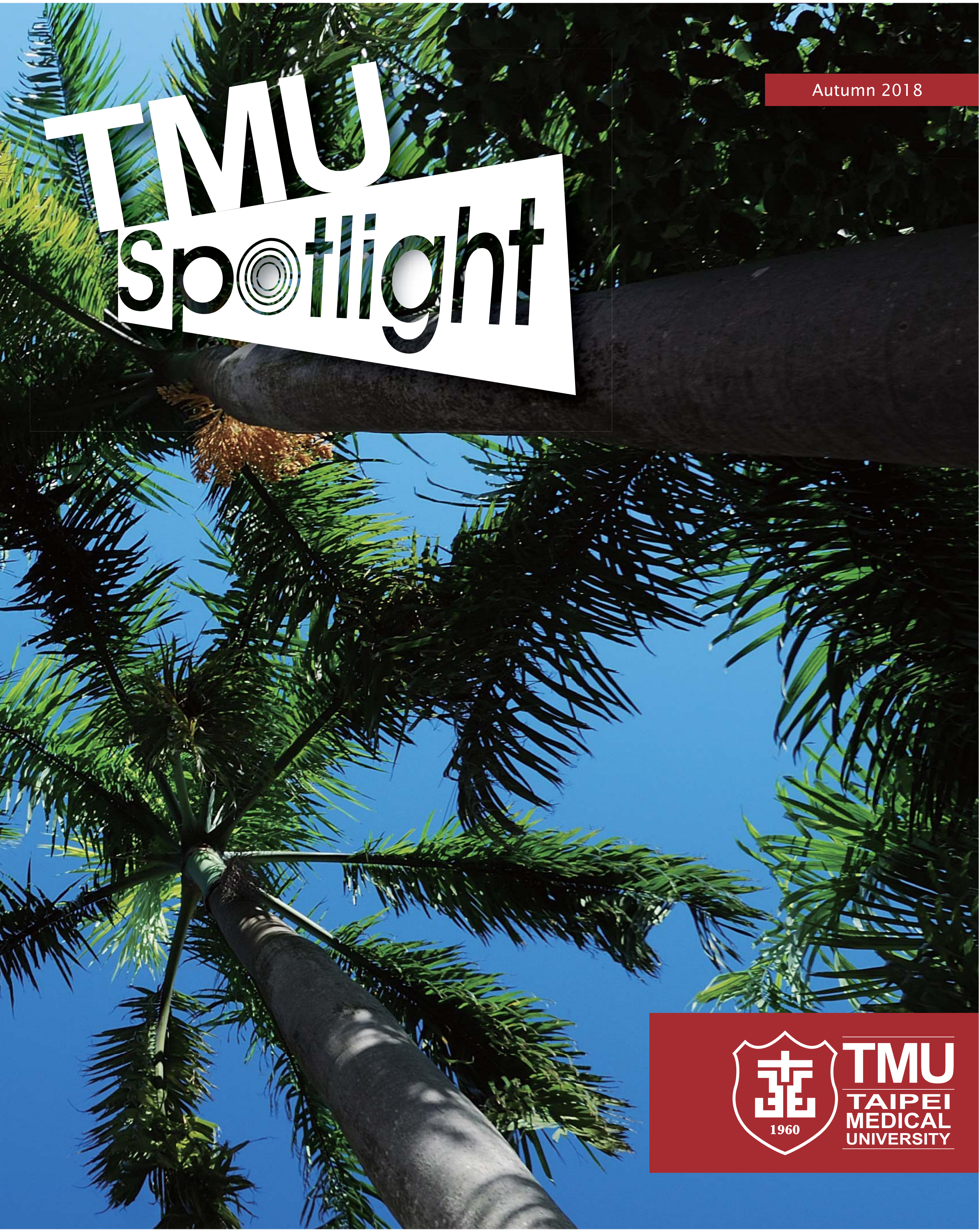
TMU Spotlight

Autumn 2018



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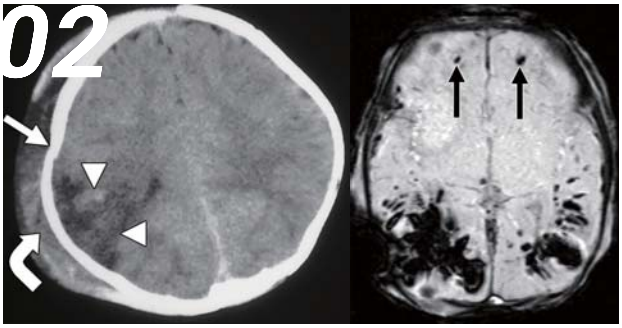


A picture tells a thousand words

Prof. Sandy Chen's big image data plus machine learning allow clinicians to skip biopsies and predict outcomes

Prof. Sandy Cheng-Yu Chen

— Professor, Department of Radiology, School of Medicine
College of Medicine, Taipei Medical University

— Chairman, Department of Medical Imaging
Taipei Medical University Hospital

— Director, Translational imaging research center
Taipei Medical University Hospital

Recently Spotlight interviewed Prof. Sandy Cheng-Yu Chen, who wears many TMU hats through his affiliations with the Department of Radiology, College of Medicine, TMU, the Center for Cancer Research and the Department of Medical Imaging, TMU hospital. He joined the university in 2013 after a long association with Taiwan's National Defense Medical Center. Scan the qrcord to find more details of Prof. Sandy Chen's publications.

Most patients have undergone routine or diagnostic medical imaging, and they may think this experience hasn't changed much over the decades as they briefly hold their breath for an X-ray or scan. As TMU radiologist and medical imaging researcher Prof. Sandy Cheng-Yu Chen notes, CT[1] scans have been both useful and increasingly affordable for 30 years, and MRIs[2] have been used for 20 years.

Yet what has changed vastly, especially with computing advances, is how these images are used: "What's new is that with big data we can extract features from these images, and use machine learning to develop algorithms that are useful in many ways."

Tall and energetic, Prof. Chen has a kindly manner when reassuring anxious patients; he notes modestly that "After all, we [radiologists] are doctors too." It might be a radiologist, not an oncologist or surgeon, who performs a tricky needle biopsy of a lung mass while watching its position carefully on a display screen.

But his wry sense of humor also emerged in a recent discussion of imaging research advances at TMU. He joked that high-tech imaging and AI that compares results and prognoses may cost many doctors their jobs. As such diagnoses are increasingly assisted by computers by comparing vast databases of cases, he said many radiologists may concern about their jobs being sidelined.

"We physicians love the new artificial intelligence techniques," Prof. Chen said. "Yet we also see how they might be able to do our jobs in the future – and radiology is likely to be one of the first [medical subfields] to be mechanized."

Just like a fortune teller

Why are these computerized results superior to decades of human clinical experience? "AI offers precise deductions from thousands of images, rather than of relying on human judgments as in all past medical eras. Two doctors can look at an image and see different things – but with a library of ten thousand images, the machine can assist in drawing consistent conclusions."

And it is both computing power and imaging detail that have made such conclusions reliable. "We can now go to the 'pixel level' to observe the smallest details of anatomical structure changes confered by genomic and molecular alternations," Prof. Chen said. "We can observe these changes to predict histopathology-alike diagnoses based on evidence and algorithms, not our human experience."

TMU's research in this area is widely noted by both research funders and scientific journals. He explained that his team's brain tumor study will soon be published in a level-10 impact factor journal, Clinical Cancer Research: "It was accepted in part because this government-funded study correlates multi-center's data in new and useful ways. … What this model offers is predictive power based on both retrospective and prospective studies.

> *" With this [imaging] data, we don't even need to biopsy to understand what a tumor is likely to behave, based on the facts of how long patients with similar neoplasms survived. I can extrapolate outcomes – just like a fortune teller! – based on separate groups of similar cases. "*

"If we follow hundreds or thousands of people through the course of a disease, or who experience similar types of trauma, then we will know how long they lived. We analyze their images, genomic, survival data and other case factors to look for patterns."

Many patients can thank this new technology for sparing them from uncomfortable and invasive diagnostic techniques such as biopsies that previously were needed to predict tumor growth and response to various treatments: "With this [imaging] data, we don't even need

[1] A CT scan, also known as CAT scans, are computed axial tomography scans that combine many X-ray measurements from different angles toproducecross-sectional (or tomographic) images that show "slices" of a scanned area,allowing the user to see inside withou cutting.

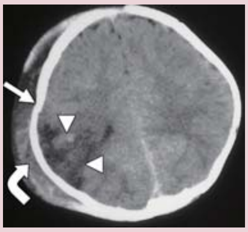
[2] Magnetic resonance imaging (MRI) uses the magnetic properties of different tissues and bones to produce detailed images without X-rays. MRIs require massive machinery and cannot be used on patients with metal stents or artificial joints because of the powerful magnets used to make the images.

to biopsy to understand what a tumor is likely to behave, based on the facts of how long patients with similar neoplasms survived. I can extrapolate outcomes – just like a fortune teller! – based on separate groups of similar cases."

TMU ranked #1 in imaging grant

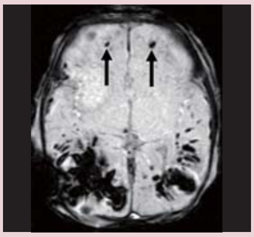
Prof. Chen says TMU is a leader in this area because of its in-deep research background in both cancer and trauma, as well as because of its leadership in applying these advanced imaging technologies in artificial intelligence.

"It takes a big project to collect and analyze big data – and Taiwan's Ministry of Science and Technology selected the top three institutes to lead this [imaging and artificial intelligence] research. TMU received the highest rating of around thirty applicants. … This project came to TMU based on our history of productive work in this area, but also based on our access to a huge archive of data resources. It's a huge, heavy artificial intelligence job!"



[Fig.1]

Impact type of nonaccidental-trauma (6-month-old boy. Axial CT scan shows right -frontaldepressed skull fracture (straight arrow) along with frontopartallobe contusion (arrowheads). Subgalealhematoma is also present (curved arrow).



[Fig.2]

11-month-old boy with shaking impact injury (Susceptibility-weighted MR image shows additional bilateral hemorrhagic foci (arrows) in frontal lobes; finding inconsistent with dif-fuse axonal injury.)

Yet cancer remains a fearsome opponent, and Prof. Chen voiced frustration at the low survival rates for brain, lung and pancreatic cancer, noting that these have hardly improved over the past four decades.

In 1976, the US National Cancer Institute published the major cancer survival rates based on data available then. He said, "The five-year survival rate was very low for brain and lung cancers, but it was much better for prostate cancer – maybe a 67.8 percent five-year survival rate – and for other types of cancers.

"In 2012 a similar study showed that prostate cancer now has reached a 99 percent five-year survival rate. Yet the five-year survival rate for brain and lung cancers improved by barely ten percent over what it had been four decades earlier and remains very low, as does five-year survival for pancreatic cancer."

Prof. Chen hopes the new AI tools will enable more progress against the deadliest cancers. "Now we also have immunotherapy after many decades of relying on radiation, surgery and chemotherapy as our only weapons against cancer. And imaging can potentially guide us where the T cells and natural killer cells fail to kill residual cancer."

Investigating tumor margins

He said most challenging aspect of image analysis is "locus-specific correlation" because of tissue heterogeneity. This means that a tumor is not just one thing: it has different kinds of tissues in different places within a single tumor. The margins of the tumor are those battle fields that our immune system fights with the cancer cells. "

There is no discrete edge on a brain tumor by eyeballing, he explained. "The brain is a soft substance, and we can't just keep removing tissue to try to ensure that we have taken enough – the more brain tissue that is removed, the more patients lose vital cognitive and body functions.

"But why do brain tumors almost always grow back, when we think we have left no visible traces? We are studying what happens on the edges of these tumors, trying to find the heterogeneity by precision-mapping our tissue samples and corresponding imaging to study tumor microenvironments."

If this is the case, readers might wonder how soon such diagnoses will be the rule rather than the exception (i.e., the standard care). Given TMU's experience in full-spectrum "bench to bedside" research, many patients at the university's affiliated hospitals enjoy a comparative clinical advantage with the government grants sponsoring their testing.

Prof. Chen noted that "Our patients are getting more precision with their medical treatment, because we can use the information from these thousands of images. ... Imaging now can tell benign from malignant masses in some cancers that formerly required invasive biopsies. And certain genetic profiles, such as the IDH1 mutation, offer clues as to who will respond well to chemotherapy – expensive laboratory-based analysis might be spared, just images."

Tools lead to new standards

TMU's progress helps patients at other care institutions as well. Asked if hospitals with vast image libraries are logically where cancer patients should seek the best treatment, he said the scientific publication process ensures that advances can quickly benefit all patients: "The purpose of research is to share knowledge, and everyone has to share their data as part of the publication process, both for replicability and credibility."

However, he said TMU enjoys some competitive advantages in clinical practice because of this high-tech imaging research: "We have the most experienced neurosurgeons, because of our long and deep work in

" This project came to TMU based on our history of productive work in this area, but also based on our access to a huge archive of data resources. It's a huge, heavy artificial intelligence job! "

neurotrauma, stroke and other areas. And with the government's research support we can offer patients cost-free genetic analyses."

These results would otherwise easily cost each patient 100,000 Taiwan dollars, since tissue samples are taken from several sites in the tumor, and each site biopsy costs 20,000 Taiwan dollars to analyze.

"When we schedule their surgery, we ask them to authorize us to remove the tissue samples just before the tumor itself is treated or removed," Prof. Chen said. "And because of our protocols, we then have precise images and reliable measurements of where these biopsy samples were taken, and from what kinds of tumors."

Images clarify brain trauma

Although Prof. Chen is eager to fight the most refractory cancers, he is also proud of TMU's work with brain trauma imaging. "Our research into mild traumatic brain injury (mTBI) has been very fruitful, in part because we and our partner hospitals have followed six hundred trauma patients for six years. With so many scooters in Taiwan we have a lot of concussion patients, even while the mandatory helmet law limits skull fractures and brain hemorrhages.

"And while concussion seems mild in terms of treatment and immediate outcomes, with maybe a week of rest prescribed as treatment, there is great concern about later onset dementia" and other serious after-effects that may take years or decades to emerge. At TMU we also analyze brain injuries in rats, notably by using a very powerful imaging tool, a seven-Tesla MRI."

This record of leadership in trauma and cancer research is why TMU is building on Prof. Chen's research legacy by prioritizing artificial intelligence. Imaging and big data offer insights that can lead to new treatments for impact and blast injuries, as well as for cancers and other diseases.

'Full-spectrum' CWRU parnership keeps growing

New directions include joint degrees, student mobility and research collaboration

Long before anyone heard of globalization, higher education aspired to house the broadest possible knowledge – after all, universities were named to reflect the universe. "Sister school" partnerships have long leveraged each campus's strengths by sharing them, so students and faculty can benefit from multiple resources and perspectives. International educational programs further extend these benefits to expose students to different societies, cultures and languages.

TMU has many partner universities with active educational collaborations, but one stands above them all in terms of committed colleges, programs and research projects: Case Western Reserve University in Cleveland, Ohio.

CWRU's roots go back nearly two centuries to the era when one of America's original 13 colonies, Connecticut, still had hundreds of miles of "western reserve." Western Reserve University was established in Cleveland in 1826, and the Case School of Applied Science was founded nearby in 1880. They merged in 1967 to create a research-oriented university with unusually high faculty-student ratios. CWRU boasts 16 Nobel Prize winners among its faculty and alumni, including America's very first Nobel Laureate, in, 1907 and last year's Economics laureate.

The university's eight schools and colleges place it in the top 40 US universities, according to the widely respected US News and World Report rankings. CWRU receives $244 million in funding from the U.S. government, $66 million from nonprofit sources and $16 million from industrial partners. Four major medical complexes, including the world-famous Cleveland Clinic, offer abundant career opportunities for its graduating health professionals.

Visit builds new programs

The TMU-CWRU linkages extend far beyond training clinicians. After well over a dozen visits by CWRU teams in the past seven years, Vice Provost David Fleshler's visit this May continued to build one of TMU's most valued partnerships in other directions. Mr. Fleshler presented details of student exchange and dual degree programs to a large audience at an International Partnership week presentation in TMU's new Interdisciplinary College (see related story). He also met with TMU leaders from the colleges of Biomedical Engineering and Medical Science and Technology to discuss expansion of educational collaborations.

The two universities began working together in 2012, and the partnership has since expanded across a wide range of functions. These include educational collaboration on dual degrees and short-term student mobility programs, jointly funded research projects, and regular staff visits and meetings.

"TMU is at the center of our international strategy," Mr. Fleshler said. And this international strategy has been at the center of CWRU's action agenda, ranking as one of three top priorities since 2008. When Mr. Fleshler joined CWRU as vice provost nine years ago, international contacts were mostly personal partnerships involving faculty research projects and seen as individual and uncoordinated efforts with no guiding strategy. Now the university broadly backs focused projects with substantial institutional resources.

From a one-quarter-time study abroad adviser and a small office that helped with visa paperwork, Mr. Fleshler's Center for International Affairs has grown to major office in the center of campus dedicated to the many aspects of globalization. He credits this growth to broad "buy-in" following the 2012 passage by the faculty senate of the university's internationalization plan; this vote decisively supported expansion of physical facilities and human resources dedicated to international infrastructure.

The new and expanded functions in the Center for International Affairs include inbound and outbound student advising, advocacy and an Office of Global Strategy that manages outreach to other universities, as well as to government agencies and supportive partners in industry. But CWRU's globalization is by no means complete: its strategic plan was updated in 2015 with an expanded focus on attracting international graduate students and on high-impact collaborative research projects. Clearly the emphasis has moved from individual ties to institutional links, including ongoing commitments of funding and research teams to initiatives with Taipei Medical University.

Aiming for real-world outcomes

"We've accomplished a great deal over the past five years," Mr. Fleshler said of the TMU partnership. As one five-year Memorandum of Understanding concludes and another has been launched, he credits this successful collaboration to both universities' deep commitment to "comprehensive internationalization."

TMU is "one of the top 4 or 5 institutional partners" that CWRU has pursued for strategic relationships, Mr. Fleshler said, "Because we're both interested in each other's mission, spanning basic and translational research. We both invest in this relationship and our joint projects. It's important to develop areas of research into devices, drugs and industries. These are the outcomes we hope to see.

"And of course there's the basic educational mission. In a globalized world, the important issues are trans-border, and their solutions must be global as well," he said. "This mission requires infrastructure, like the 3+2 [B.S.+M.S.] and 1+1 [dual master's degree] programs, faculty and student exchanges, and PhD visits.

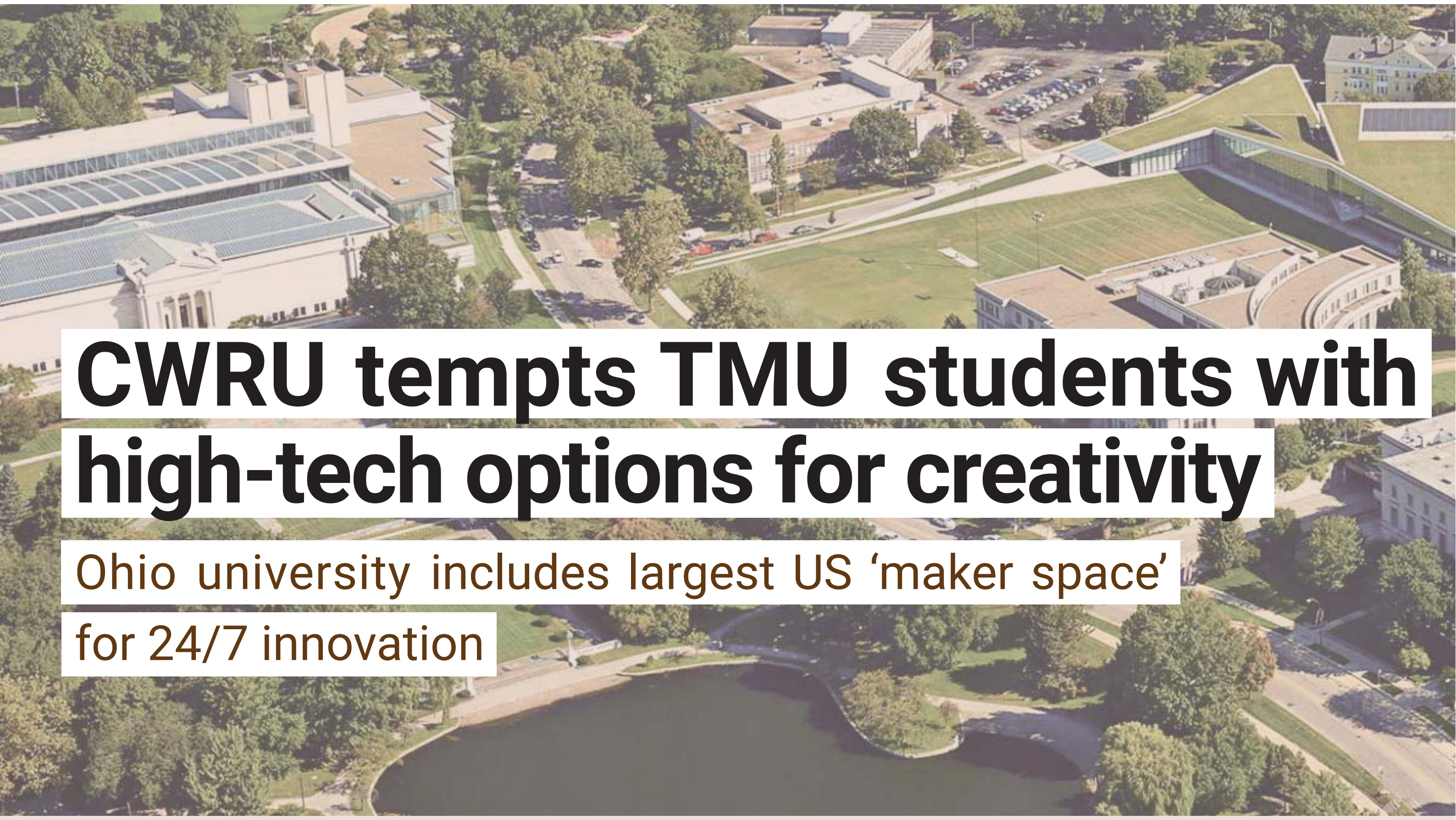
"These educational relationships are growing closer, in part because students on both sides need the correct [international] preparation for optimal results and successful programs. To succeed, they need to prepare culturally, linguistically and academically" – both as foreign students and in their further global research careers.

'A rare dynamism'

When asked why a small school like TMU is among the handful of those schools he termed "favorite partners" among more than 200 CWRU sister schools, Mr. Fleshler said, "Your university has a rare dynamism and drive to globalize. You work seriously on both the educational and research missions.

"TMU has taken the time and made the effort to create this institutional relationship, and we have seen a rare breadth of interest from multiple [TMU] schools. This is a testament to the people and leaders of TMU. In fact, it's been a huge pleasure to work with people here." He noted that CWRU's Taiwan members include former leaders of the nation's High-Speed Rail system and Taiwan's National Institutes of Health (see related story on Professor Hsing-Jien Kung). "The fact that we have alumni who are recognized leaders in Taiwan, and our veteran faculty members are active in working on behalf of the university, has helped grow CWRU's relationships at TMU and throughout Taiwan," said Mr. Fleshler.

Just as CWRU began to build a global strategy nine years ago and has markedly increased its resources impact, TMU also has vastly expanded its international footprint in the past decade, including creating more than 200 partner-school relationships. Nearly twenty CWRU-related visits, agreements and programs provide ample evidence that the TMU – CWRU partnership will continue to grow in the decades to come.



CWRU tempts TMU students with high-tech options for creativity

Ohio university includes largest US 'maker space' for 24/7 innovation

Vice Provost David Fleshler's background in legal studies showed in the strong and persuasive case he made for TMU students to partake of opportunities at Case Western Reserve University. Whether joint degree programs or research and medical school partnerships, the architect of CWRU's ambitious Center for International Affairs persuaded the overflow International Partnership Week crowd that Cleveland, Ohio, has much more to boast about than basketball star LeBron James.

Mr. Fleshler's presentation spelled out many advantages of joining this top US research university in a city he said is unfairly overlooked. Although TMU students were more familiar with the Cavaliers' star player, he noted that the world-famous Cleveland Orchestra's concert hall adjoins the campus, and the Rock and Roll Hall of Fame is in downtown Cleveland and overlooks Lake Erie, a 15 minute bus ride from CWRU.

More to the point, Ohio has a great job market for students who decide to try their career skills in an American context; major corporations like Proctor & Gamble and Progressive Insurance have headquarters there. Among America's oldest and most distinguished schools, CWRU trains health professionals in four affiliated hospitals, representing different aspects of the US health care system: the Metro Health system serving city residents, the federal Louis Stokes VA Hospital, Cleveland University Hospitals that ranks in America's top twenty, and the renowned Cleveland Clinic, which is ranked #2 nationwide.

Like TMU, CWRU stands out from most universities by promising all students a chance to learn laboratory skills and participate in active research projects with real-world goals. In fact, graduate students outnumber undergrads by nearly a thousand students, thanks to an almost two billion-dollar endowment and generous operational funding. The faculty-student ratio overall is 11 to 1, but this ratio is sometimes lower in graduate level programs.

Making up 20% of CWRU's student body, foreign students are highly valued, with 65 percent coming from China and some 37 students from Taiwan. Supported by a strategic plan that received input from faculty members, administrators, alumni and community members, 30% of CWRU students have significant study abroad experience by the time they graduate. The university also attracts inbound international students, including those from TMU, with a variety of programs and facilities.

One example of CWRU's unique facilities is the tinkerers' playground called think[box], a 7-story "maker space", which is open around the clock to the university community. think[box] offers the largest facility of any US university with an open-access array of sophisticated equipment. If a student has a good idea at 3am, there's

no need to wait until business hours or make a reservation to test it out.

Students enjoy equal priority with faculty members and research teams if they want to learn to use the 3D printers, powerful materials cutters and welding equipment. There's also art and design support for packaging and logos, as well as help and advice regarding business planning and legal issues, including patent protection. CWRU is well known for its investment in entrepreneurship training for faculty members and students. One heartwarming outcome of student inspiration is "internet teddy bears" that allow users to give a hug to a stuffed animal in one location that will be replicated by the bear on the other end – an ingenious way to say "I love you" to distant family and friends.

Reminiscent of aspects of think[box], TMU in April opened the doors of its College of Interdisciplinary Studies. The new unit is dedicated to nurturing students' thinking beyond their individual subjects of study by offering entrepreneurship education as well as a well-appointed basement "maker space" to encourage innovation.

Another CWRU milestone is a state-of-the-are health education campus (HEC) that will open next year. The vice provost said this new facility, which is being built in conjunction with the Cleveland Clinic, will also have a multidisciplinary focus to "bring together different fields" so that that the education and training of medical, dental, and nursing students will occur side-by-side, which will better prepare them to deal with life-and-death patient care decisions as they "study in newly-combined classes and join in the HEC atrium to work on project-based learning together."

CWRU's medical school ranks in America's top 25, and also ranks as #39 in primary care. With 59 different clinical departments and 14 graduate programs, CWRU offers training in the skills increasingly in demand by both US and international employers. As proof, Mr. Fleshler noted that 71% of graduating doctoral students in the School of Medicine receive faculty or postdoctoral positions. 75% of PhD graduates in the School of Medicine are now at top-25 research institutions in the United States.

Collaborating with some of CWRU's prestigious programs, TMU's joint degree arrangements offer students further advantages. "3+2" programs allows students to earn dual diplomas (an Undergraduate degree from TMU and a Master's degree from CWRU) in nutrition (CWRU's program ranks sixth nationwide) and in biomedical engineering (CWRU ranks fifteenth). The vice provost's presentation surely convinced more TMU students to give the Ohio experience a try.

Interview with Dean of the College of Humanities and Social Sciences, GIMBC Director

Prof. Timothy Joseph Lane

— Dean, College of Humanities and Social Sciences

— Director, Brain and Consciousness Research Center

— Advisor, Office of Research, Shuang Ho Hospital

Asking the Big Questions

"For people like me, there's two main mysteries in the world. One is look out into the sky at night. How far out does it go? How long will it continue to expand? What really happens when things get sucked into pockets of extremely powerful gravity?

The other is looking inward.

Our brain, which generates our experience of the world, is locked inside of a skull. It's cut off from the world. So how is it that we're able to generate these cinema-like images of the world, sight and sound and all the other sensory apparatus, integrated into one unified picture?"

Creating TMU's Neuroscience Future

You might not guess at first glance, but Dr. Tim Lane just turned 65. Perhaps his spry figure comes from days playing baseball; a dufflebag of ball gear sits in his office corner belying a spirit of good-natured competition. A competitive spirit and emphasis on results also drive Dr. Lane to create a well-rounded educational program that brings the next generation of TMU's neuroscience researchers and practitioners together.

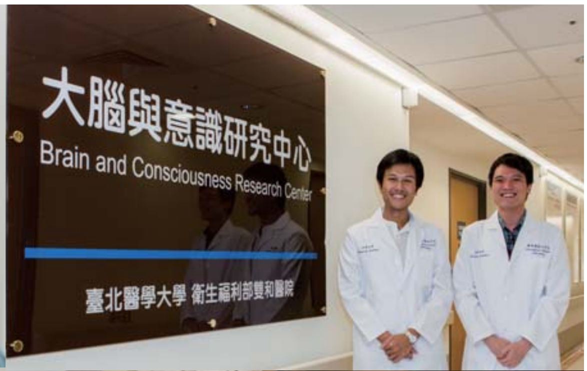
Dr. Lane's interest in mind and consciousness began at the University of Pittsburg in 1976. While studying Philosophy of Science he came across the book "The Origin of Consciousness and the Breakdown of the Bicameral Mind" by Princeton psychologist Julian Jaynes, who later became his mentor. Taken with Jaynes' somewhat eccentric ideas, Dr. Lane wanted to approach the theory through neuroimaging studies. His work caught the attention of a visiting scholar from Taiwan which led to a position at Academia Sinica. After that, Dr. Lane worked at National Cheng Chi University and National Chung Cheng University before arriving at TMU in 2012. In 2014, he began serving as Dean of the College of Humanities and Social Sciences.

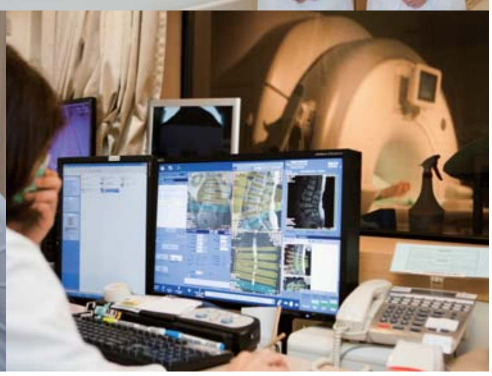
With a background that spans both philosophy and neuroscience, Dr. Lane is one of the few academics who have been published in journals as varied as The Journal of Philosophy, Analysis and Phenomenology, Phenomenology and the Cognitive Sciences, and Trends in Cognitive Science. Papers covering, psychiatric disease, rubber hand illusions, and neuroexistentialism are a reflection of the multidisciplinary approach to neuroscience that Tim is trying to bring to TMU's College of Humanities and Social Sciences.

Research to Help Patients

"One thing that people mistake about vegetative state patients is that they think they don't do anything. Actually, they do a lot. When they sleep, some of them dream. They have the same kind of brain waves that you would see if you were looking at a healthy person." Though not visibly conscious, up to 40% of patients who may have been misdiagnosed as vegetative could benefit down the line. "Dreams are an example of consciousness, so you can say vegetative state patients do have conscious states." Dr. Lane and his team are working on distinguishing the level of consciousness using PET and fMRI in combination to eventually predict improvement or recovery.

They're also making progress with depression. Eye tracking, EEG, fMRI, and blood data are improving





diagnoses; the research team is also in the process of developing non-invasive brain stimulation techniques to improve the moods of these patients. "I would like to start doing that [TMS], especially targeting the left dorsolateral prefrontal cortex, and see if we can elevate activity there and use that as a way of treating depression."

Collaborations through TMU and Shuang Ho and Wanfang hospitals in radiology, psychiatry, neurology, and neurosurgery are an important part of turning this research into treatments. The University's many other established research teams, such as Dr. Robert Chiang on brain injuries, Dr. Chaur-Jong Hu, Dr. Cheng-Yu Chen for imaging, and Dr. Yi-Hua Chen on child development, have also offered plenty of opportunities for multi-faceted collaboration.

Building the GIMBC Team

As Director of the Graduate Institute of Mind Brain and Consciousness, Dr. Lane's strategy is to recruit up-and-coming faculty with diverse academic backgrounds, varied interests, and technical expertise. So far the GIMBC team includes Dr. Niall Duncan – philosophy and neuroscience, Dr. Changwei Wu – engineering and neural imaging, Dr. Jihwan Myung – physics, physiology, and economics, and Dr. Phillip Tseng – experimental psychology and TMS, and Dr. Tzu-Yu Hsu – EEG and cognitive neuroscience.

Hiring a young, driven faculty is not without challenges for the competitive academic. "Because they're good and smart, they have their own opinions, and they don't necessarily do what you want them to do." But creating team who can produce important research in the long term is worth any minor headaches. "I think if you care about sustainability … you try to hire people who complement one another and who can do things you can't do."

GIMBC Programs

The GIMBC Master's and Ph.D. programs are practical, hands-on experiences that train students in EEG, PET, fMRI, TMS, use of animal models, computation, etc., and provide a solid foundation in experimental design and data analysis. Dr. Lane welcomes med students interested in doing research along with clinical work, engineers interested in the brain, people with backgrounds in psychology who like to work with high tech imaging tools or patients, or philosophers with a craving to know what minds are really like to apply to the Graduate Institute of Mind, Brain and Consciousness (http://gimbc.tmu.edu.tw/). "Even if you're just one of these people interested in fundamental questions of existence, there's something important here [for you]."

GIMBC Graduate Institute Of Mind, Brain, And Consciousness

TMU's Graduate Institute of Mind, Brain, and Consciousness unites scientists, clinicians and philosophers who investigate the levels and contents of consciousness. We conduct research into normal and altered states of consciousness through a range of techniques, including multi-modal brain imaging and brain stimulation. The aim of our research is to advance the understanding of what consciousness is and how it can be impaired. We hope these advances can be used to develop improved diagnoses and treatments for psychiatric and neurological disorders.

TMU RCBC 大腦與意識研究中心 RESEARCH CENTER OF BRAIN AND CONSCIOUSNESS

The Research Center of Brain and Consciousness investigates the levels and contents of consciousness, along with the cognitive mechanisms that modulate these. Central to this work is the use of different brain imaging and stimulation techniques to directly measure and manipulate brain actions and understand how these work in health and disease.

Neuroscience Research at Taipei Medical University

With more than 200 neuroscience physicians and researchers, Taipei Medical University's Taipei Neuroscience Institute (TMU-TNI) is the largest of its kind in Taiwan. The institute also is among the nation's most experienced in robot-assisted surgery. Focused on key areas of neuroscience research such as neuro-oncology, degenerative disease, spinal and peripheral nervous disorders, neuropsychology and cognitive function, TMU-TNI provides the best possible solutions to neuro-medical conditions through translational research that links new findings to treatments.

Be part of
TMU's neural
creativity

http://oge.tmu.edu.tw/research/research-highlights/neurosciences

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TAIPEI MEDICAL UNIVERSITY

Neuroscience at TMU

Creating Interdisciplinary Interaction

A Window into Neuroscience at TMU

How does one go about understand what happens in the most complex object in the known universe?

The human brain is a squishy clump of a hundred billion nerve cells inside our heads that controls much of our lives, from heartbeat and breathing to memory to our very consciousness and sense of self. Considering the wide variety of interdisciplinary perspectives that are being used to study the brain - pharmacology, artificial intelligence, engineering, psychology, and philosophy for instance - it can be challenging to get a handle on just what exactly "neuroscience" is and what neuroscientists do.

To help us better understand this wide-ranging field, we approached four neuroscientists from TMU whose work ranges from the micro level molecular bases of neurotransmission to macro levels of human behavior. We asked them about their work, collaborations, and just what makes neuroscience so interesting in the first place.

Researcher Highlight

Dr. John Wu, Clinical Neuroscientist

Dr. Wu grew up in the beach town of Los Alamitos in Southern California. He graduated with a major in molecular cell biology and computer science from the University of California, Berkeley before returning to Taiwan to complete his MD and PhD from the National Defense Medical Center. He also holds a Post-Doctoral Professional Master in Bioscience Management from the Keck Graduate Institute. Dr. Wu's surgical specialties include oncology and spine cases.

What is neuroscience, and what specifically is clinical neuroscience?

Neuroscience is the science of neurons and the supporting structures in general in the central and peripheral nervous system. There are lots of studies in peripheral pain, oncology, trauma, stroke, you name it, any type of pain, dizziness, any symptoms, basically has to do with neuroscience.

Clinical neuroscience is just taking the aspect of the patient, using that as an indicator to tell us whether or not what we are thinking in the neuroscience field is sound or inadequate, or needs work.

How did you first get interested in clinical neuroscience?

The first time I was looking at a brain was in high school in a dissecting lab. Everybody was looking at the heart, intestines and all that. I was looking at this tofu kind of tissue that nobody could make sense of. I was astounded by how this thing that just looks like a glob and yet has so much function in controlling the body. That was amazing to me.

Further into college I got into the electrophysiologies of neurons and I was really amazed by how a cell can be incorporated into a network and into the brain, and how different parts have different functions. That was amazing. That was where it started.

Throughout the training, at first when I was an intern, I was like, 'There's no way I'm gonna be a neurosurgeon!' [Laughs] I was looking at some older physicians, attendings, and residents, looking at their schedules… there's no way I'm going to take that kind of schedule. But over the years, it felt like, yeah, this is the calling. This is where I'm supposed to be.

Do you collaborate with other branches of neuroscience to help you in clinical neuroscience?

In clinical neurosurgery part we don't do much molecular work, but in the neuroscience field we want to look at a mechanistic view, at genetics, and proteomics fields. For example if we have a trauma, we might have a delayed hemorrhage. How does that occur, what is the mechanism behind that? So we collaborate with the neuroscience staff at TMU, we have clinical trials, collecting specimens, documenting patients to see their symptoms [over time], and try to run genetic, proteomic studies to figure out what happened. That's been really exciting.

[At the Neuroscience Center] we have a very diverse team, from psychology, to internists, to neurosurgeons, we hope to cover most of the fields. The first attempt to have something like this go on was about seven years ago. We were trying to get everyone working together for neuroscience. The efforts were beneficial and everyone started trying to see what everyone is doing and to help each other out. That's been helpful. And slowly over the years there's been a lot of collaborations and achievements, and we also see our own deficits. We're hoping to get more collaboration with the basic sciences and neurologists, psychologists, psychiatrists. I think the process will be challenging. Ultimately it will be there.

What other kinds of interesting neuroscience research is happening at TMU?

Medical imaging at our hospitals is really advanced, so there are a lot of clinical trials going on. A really big project is the oncology imaging genomics study. We look at a tumor to see different parts of the image and check it against genomics. We ultimately hope to use MRIs or other imaging methods to determine if the tumor is really malignant, or benign, and try to see the molecular aspects of the tumors.

Pharmacology is very interesting because they have lots of small molecules, lots of Chinese herbs that people have known to be helpful for brain tumors for decades. But is it really that molecule, that medication? What in that Chinese herb is the active ingredient that's helping the cancer? I think that's really interesting right now. We've been talking to the people at pharmacology trying to get molecules, trying to review the articles, trying to get down to what's really helpful in treating the tumors.

And I think artificial intelligence, nano-robotics and nano-medication, that will be another interesting and impactful field for the treatment of diseases and neurosurgery as well. We're really excited about the collaborations between these different groups.

Researcher Highlight

Dr. Philip Tseng, Behavioral Neuroscientist

Dr. Tseng is an associate professor at the TMU Graduate Institute of Mind, Brain, and Consciousness. He grew up in San Jose, California and completed his undergrad at UC San Diego. After finishing his PhD at UC Santa Cruz, he spent a year in Silicon Valley studying driving behavior at Volkswagen's Electronics Research Lab. He's been at TMU for the past three years, and was honored in 2017 as one of the Ten Outstanding Young Persons of Taiwan for his pioneering work in EEG recording and brain stimulation.

Can you describe neuroscience and behavioral neuroscience for us?

Neuroscience is a big term that covers many things. You can study the brain at the cellular level, or even at the genetic level. For me and my colleagues, we are at the very end where we study behavior. You can know everything about what each little neuron is doing, but how does that translate into emotions or memory and human behavior? That's tough. We look at system level neuroscience, we look at how different brain regions talk to each other, and how activity changes within these brain regions affect human behavior.

So we're on a more macroscopic level, whereas the molecular or cellular neuroscientists are looking at a much finer level, though we can all be studying the same problem from a very different perspective. For me it's more fun this way, but it's also complicated.

Why is neuroscience interesting to you? How did you first get interested in behavioral neuroscience?

I wasn't actually a psychology major to begin with, I was a biology major. I found genetics very interesting. I wanted to blend computer science and genetics. Now it would be called bioinformatics, and I thought that was the coolest thing. I was taking psychology as a GE course, but one of the perceptual lectures just blew my mind. In the lecture the instructor showed all these visual illusions… Have you seen the white and gold dress or black blue dress on the internet? Your brain made up everything you see, you touch, you hear and smell—we practically live in a virtual world the brain has constructed for us, and for a good reason, for survival. But it makes a lot of mistakes all the time… We're not even aware of it, and that's the coolest part. After taking that lecture, I was like whoa, I have to change my major! I have to do this for the rest of my life. Then I realized, oh wow, I needed ten more years of education. That was a painful realization at the time.

What kind of research are you doing at TMU now?

Could we manipulate brainwaves to help people that are having problems paying attention? Maybe, if we could inject waves back into the brain – our results indicate that this is the case sometimes. For example people with poor short term memory, after electric stimulation, they can improve their performance. But for people at the high end, their performance do not improve. No matter how you zap their brain they're not going to be superhuman. But for people whose average [memory performance is lower], they can actually improve their performance by 20-30%.

I'm now also trying to blend brain stimulation with driving performance. Is there any region in the brain I can stimulate to make people less fatigued or to make people more alert? Or maybe to make people more conservative in their driving behavior, less risk-taking?

The next aim is to get as many people into our driving simulator, and find if some of those tasks can be predictive of people's driving behavior in the real world. I'm trying to establish a stationary task that could be predictive of people's driving behavior. I'm also thinking about planting electrodes in a motorcycle helmet for brain stimulation.

I think you're also doing some research on cross-cultural reasoning, religion, and moral judgement.

Yeah, [moral reasoning and judgment in different populations] is a new line of research that Tim, the Dean of the College of Humanities and Social Sciences, and I try to collaborate on. He does philosophy of neuroethics, it ties together philosophy and neurology and law all together. I'm personally very interested in the effect of religion on moral judgments because it seems when you're so invested in one school of thought or one religion, it takes over people's reasoning abilities. We're trying to investigate that and see which brain regions are responsible for this kind of phenomenon. We're also doing some cross-cultural reasoning on moral judgments between Taiwan and the US and Europe.

What's next for your research?

All this research is keeping me busy, but now my main focus is how to use EEG and maybe brain stimulation to do memory detection. If someone denies ever seeing some crime-related items, yet there's a beautiful memory trace showing on their EEG, then we may have good reason to suspect the person might be lying. We're detecting memory traces that only the guilty would have. You can also apply this to eyewitness memory. We can use EEG to see if eyewitness confidence is real or not, should we trust this person's testimony or not.

Right now I'm also working with the investigation bureau (located next door to the Da-an Campus). We're trying to work out techniques beyond the polygraph, such as using EEG to monitor cognitive load. But of course there is still a long way to go.

How can other branches of neuroscience help you in behavioral neuroscience?

I work very closely with my colleagues in our Brain, Mind, and Consciousness program. All of us come from different backgrounds. Our leader Tim is a philosopher, I'm a trained cognitive psychologist, Tzu- Yu (Dr. Tzu-Yu Hsu) is a cognitive neuroscientist, Niall Duncan from Scotland is a biologist with a background in philosophy and pharmacology, Chang-wei (Dr. Chang-wei Wu), he's an electrical engineer who's interested in consciousness, and Jihwan (Dr. Jihwan Myung) the new faculty from Korea is a physicist, and he's interested in mood and time perception. I get a lot of interdisciplinary stimulation. Outside of our department I collaborate with Po Fang (Dr. Po-fang Tsai), a sociologist from the humanities in medicine department.

It's a very interesting experience to step outside of my comfort zone and listen to the other subfields. It's fascinating to see the difference in rationale between the subfields. As neuroscientists, we can explain the neural activity and link it to behavior, but what is the background? Is it evolutionary forces, or is it culture that influences what we observe in the brain. For that I need to rely on people in other subfields. At the end, everything is interdisciplinary. You can't just lock yourself up in the lab. It's sometimes hard to integrate because we're all looking at things from different perspectives and it can be hard to find the same language to talk to one another. But when you do, that's when big discoveries are made.

What other kinds of neuroscience research are going on at TMU that's interesting to you?

There's a group of scientists from the neuro-regeneration program who are doing structural analysis of MRI images, diffusion spectrum imaging. It's a variation of FMRI to track down the fibers in the brain. Arica Lo is using that to study children with autism. That's very interesting work that she's doing and she's making a lot of progress.

There's also a group of MDs at the TMU hospital from the rehabilitation department that are using brain stimulation, but in a different way from how I would normally use it. Usually I would lock my stimulation to [a specific] task, but these people are doing stimulation over the motor cortex or over the spinal cortex to help facilitate the rehab program. I think that's pretty cool.

I also know some psychiatrists at Wanfang who are analyzing sleep patterns of schizophrenia patients and heart rate variability in different psychiatric disorders. I think it's all connected, the biology, the physiology, and the psychiatric disorders, so I think that in the next couple of decades psychiatry should experience a huge breakthrough, given what we know in neuroscience.

Researcher Highlight

Dr. Tzu-Jen Kao, Developmental Neuroscientist

Dr. Kao studied biology at Baylor University in Texas, earned his PhD in Biomedical Science at the University of South Carolina, and completed postdoctoral work at McGill University in Montreal. He's been teaching and researching at TMU for four years, and holds an Assistant Professorship at the Program for Neural Regenerative Medicine and the Center for Neurotrauma and Neuroregeneration.

How would you define neuroscience?

It's a really broad topic. Traditionally people think neuroscience is only related to the brain and spinal cord, but it's related to other parts of the body, like controlling heartbeat, breathing, all the muscles, things like that. So neuroscience nowadays is more multidisciplinary. It's getting popular because and people are trying to collaborate, trying to link the function of how the brain or spinal cord can control these other parts.

And what's developmental neuroscience?

You can start from the very beginning of the different mental stages, like the embryonic stage, how brain and spinal cord develop. Because once all the networks are differentiated, the neuronal types are set for life and they don't divide any further. So understanding how the brain is structured and how the networks are formed to properly control the different parts of body is very important. That's why I'm studying developmental biology.

How did you first get interested in neuroscience?

When I decided to start my life science career, [it was] either cancer or neuroscience, because I knew it's realistic to get funding. But unfortunately, at the beginning of my PhD studies all the neuroscience labs, all of the cancer labs, the faculty weren't taking new students. So that's how I chose biology. They also study calcium, which is a very important source for neurons to make action potentials to transmit information from one [cell] to the other.

I was thinking, okay, maybe that's one way to compromise. I studied the same molecules, the same pathways, but a different system. So after that … I really want to go to these two labs. So I'm when I'm submitting my resumes, I only choose the cancer lab or the neuroscience lab. That's why I found my postdoc position at McGill.

What kinds of work and research are you doing at TMU now? Are there applications for your work?

The main topic is the guidance process during the stages of neural development. I'm doing a very fundamental part of the studies but how you can apply that is also very interesting. For example, I studied how nerves can grow to the proper targets, like how a neuron can bind to a muscle target so you don't misinterpret the signals. This happens at the very early stages of embryonic development.

But what happens is when the spinal cord or brain get injured, those molecules [that guide nerve growth] will have abnormal expression at a very high level. I think maybe that's one of the reasons for the inhibition of the regeneration of the nerves.

We found that in some neurodegenerative disease, the patients experience abnormally high levels of those molecules, and the earlier [this starts] affects the onset of disease and how bad it will progress. If we know the molecular mechanisms underlying the pathways, that can also help us to find a treatment of those diseases.

In addition to that, there are also cancer studies. During metastasis of the cancer cells, they also expressed high levels of those guidance molecules. Through the interaction between the receptor and cues, that can facilitate or increase the probability of metastasis. So we sort of use on the guidance system as a model to study this, and the by knowing more about the molecular mechanisms, this can help us to fight cancers or neurodegenerative disease.

What other kinds of neuroscience research is happening at TMU that's interesting to you?

I think we have a good history [with] traumatic brain injury studies. We have established the labs here since Dr. Wen-Ta Chiu (TMU President from 20 years ago) studied the essentialness of wearing helmets when you ride a motorcycle. It's one of the big advantages of our neuroscience related studies at TMU.

Another thing is cognitive neuroscience, led by Lan-Ting (Dr. Tim Lane, Dean of the College of Humanities in Medicine and Director of the Brain, Mind and Consciousness program). I think he's doing a really good job.

And then, of course, there's field of AI. It's more like designing software that can help us to pull the data from a big database. In this way it can help the doctors to prescribe drugs and find the proper treatment. They can rely on powerful software to analyze according to the symptoms and medical histories of the patients.

Would you have any advice for prospective students who are interested in neuroscience?

I would say it's still a very hot topic. People still don't know too much about, for example, the mechanisms of the brain. And also there are many neurodegenerative diseases that we still didn't find a cure [for]. We can use drugs to prolong life span of the patients but [neurodegenerative disease] is not reversible. So I think they is still a lot of potential for all the students to start if they're interested in neuroscience.

Do you have any other thoughts about neuroscience at TMU?

I think neuroscience is for the future. The schools are going to recruit more faculty in the neuroscience field to join either our programs or other departments. I would say the future it's very bright, and also the funding situation is pretty generous in our field. So I'm thinking I won't lose my job in the next 10 years or so! [Laughs]

I think in the long run if you have better foundations [in basic research] that can help you in the future. That's what I'm doing. I hope to do more basic science and help people in the long run.

Dr. Niall Duncan, Cognitive Neuroscientist

After earning a BSc with Honors in pharmacology and an MLitt in philosophy of the mind at the University of Glasgow, Dr. Duncan followed his PhD advisor from Germany to Ottawa's Carlton University, where he completed his Doctorate in biology, specializing in neuroscience.With a background in both neuroscience and philosophy, Dr. Duncan was recruited to TMU's Brain and Consciousness Research Center. He has been at TMU for the past three years.

Can you please briefly describe neuroscience and cognitive neuroscience for us?

It's constantly changing, especially as it becomes a fashionable term. I would say it's the study of brain trying to answer the questions of why do I see anything, why do I feel anything, why do I want anything. For example, a psychologist might ask why this person is happy, but they're not necessarily asking what's happening in their brain to make them happy. The neuroscientists are answering that question by approaching it from the biological side. That's the ambition anyways. And that deals with single cells, or even gene expression, all the way up to what I'm doing with brain imaging in humans and so on, and finally looking at the behavior that arises.

At every point on that continuum from gene expression to behavior there are always collaborations. There are no fixed boundaries to what neuroscience is. There are these huge questions, and this person that does computer science has a really good perspective, or this physicist is doing something that's applicable, or this mathematician or economist, all sorts of people. It's becoming more and more multidisciplinary and an umbrella term.

I do brain imaging, neuroimaging if you want… which is the field that is looking at trying to measure brain function and structure in living animals. And so it's a kind of continuation of the old work that people used to only be able to do with animals, to extend that biology research into living humans by using the technology that is now available.

Why is neuroscience interesting to you? How did you first get interested in neuroscience?

From the beginning it was always the brain stuff that was the most interesting. We've got this lump of meat in our head, and we all see stuff, we feel stuff, we're sad, we're happy. How does that happen? That's such a cool question. In pharmacology we dealt with neurotransmission a lot, because that's what the drugs are acting on. The work I do now continues from that, in that I look at neurotransmitters in the human brain and their influence on brain activity and on people's experience. In philosophy I focused on the philosophy of mind. One of the major questions is 'why are we conscious?' Between the biology and the philosophy, it was an obvious path towards where I am.

What kinds of research are you doing at TMU now? What are some applications of your work?

My background was doing a lot of psychiatric disease related neuroscience, and along with Dr Tzu-Yu Hsu I'm currently running a big project with depression patients. We're trying to use a range of neuroimaging techniques to get a picture of what's going on in their brains from different perspectives, and putting that together. A key focus is on rumination – people with depression get trapped in negative thoughts about themselves. We're trying to look at the neural changes that might be producing those negative thoughts and how we might go about stopping them. We're doing some fMRI, some EEG, we're even taking blood samples and collaborating with Dr Thierry Burnouf [College of Biomedical Engineering] who's going to look at inflammatory markers. This primary research is essential to develop treatments that work.

There's currently a lot of research going on identifying the fact that depression is not one homogenous disease, it's more like a whole set of different diseases that produce symptoms that look similar. So of course if you give a drug that treats one of those subtypes it's not going to treat the other ones. We need to work out what the subtypes are, how to identify them, and how to treat those ones specifically. That's a little bit down the line, but we're getting there, and some of the work that we're doing will play a part.

We try to approach some of these diseases from the point of view of consciousness. You need to think in theoretical terms, which is why having philosophers around is useful. Neuroscientists are thinking in quite a big picture, about how does this organ work, but then there's an even bigger picture of what does that mean and why has it come to work that way. They seem like abstract questions but I would argue that they're fundamental. If you don't understand what your brain is for, then it's really hard to work out what's gone wrong with it.

Who else are you working with?

[Our center] is definitely interdisciplinary. We have engineers, Tim's a philosopher, we've got some psychologists, and Dr. Jihwan Myung who recently joined the faculty does some really interesting stuff with mice and circadian rhythms. He's currently in his office building circuit boards and filling the place with glue. He's just getting started [researching] the application of these longer term rhythms. A lot of my analysis is based on brain activity rhythms in the short term, and he's extending that out. We're trying to put together some projects that will let us go from the single cells in the mice up to looking at the whole human brain, and how it's being influenced by these rhythms.

What other kinds of neuroscience research is happening at TMU that's interesting to you?

We're running a really important project with disorders of consciousness patients. Tim (Dr. Tim Lane) is leading that. We're taking patients with unresponsive wakefulness syndrome and minimally conscious states and firstly seeing if we can give an intervention to improve their condition, but then also doing a lot of brain imaging to try to work out what's gone wrong - we know what's gone wrong, they've been hit by a car - but which specific changes mean they are no longer conscious of the world. That's really important research from the point of view of the basic question of where's this consciousness coming from. That's a group of patients that if we can find a way of intervening, that's such a huge difference to their life and almost more importantly to their family's life.

How do you like working and researching at TMU?

It's been a good place for me to work. I work with really great people who are doing some cool stuff, and in our center we are trying to do things a bit differently, break the mold a little bit to produce an atmosphere and ethos that leads to good research, and interesting research. That's our plan.

There's good infrastructure here. All the hospitals have got MRI scanners that are used day to day for clinical work and are also made available to us to do science. And they have invested in some animal imaging infrastructure also. At our institute we have some really good equipment available in terms of EEG measurements which are an important part of neuroscience, and we also have brain stimulation equipment like TMS and tDCS (transcranial magnetic stimulation and transcranial direct current stimulation) which my colleagues use to stimulate different parts of the brain.

Are you working to bring in new students?

Yeah, we're always on the lookout. We have our master's program running and we should be getting a PhD program next year . That will be a really important step because it's the PhD students that really drive research, if you let them. We get some really great students from all over the planet and I've been really impressed with the ones we've got so far. Our program seems to attract students that are thinking a bit differently, which is key to doing good science.

Introducing the TMU-Taipei Neuroscience Institute Leadership

The TMU-Taipei Neuroscience Institute located in Shuang Ho Hospital integrates neurological internal medicine and surgery through by uniting 12 expert groups to serve every specialized need.

Shuang Ho, Wanfang and Taipei Medical University hospitals make up the TMU Healthcare System. It serves the greater Taipei area, possessing geographical advantages in terms of multi-hospital integration. As more than a hundred attending physicians serve the TMU system in neuromedical capacities, the institute aims to integrate these specialists for faster discussion and decisions in complex clinical cases; this also facilitates development of neuromedical treatments.

The center has Asia's first ROSA Spine mechanical robotic surgical assistant for precise navigation in spinal and brain surgeries. This greatly elevates the standard of neurological care in Taiwan and provides patients with the most precise minimally invasive surgical services. The center includes specialized facilities for and experts in neuro-oncology, radiosurgery, cerebrovascular disease, neurorehabilitation, degenerative disease, neuropsychology and cognitive function, epilepsy, vertigo, sleep disorders, headache, neurotraumatology and intensive care, pediatric neurology, pain control, and spinal and peripheral nervous disorders.

▲ The center has Asia's first ROSA Spine mechanical robotic

The TMU Taipei Neuroscience Institute is headed by Superintendent Yong-Kwang Tu. He is assisted by Deputy Superintendents Yung-Hsiao Chiang, Chaur-Jong Hu and Chien-Min Lin.

Superintendent Yong-Kwang Tu

Superintendent Yong-Kwang Tu is a world-renowned neurosurgeon and former surgical director and professor at National Taiwan University's College of Medicine. He is renowned for his intracranial and cerebrovascular high-flow bypass surgeries, and has carried out hundreds of surgeries with high success rates that have been noted worldwide. He became superintendent on December 1, 2017.

Dr. Tu was the first to introduce challenging neurovascular surgical techniques and skull base brain tumor surgery to Taiwan in the 1980s. He is the founding chairman of the Taiwan Society for Skull Base Surgery and the Taiwan Society for Neurovascular and Interventional Surgery.

On September 16, 2011, he was voted President-elect of the World Federation of Neurosurgical Societies, the first Asian in this position in the organization's 60-year history, raising Taiwan neuroscience's standing globally.

Prof. Tu is responsible for integrating neuromedical resources within the TMU medical system. Compared with other disciplines, neuromedicine is a comparatively new field, he said, and information technology developments such as computerized tomography (CT) and magnetic resonance imaging (MRI) have helped it make rapid progress. In other countries, the integration of such medical resources is an important trend, and that is why TMU created the Neuroscience Institute.

Teaching will change for the better as well. Formerly, when residents rotated between different divisions they were taught the same thing multiple times. Since the integration, instructing physicians teach based on themes and fields. This can save teaching time and allow students to learn with less redundancy. The integration will also allow basic and clinical researchers to work together for deeper partnerships.

Deputy Superintendent Yung-Hsiao Chiang

Deputy Superintendent Yung-Hsiao Chiang is a well-known Taiwan neurosurgeon who has served as academic director and clinical director at TMU and its affiliated hospitals since 2007. He has worked in the neuroscience field for over 30 years and became deputy superintendent of the Neuroscience Institute in April.

He has long dedicated his research efforts to brain trauma and tumors as well as spinal, neurovascular and Parkinson's diseases and neuro-regenerative medicine, contributing much to the neurosurgery and spinal surgery field in Taiwan. He believes that making the correct diagnosis is critical, as one misdiagnosis can lead to a lifetime of suffering, and that physicians continue to carry responsibility until patients are healthy again. Thus he remains calm and patiently listens to patients to understand and make the correct diagnosis. He places emphasis on the doctor-patient relationship, and has published books detailing real-life stories as he accompanies patients through their treatments.

Deputy Superintendent Chaur-Jong Hu

Deputy Superintendent Chaur-Jong Hu also serves as deputy superintendent for research at Shuang Ho Hospital. Professor Hu's research focuses on clinical and molecular neuroscience, particularly molecular mechanisms and biomarkers in strokes and dementia. He has long received financial support from Taiwan's Ministry of Science and Technology, and has set up a TMU molecular neuroscience laboratory while assisting in several multinational and multicenter clinical studies.

In 2017, Professor Hu became director of TMU's neuroregenerative medicine Ph.D. program. This links the course and the Neuroscience Institute, uniting basic neuroscience and clinical medicine to raise the standard of research.

With the establishment of the Neuroscience Institute in 2017, Professor Hu became deputy superintendent. He will continue to promote neuromedical innovation and interdisciplinary research to enhance the institute's service, teaching, research and visibility on the global stage.

Deputy Superintendent Chien-Min Lin

Deputy Superintendent Chien-Min Lin has served as neurosurgery attending physician and director of the surgical intensive care unit (ICU) at Wanfang Hospital and Shaung Ho Hospitals. His activism led to a 2009 award for facilitating and promoting organ donation. Upon becoming neurosurgery director in 2013, he helped develop various minimally invasive, guided and robotic surgical techniques. With the support of the university and the hospital, he initiated Asia's first ROSA Spine robotic surgical system.

Dr. Lin specializes in minimally invasive spinal surgery as well as brain trauma and various intensive care techniques, and his research focuses on neuron protection and glioma cells in the brain. To enhance translational research, he has set up specialized laboratories that contribute to the overall improvement and development of neurosurgery in the TMU Healthcare System.

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