain connectivity in the ageing population using the UK Biobank data.

Why is this work important?
This work allows me to elucidate the underlying biological mechanisms of normal ageing and different disease states observed in functional brain connectivity. In turn, this may allow for the development of prevention and intervention strategies against diseases common to ageing.

What inspired you to choose this field of study?
Having had a close family member diagnosed with Parkinson's disease, I was exposed to the fragilities of the human brain. Even though watching the slow deterioration had been distressing, I also found it intriguing witness how such a complicated organ can be subjected to such large changes due to a degenerative condition. As a result of this personal experience, my desire to study the intricacy and complexities of the brain has substantially increased. I was intrigued to understand what factors influence the changes in the brain that separate normal ageing from disease states.

Why did you choose to do your postdoc here?
CBIG is the most fitting lab that allow me to pursue the goal of using computation to explore the fundamental principles of brain network organization and factors that influence it. Moreover, being in Singapore also allows me to be close to family and friends.

What are the long-term goals of your research?
My long term goal of my research is to gain a clearer picture of the underpinnings of the neurobiology of the brain in order to develop interventions to help elderly patients regain normalcy and control of their lives.

What are some of the best experiences that you have had in the lab?
I enjoy the collaborative spirit of the lab. I also enjoy the weekly "brain tea" sessions that we have where we catch up with each other on a social level, play games, and snack together.

What are some hobbies that you do in your spare time?
In my free time, I enjoy catching up with my friends, playing tennis, and swimming.

Dr. Ruth Leong is a research fellow in the Sleep and Cognition Laboratory. She completed her PhD in Psychology at the National University of Singapore before joining Prof. Michael Chee's lab in 2019.

What is your area of research?
The questions I'm currently interested in are to what extent naps benefit cognitive processes like memory, and how we can improve guidelines on napping for different segments of the population.

Why is this work important?
Obtaining adequate sleep can be complicated, and there has been an increased interest in how naps can be used to fulfil sleep need. However, whether or not naps benefit or are feasible to implement might depend on many factors like timing of the nap, nap duration, one's current sleep patterns, etc., as well as what cognitive or well-being goals one might be hoping to achieve. This may vary for different age groups as well, so a better understanding of these aspects would help a lot in providing meaningful recommendations about napping.

What inspired you to choose this field of study?
I've always been pretty interested in ways to improve sleep health through strategic interventions targeting sleep education and sleep hygiene practices.

Why did you choose to do your postdoc here?
I did my PhD here, and I enjoy working with everyone here a lot!

What are the long-term goals of your research?
I guess the hope is that our work will make a meaningful impact on the way people work toward sleeping better.

What are some of the best experiences that you have had in the lab?
There is a lot of camaraderie in the lab, especially seen when things get busy or stressful. Everyone works hard to support each other, and it makes me happy to be part of a genuine team.

What are some hobbies that you do in your spare time?
I am learning classical ballet and training under a school of technique called the Vaganova method. I like it a lot and have found it very fulfilling!

Featured Students

Aihuiping is a final year PhD student in the Computational Brain Imaging Group. She graduated with Master's degree in Electrical Engineering at Shanghai Jiao Tong University. Currently, she is completing her PhD at NUS Electrical and Computer Engineering under A/P Thomas Yeo.

What is your area of research?
My work focuses on the functional organization of the cerebellum within individuals, including the spatial topography and the relationship between brain organization and human behaviors.

Why is this work important?
The cerebellum is an important part of the human brain. However, most studies focus on the cerebral cortex. The cerebellum and other subcortical structures might not be discussed or excluded in the methods in the first place. Revealing the organization of the cerebellum can help us understand the human brain better.

What inspired you to choose this field of study?
I did not have good experience in my previous studies, so I was finding something different to do. Since I have an engineering background, I never thought about studying neuroscience. But after I met Thomas, I found it's a very meaningful field and I can use my coding skills to explore the human brain.

Why did you choose to do your degree here?
I would like to have some overseas experience and I found Thomas' lab fits me well. Singapore is also a nice place to live just like my home city.

What are the long-term goals of your research?
In this field, we usually propose some hypotheses to explain our results, but current technology cannot really confirm these hypotheses. Personally, I also don't know whether my hypothesis is correct or not. I'm looking forward to future technologies which can be used to prove our hypotheses.

What are some of the best experiences that you have had in the lab?
Generally, our lab has a relaxed atmosphere and our lab members are friendly. We share our life during lunch and "brain tea" every week. We also celebrate birthdays for everyone. I like these gatherings which make us not only lab mates but also friends.

What are some hobbies that you do in your spare time?
I play tennis with my friends when I want some exercise. It's more fun than running or swimming. I also enjoy simracing, driving racing cars with a simulator, a safe way to experience the speed and thrill. I feel I can leave the pressure at work behind me when I accelerate so I can always get refreshed.

Michelle Tong is a final year Psychology undergraduate with Faculty of Arts and Social Sciences. She is currently completing an independent study under Dr June Lo.

What is your area of research?
I am currently investigating the relationship between sleep duration and the following day's mood in school-age children and the effect of digital screen usage on nocturnal sleep duration in this age group.

Why is this work important?
With high demands placed on academic achievements in Singapore, school-age children commonly sacrifice their sleep to study. As a result, delayed bedtimes but unchanged wake times may put children at risk for sleep deficiency. Lack of sleep may have long term repercussions on children's psychological health. Therefore, it is important to understand the relationship between sleep and mood before identifying possible interventions to tackle this public health concern.

What inspired you to choose this field of study?
Sleep plays a pivotal role in our mental and physical well-being. However, in Singapore's fast-paced society, many view sacrificing sleep as a badge of honour without fully realising its negative impacts. By studying in this field, I hope to raise awareness of the importance of sleep and help individuals make positive behavioural changes to their sleep habits.

Why did you choose to do your Independent Study under SHL?
After taking *Sleep: A Cognitive Neuroscience Perspective* under Dr June Lo, I realised the substantial impact sleep had on an individual's health. Having a keen interest in clinical psychology and an awareness that mood disorders and sleep can influence one another, I wanted to learn more about the effects of sleep on one's psychological well-being.

What are the long-term goals of your research?
Currently, I am in my final semester as a Psychology undergraduate. I would like to pursue a career related to psychology especially in clinical and health psychology. Nevertheless, I am happy to keep my options open and see what the next chapter of life takes me to.

What are some of the best experiences that you have had in the lab?
I enjoy learning about how various sleep lab experiments are conducted and understanding the process of data collection and analysis of sleep related data. It has been an eye-opening experience and definitely a core memory for my undergraduate years.

What are some hobbies that you do in your spare time?
I like doing craft work such as sewing and would like to pick up a new crafting skill like crocheting. I also enjoy spending time with my family and friends.

Yu Xiao is a final year PhD student in the Multimodal Neuroimaging Laboratory. She graduated with a Bachelor degree in National Information Management at Sun Yat-sen University. Currently, she is a Duke-NUS IBB PhD student under A/P Helen Zhou.

What is your area of research?
I am currently working on applying graph convolutional network to predict Alzheimer's disease progression using functional and structural MRI images.

Why is this work important?
Alzheimer's disease is an irreversible progressive neurodegenerative disorder with no efficient treatments. Thus, early detection of AD is beneficial for early intervention. We sought to build an accurate and interpretable model capable of forecasting individual brain regional atrophy and cognitive decline, as well as identifying important brain regions that would contribute to the prediction. As a result, the findings could be a significant step toward developing prognostic assays for disease progression prediction.

What inspired you to choose this field of study?
Since my undergraduate studies, I've been fascinated by neuroscience and brain disorders. Following the completion of my final year project, I became interested in using machine learning models to solve neuroscience problems. I learned more about neurodegenerative diseases, particularly Alzheimer's disease, after joining Helen's lab. As a result, I wanted to use my machine learning knowledge to address the issue of neurodegenerative disease prognosis and diagnosis.

Why did you choose to do your PhD here?
I wanted to do my PhD in a lab that specialized in neuroimaging and was close to China.

What are the long-term goals of your research?
I hope to eventually apply what I've discovered in clinical settings. For example, I hope to identify reliable regions that can be used as potential early treatment targets.

What are some of the best experiences that you have had in the lab?
I particularly enjoyed interacting with the people in the lab. All of the post-docs, students and RAs in the lab are nice and easily approachable, I can always get ideas from the others.

What are some hobbies that you do in your spare time?
Watching dramas, catching up on sleep and meeting up with friends. I enjoy going hiking and playing board games with my friends.

Featured Staff

Kia Hui Wee is a senior executive at the Centre for Sleep and Cognition since 2021.

What is your area of work?
I am a senior executive at the Centre for Sleep & Cognition. My area of work covers the admin aspects under grant management, finance, procurements and operations.

Why is this work important?
This work will enable the smooth operation of CSC and that administrative, finance and procurement tasks are taken care of. This will provide my colleagues with time to concentrate more on their research work.

What inspired you to work in this field?
Working in the Centre gives me a greater sense of achievement of the tasks assigned and completed efficiently, and I greatly appreciate of all the guidance and expertise that the PIs and colleagues have provided me over the years.

What are some of the best experiences that you have had in the office?
My colleagues in the centre are approachable and the environment in the office makes me feel comfortable working. This work also allows me to communicate with different departments in the university, and learn to build up my relationships with colleagues everywhere.

What are some hobbies that you do in your spare time?
I enjoy watching movies and listening to music.

Publications

For us, publishing 'well' involves the genesis and dissemination of innovative ideas to measure, inform, assess risk, educate, and evaluate outcomes related to human performance, health, and wellbeing. From student projects to complex multi-year, multi-party collaborations, we seek to make a difference in thinking, practice, and lives. Our roster of scientific publications is testament to this philosophy.

*shared first author; ^shared senior author.

Sleep and Cognition Lab

Golkashani, H. A., Leong, R. L. F., Ghorbani, S., Ong, J. L., Fernández, G., & Chee, M. W. L. (2022). A sleep schedule incorporating naps benefits the transformation of hierarchical knowledge. Sleep, 45(4), zsac025. Link

Chen, C., Long, R., Pu, Z., & Massar, S. A. A. (2022). Limited evidence for enhanced working memory performance and effort allocation in the face of loss versus gain incentives: A preregistered (non) replication. Psychophysiology, 59(11), e14083. Link

Ghorbani, S., Golkashani, H. A., Chee, N. I., Teo, T. B., Dicom, A. R., Yilmaz, G., Leong, R. L., Ong, J. L., & Chee, M. W. (2022). Multi-Night at-Home Evaluation of Improved Sleep Detection and Classification with a Memory-Enhanced Consumer Sleep Tracker. Nature and Science of Sleep, 14, 645–660. Link

Lau, T., Ong, J. L., Ng, B. K. L., Chan, L. F., Koek, D., Tan, C. S., Müller-Riemenschneider, F., Cheong, K., Massar, S. A. A., & Chee, M. W. L. (2022). Minimum number of nights for reliable estimation of habitual sleep using a consumer sleep tracker. SLEEP Advances, 3(1), zpac026. Link

Leong, R. L. F., & Chee, M. W. L. (2023). Understanding the Need for Sleep to Improve Cognition. Annual Review of Psychology, 74(1), null. Link

Leong, R. L. F., Lo, J. C., & Chee, M. W. L. (2022). Systematic review and meta-analyses on the effects of afternoon napping on cognition. Sleep Medicine Reviews, 65, 101666. Link

Massar, S. A. A., Ng, A. S. C., Soon, C. S., Ong, J. L., Chua, X. Y., Chee, N. I. Y. N., Lee, T. S., & Chee, M. W. L. (2022). Reopening after lockdown: The influence of working-from-home and digital device use on sleep, physical activity, and wellbeing following COVID-19 lockdown and reopening. Sleep, 45(1), zsab250. Link

Pu, Z., Leong, R. L. F., Chee, M. W. L., & Massar, S. A. A. (2022). Bedtime procrastination and chronotype differentially predict adolescent sleep on school nights and non-school nights. Sleep Health: Journal of the National Sleep Foundation, 0(0). Link

Leong, R. L. F., Lo, J. C., & Chee, M. W. L. (2022). Systematic review and meta-analyses on the effects of afternoon napping on cognition. Sleep Medicine Reviews, 65, 101666. Link

Ong, J. L., Jamaluddin, S. A., Tandi, J., Chee, N. I. Y. N., Leong, R. L. F., Huber, R., Lo, J. C., & Chee, M. W. L. (2022). Cortical thinning and sleep slow wave activity reductions mediate age-related improvements in cognition during mid-late adolescence. Sleep, 45(1), zsab206. Link

Baldwin, H., Radua, J., Antoniades, M., Haas, S. S., Frangou, S., Agartz, I., Allen, P., Andreassen, O. A., Atkinson, K., Bachman, P., Baeza, I., Bartholomeusz, C. F., Chee, M. W. L., Colibazzi, T., Cooper, R. E., Corcoran, C. M., Cropley, V. L., Ebdrup, B. H., Fortea, A., … Fusar-Poli, P. (2022). Neuroanatomical heterogeneity and homogeneity in individuals at clinical high risk for psychosis. Translational Psychiatry, 12(1), Article 1. Link

Sleep Health Lab

Groeger, J. A., Lo, J. C.-Y., Santhi, N., Lazar, A. S., & Dijk, D.-J. (2022). Contrasting Effects of Sleep Restriction, Total Sleep Deprivation, and Sleep Timing on Positive and Negative Affect. Frontiers in Behavioral Neuroscience, 16, 911994. Link

Lo, J. C.-Y., Ang, J. W. A., Koa, T. B., Ong, J. L., & Lim, J. (2022). Predicting vigilance vulnerability during one and two weeks of sleep restriction with baseline performance metrics. Sleep Advances, zpac040. Link

Lo, J. C.-Y., Koa, T. B., Ong, J. L., Gooley, J. J., & Chee, M. W. L. (2022). Staying vigilant during recurrent sleep restriction: Dose-response effects of time-in-bed and benefits of daytime napping. Sleep, 45(4). Link

Wong, K. F., Perini, F., Lin, J., Goldstein, M., Ong, J. L., Lo, J., Ong, J. C., Doshi, K., & Lim, J. (2022). Dissociable changes in sleep architecture with mindfulness and sleep hygiene intervention in older adults: Secondary and exploratory analysis of polysomnography data from the Mindfulness Sleep Therapy (MIST) trial. Sleep Health, 8(4), 364–372. Link

AWAKE Lab

Shaif, N. A. S., Doshi, K., & Lim, J. (2022). Effects of mindfulness-based therapy for insomnia and a sleep hygiene/exercise programme on subjective-objective sleep discrepancy in older adults with sleep disturbances: Exploratory secondary analysis of a randomised clinical trial. Journal of Sleep Research, e13700. Link

Wong, K. F., Perini, F., Lin, J., Goldstein, M., Ong, J. L., Lo, J., Ong, J. C., Doshi, K., & Lim, J. (2022). Dissociable changes in sleep architecture with mindfulness and sleep hygiene intervention in older adults: Secondary and exploratory analysis of polysomnography data from the Mindfulness Sleep Therapy (MIST) trial. Sleep health, 8(4), 364–372. Link

Teng, J., Massar, S., & Lim, J. (2022). Inter-relationships between changes in stress, mindfulness, and dynamic functional connectivity in response to a social stressor. Scientific reports, 12(1), 2396. Link

Multimodal Neuroimaging in Neuropsychiatric Disorders Lab

Ng, K. P.*, Qian, X.*, Ng, K. K., Ji, F., Rosa-Neto, P., Gauthier, S., Kandiah, N., Zhou, J. H., & Alzheimer's Disease Neuroimaging Initiative. (2022). Stage-dependent differential influence of metabolic and structural networks on memory across Alzheimer's disease continuum. ELife, 11, e77745. Link

An, L., Chen, J., Chen, P., Zhang, C., He, T., Chen, C., Zhou, J. H., & Yeo, B. T. T. (2022). Goal-specific brain MRI harmonization. NeuroImage, 263, 119570. Link

Baldwin, H., Radua, J., Antoniades, M., Haas, S. S., Frangou, S., Agartz, I., Allen, P., Andreassen, O. A., Atkinson, K., Bachman, P., Baeza, I., Bartholomeusz, C. F., Chee, M. W. L., Colibazzi, T., Cooper, R. E., Corcoran, C. M., Cropley, V. L., Ebdrup, B. H., Fortea, A., … Fusar-Poli, P. (2022). Neuroanatomical heterogeneity and homogeneity in individuals at clinical high risk for psychosis. Translational Psychiatry, 12(1), Article 1. Link

Bethlehem, R. a. I., Seidlitz, J., White, S. R., Vogel, J. W., Anderson, K. M., Adamson, C., Adler, S., Alexopoulos, G. S., Anagnostou, E., Areces-Gonzalez, A., Astle, D. E., Auyeung, B., Ayub, M., Bae, J., Ball, G., Baron-Cohen, S., Beare, R., Bedford, S. A., Benegal, V., … Alexander-Bloch, A. F. (2022). Brain charts for the human lifespan. Nature, 604(7906), Article 7906. Link

Chan, S. Y., Ong, Z. Y., Ngoh, Z. M., Chong, Y. S., Zhou, J. H., Fortier, M. V., Daniel, L. M., Qiu, A., Meaney, M. J., & Tan, A. P. (2022). Structure-function coupling within the reward network in preschool children predicts executive functioning in later childhood. Developmental Cognitive Neuroscience, 55, 101107. Link

Hu, M., Qian, X., Liu, S., Koh, A. J., Sim, K., Jiang, X.^, Guan, C.^, & Zhou, J. H.^ (2022). Structural and diffusion MRI based schizophrenia classification using 2D pretrained and 3D naive Convolutional Neural Networks. Schizophrenia Research, 243, 330–341. Link

Li, X.*, Ng, K. K.*, Wong, J. J. Y., Lee, J. W., Zhou, J. H.,^ & Yow, W. Q.^ (2021). Bilingual language entropy influences executive functions through functional connectivity and signal variability. Brain and Language, 222, 105026. Link

Ooi, L. Q. R., Chen, J., Zhang, S., Kong, R., Tam, A., Li, J., Dhamala, E., Zhou, J. H., Holmes, A. J., & Yeo, B. T. T. (2022). Comparison of individualized behavioral predictions across anatomical, diffusion and functional connectivity MRI. NeuroImage, 263, 119636. Link

Qian, X., Ji, F., Ng, K. K., Koh, A. J., Loo, B. R. Y., Townsend, M. C., Pasternak, O., Tay, S. H., Zhou, J. H.^, & Mak, A.^ (2022). Brain white matter extracellular free-water increases are related to reduced neurocognitive function in systemic lupus erythematosus. Rheumatology, 61(3), 1166–1174. Link

Wu, Y., Ji, F., Chong, Y. F., Chen, C. L.-H., & Zhou, J. H. (2022). Deeply supervised network for white matter hyperintensities segmentation with transfer learning. Medical Imaging with Deep Learning. Link

Computational Brain Imaging Lab

An, L., Chen, J., Chen, P., Zhang, C., He, T., Chen, C., Zhou, J. H., & Yeo, B. T. T. (2022). Goal-specific brain MRI harmonization. NeuroImage, 263, 119570. Link

Benkarim, O., Paquola, C., Park, B., Kebets, V., Hong, S.-J., Vos de Wael, R., Zhang, S., Yeo, B. T. T., Eickenberg, M., Ge, T., Poline, J.-B., Bernhardt, B. C., & Bzdok, D. (2022). Population heterogeneity in clinical cohorts affects the predictive accuracy of brain imaging. PLOS Biology, 20(4), e3001627. Link

Bethlehem, R. A. I., Seidlitz, J., White, S. R., Vogel, J. W., Anderson, K. M., Adamson, C., Adler, S., Alexopoulos, G. S., Anagnostou, E., Areces-Gonzalez, A., Astle, D. E., Auyeung, B., Ayub, M., Bae, J., Ball, G., Baron-Cohen, S., Beare, R., Bedford, S. A., Benegal, V., … Alexander-Bloch, A. F. (2022). Brain charts for the human lifespan. Nature, 604(7906), 525–533. Link

Bian, L., Cui, T., Thomas Yeo, B. T., Fornito, A., Razi, A., & Keith, J. (2021). Identification of community structure-based brain states and transitions using functional MRI. NeuroImage, 244, 118635. Link

Bolt, T., Nomi, J. S., Bzdok, D., Salas, J. A., Chang, C., Thomas Yeo, B. T., Uddin, L. Q., & Keilholz, S. D. (2022). A parsimonious description of global functional brain organization in three spatiotemporal patterns. Nature Neuroscience, 25(8), 1093–1103. Link

Chen, J., Tam, A., Kebets, V., Orban, C., Ooi, L. Q. R., Asplund, C. L., Marek, S., Dosenbach, N. U. F., Eickhoff, S. B., Bzdok, D., Holmes, A. J., & Yeo, B. T. T. (2022). Shared and unique brain network features predict cognitive, personality, and mental health scores in the ABCD study. Nature Communications, 13(1), Article 1. Link

Deng, S., Li, J., Thomas Yeo, B. T., & Gu, S. (2022). Control theory illustrates the energy efficiency in the dynamic reconfiguration of functional connectivity. Communications Biology, 5(1), 295. Link

Dhamala, E., Ooi, L. Q. R., Chen, J., Kong, R., Anderson, K. M., Chin, R., Yeo, B. T. T., & Holmes, A. J. (2022). Proportional intracranial volume correction differentially biases behavioral predictions across neuroanatomical features, sexes, and development. NeuroImage, 260, 119485. Link

He, T., An, L., Chen, P., Chen, J., Feng, J., Bzdok, D., Holmes, A. J., Eickhoff, S. B., & Yeo, B. T. T. (2022). Meta-matching as a simple framework to translate phenotypic predictive models from big to small data. Nature Neuroscience, 25(6), Article 6. Link

Kong, X., Kong, R., Orban, C., Wang, P., Zhang, S., Anderson, K., Holmes, A., Murray, J. D., Deco, G., van den Heuvel, M., & Yeo, B. T. T. (2021). Sensory-motor cortices shape functional connectivity dynamics in the human brain. Nature Communications, 12(1), 6373. Link

Kraljević, N., Schaare, H. L., Eickhoff, S. B., Kochunov, P., Yeo, B. T. T., Kharabian Masouleh, S., & Valk, S. L. (2021). Behavioral, Anatomical and Heritable Convergence of Affect and Cognition in Superior Frontal Cortex. NeuroImage, 243, 118561. Link

Li, J., Bzdok, D., Chen, J., Tam, A., Ooi, L. Q. R., Holmes, A. J., Ge, T., Patil, K. R., Jabbi, M., Eickhoff, S. B., Yeo, B. T. T., & Genon, S. (2022). Cross-ethnicity/race generalization failure of behavioral prediction from resting-state functional connectivity. Science Advances, 8(11), eabj1812. Link

Liégeois, R., Yeo, B. T. T., & Van De Ville, D. (2021). Interpreting null models of resting-state functional MRI dynamics: Not throwing the model out with the hypothesis. NeuroImage, 243, 118518. Link

Marek, S., Tervo-Clemmens, B., Calabro, F. J., Montez, D. F., Kay, B. P., Hatoum, A. S., Donohue, M. R., Foran, W., Miller, R. L., Hendrickson, T. J., Malone, S. M., Kandala, S., Feczko, E., Miranda-Dominguez, O., Graham, A. M., Earl, E. A., Perrone, A. J., Cordova, M., Doyle, O., … Dosenbach, N. U. F. (2022). Reproducible brain-wide association studies require thousands of individuals. Nature, 603(7902), 654–660. Link

Marinescu, R. V., Oxtoby, N. P., Young, A. L., Bron, E. E., Toga, A. W., Weiner, M. W., Barkhof, F., Fox, N. C., Eshaghi, A., Toni, T., Salaterski, M., Lunina, V., Ansart, M., Durrleman, S., Lu, P., Iddi, S., Li, D., Thompson, W. K., Donohue, M. C., … The Alzheimer's Disease Neuroimaging Initiative. (2021). The Alzheimer's Disease Prediction Of Longitudinal Evolution (TADPOLE) Challenge: Results after 1 Year Follow-up. Machine Learning for Biomedical Imaging, 1(December 2021 issue). Link

Ooi, L. Q. R., Chen, J., Zhang, S., Kong, R., Tam, A., Li, J., Dhamala, E., Zhou, J. H., Holmes, A. J., & Yeo, B. T. T. (2022). Comparison of individualized behavioral predictions across anatomical, diffusion and functional connectivity MRI. NeuroImage, 263, 119636. Link

Schirner, M., Kong, X., Yeo, B. T. T., Deco, G., & Ritter, P. (2022). Dynamic primitives of brain network interaction. NeuroImage, 250, 118928. Link

Valk, S. L., Xu, T., Paquola, C., Park, B., Bethlehem, R. A. I., Vos de Wael, R., Royer, J., Masouleh, S. K., Bayrak, Ş., Kochunov, P., Yeo, B. T. T., Margulies, D., Smallwood, J., Eickhoff, S. B., & Bernhardt, B. C. (2022). Genetic and phylogenetic uncoupling of structure and function in human transmodal cortex. Nature Communications, 13(1), 2341. Link

Wu, J., Li, J., Eickhoff, S. B., Hoffstaedter, F., Hanke, M., Yeo, B. T. T., & Genon, S. (2022). Cross-cohort replicability and generalizability of connectivity-based psychometric prediction patterns. NeuroImage, 262, 119569. Link

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