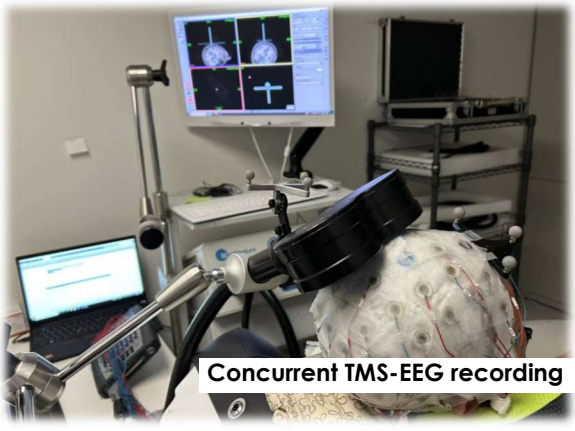
UBSN
University Research Facility in Behavioral and Systems Neuroscience
神經科學中心實驗室

NEWSLETTER
ISSUE 11 (SEP 2024)

Prof. Kenneth Fong's team Investigating the Role of Mirror Neuron System in Motor Learning for Stroke Rehabilitation

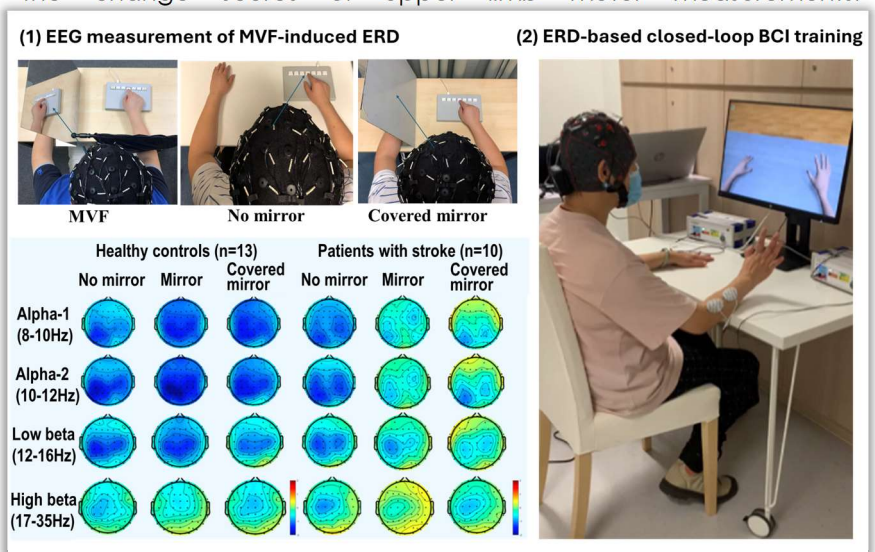
Prof. Fong administering repetitive TMS intervention on study participant

Mirror neuron system (MNS) is a network of neural substrates at the bilateral frontal and parietal lobes of human brains that are activated during action execution (AE), action observation (AO) and mental imagery (MI). Not just for the purpose of motor learning in human beings, MNS is important because it helps us to develop empathy and social behaviour through observation. Through patient group studies, currently we learnt that patients with stroke have difficulty in motor learning because of the impairment over the motor cortex over the ipsilateral hemisphere, and that children with autism have difficulty in copying others' facial expression and social emotions because of the impairment in MNS. However, we believe that MNS is adaptable and can be modified according to experiences and learning, which means that it can reflect the neuroplasticity of human brain. Below are two recent studies which we have made use of MNS in training and measurement respectively.



Concurrent TMS-EEG recording

Regarding training through MNS, one of our pilot studies is to investigate the therapeutic efficacy of Electroencephalography(EEG)-based Brain-Computer Interface (BCI) training with functional electrical stimulation (FES) and AO as feedback modalities, for upper limb function in patients with stroke. The participant has to do an MI of a 'wrist extension', the EEG captures the signal of sensorimotor event-related desynchronization (ERD) – an electrophysiological marker that captures the signal of suppression of alpha and beta bands which reflects the activity of MNS indirectly, then translates the signal to both AO and FES for a hand opening. The participant does not need to move and the BCI machine will open the hand for him/her through FES if he/she is able to 'think' correctly the movement action. Alongside with the improvement of upper limb behaviour measures after 10 sessions of 1-hour training in 3 weeks, we found that changes in ERD also associated with the upper limb recovery in stroke patients. We also found that the MI accuracy is significantly correlated with the change scores of upper limb motor measurements.



Study uses EEG to capture ERD induced by mirror visual feedback (MVF), finds that priming iTBS may facilitate post-stroke learning.

Regarding measurement of MNS, another study is to use a novel transcranial magnetic brain stimulation protocol on intermittent theta burst stimulation (iTBS) - the priming iTBS, which might benefit hemiplegic upper limb recovery in patients with stroke. We applied continuous theta burst stimulation (cTBS) before iTBS to boost the facilitatory effect of iTBS. Our behavioural findings showed that among patients with higher functioning upper limb, priming iTBS protocol was superior to the non-priming and the sham stimulations in enhancing treatment gains from conventional robot-assisted training for the hemiplegic upper limb. Moreover, the use of this priming iTBS protocol was cost-effective. In addition, our EEG results

showed that priming iTBS may facilitate post-stroke motor learning by enhancing the permissiveness of the ipsilesional sensorimotor area to therapeutic sensory modalities, as measured by the ERD induced by mirror visual feedback (MVF)-based observation.

Therefore, we proposed that ERD might be considered as a potential neurophysiological biomarker for sensorimotor neuroplasticity for stroke upper limb rehabilitation.

Publications related to the article:

- Zhang JJ, Bai Z, & Fong KN. (2022). Priming Intermittent Theta Burst Stimulation for Hemiparetic Upper Limb After Stroke: A Randomized Controlled Trial. Stroke (1970), 53(7):2171–2181. https://doi.org/10.1161/STROKEAHA.121.037870
- Bai Z, Fong KNK, Zhang JJ, Chan J, & Ting KH. (2020). Immediate and long-term effects of BCI-based rehabilitation of the upper extremity after stroke: a systematic review and meta-analysis. Journal of NeuroEngineering and Rehabilitation, 17(1):57. https://doi.org/10.1186/s12984-020-00686-2

Prof. Fong is a Professor of Rehabilitation Sciences in the Hong Kong Polytechnic University. He is an experienced occupational therapist specialised in neurorehabilitation and assistive technology. Prof. Fong is currently the Associate Head (Research, Innovation and Knowledge Transfer) of Department of Rehabilitation Sciences. He is also the Director of the Research Centre for Assistive Technology, and the management committee member of the University's Research Institute in Artificial Intelligence of Things.

His laboratory is utilising brain modulation and neuroimaging to understand the mechanisms underpinning post-stroke upper limb recovery, and exploring new technology such as using innovative wearable devices for home-based and tele-rehabilitation to promote post-stroke functional recovery.

Prof. Kenneth FONG

Professor and Associate Head

Department of Rehabilitation Sciences

UBSN's equipment update

MRI-TMS

Navigational System
Localite TMS Navigator TS

Localite's TMS Navigator TS ensures utmost accuracy and allows tailored treatment for the uniqueness of each patient's brain.

Users can customize treatment by utilising individual MRIs or a standard brain model (MNI), adapting it to the patient. The choice of target definition includes brain atlases, anatomical, and functional data.

Features:

- Optimal precision through optical tracking
- Personalisation using MRIs or standard templates
- Diverse treatment planning with universal or personalised targets
- Seamless integration with MagVenture stimulator for treatment documentation
- Setup flexibility with a camera cart for precise positioning
- Effortlessly and reliably targetting

Officer-in-charge:

Dr. Celia DONG (celia.dong@polyu.edu.hk) (MRI), and

Dr. Tommy LAM (lh-tommy.lam@polyu.edu.hk) (Human equipment)

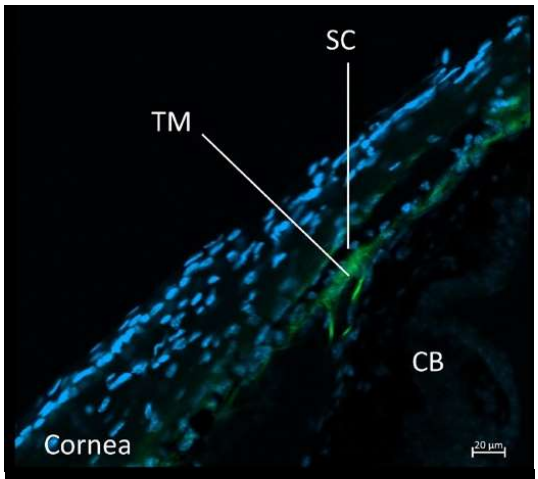
More information on UBSN equipment: https://www.polyu.edu.hk/ubsn/facilities/equipment/

PolyU scholar discovers key mechanism of intraocular pressure regulation suggesting novel treatment approaches for glaucoma

One of our UBSN users from School of Optometry, **Dr. Samantha SHAN**, has recently reported her study results researching glaucoma, with part of her study making use of UBSN's **Upright Confocal Microscope**.

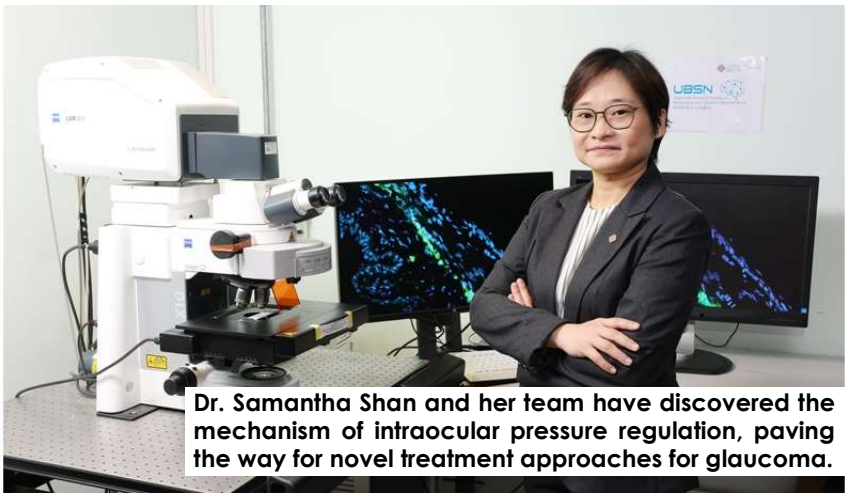
Glaucoma is one of the leading causes of visual impairment and blindness. According to statistics from the Hospital Authority, in Hong Kong, three out of every 100 individuals aged over 40 suffer from glaucoma. In its early stages, obvious symptoms may not be present and those less obvious are often overlooked. By the time patients notice changes in their vision, the condition is usually severe. Dr. Samantha Shan, Research Assistant Professor of the School of Optometry of The Hong Kong Polytechnic University (PolyU) and her team have discovered the mechanism of intraocular pressure (IOP) regulation, paving the way for novel treatment approaches for glaucoma, with the aspiration of preventing vision loss from this disease.

In glaucoma patients, the fluid within the eye (known as "aqueous humour") continuously flows, resulting in higher IOP for which long-term medication is required. However, current drugs have limitations in that they can only slow disease progression rather than halt it completely. Drugs may also have suboptimal tolerability and their efficacy diminish over time.



Immunostaining on TSP-1

The microRNA(miR)-17-92 cluster is known to play an important role in cell signalling, but its specific functions in the eye are not well understood. In this respect, Dr. Shan and her team's research focus lies in gaining insights into the mechanisms of miR-17-92 cluster members and their effects on IOP. The team has identified thrombospondin-1 (TSP-1) as a protein that reduces the outflow of aqueous humour and increases IOP. Concurrently, the team mimicked three members of the miR-17-92 cluster in human trabecular meshwork (hTM) cells which are responsible for draining


Dr. Samantha Shan and her team have discovered the mechanism of intraocular pressure regulation, paving the way for novel treatment approaches for glaucoma.

aqueous humour within the eye. It showed that the expression of TSP-1 was repressed, resulting in an approximately 73% increase in the outflow of aqueous humour in mice.

Dr. Shan's team has recently been recognised with a prestigious 2024 Shaffer Research Grant from the Glaucoma Research Foundation to further explore the effects of miR-17-92 members in IOP regulation. Looking forward, the team will investigate the direct interaction between specific miRNAs and TSP-1 by blocking the potential target sites of the three miRNAs in TSP-1 in hTM cells. They will also examine the functional consequences of modulating this pathway on aqueous humour outflow and IOP regulation in vivo. This would be achieved by utilising intravitreal injections of a TSP-1 target-specific blocker or miRNA mimics in mouse eyes.

Dr. Shan remarked, "Genomic and proteomic approaches play a crucial role in understanding the genetic and molecular mechanisms underlying diseases such as glaucoma. In the context of glaucoma treatment, these approaches can help identify potential biomarkers, therapeutic targets and personalised treatment options, with far-reaching implications. The Grant also demonstrates PolyU's excellence as hosting one of the top eye research centres in the world. It encourages me and my team to continue to make significant strides in glaucoma research and contribute to the better care of glaucoma patients."

With over a decade of experience in molecular research, in her work, Dr. Shan has demonstrated proficiency in utilising genomic and proteomic approaches. Her research interests are mechanism of aqueous humour formation, outflow facility and IOP regulation, microRNAs on outflow facility, DNA methylation of potential candidates on outflow facility and IOP regulation.

Dr. Shan has also received support from the Hong Kong SAR Government's Health and Medical Research Fund for two projects as a principal investigator. The projects aim to discover gene editing methods for treating glaucoma and unravel the role of epigenetic regulation in glaucoma respectively. Dr. Shan has also served as a co-investigator on other diverse research topics and has secured notable research funding, including the Research Grants Council's General Research Fund.

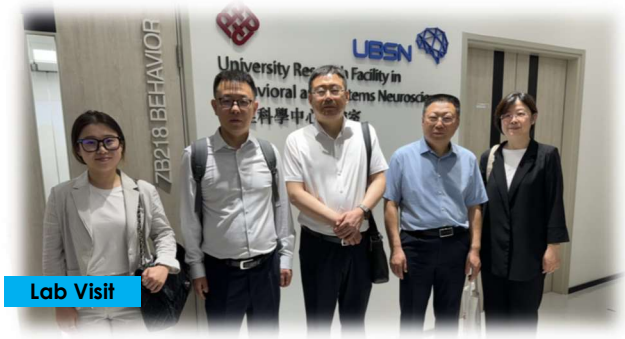
Read more:

https://www.polyu.edu.hk/en/media/media-releases/2024/0725_polyu-scholar-discovers-key-mechanism-of-intraocular-pressure-regulation/

https://www.media-outreach.com/news/hong-kong/2024/07/25/315394/polyu-scholar-discovers-key-mechanism-of-intraocular-pressure-regulation-suggesting-novel-treatment-approaches-for-glaucoma/

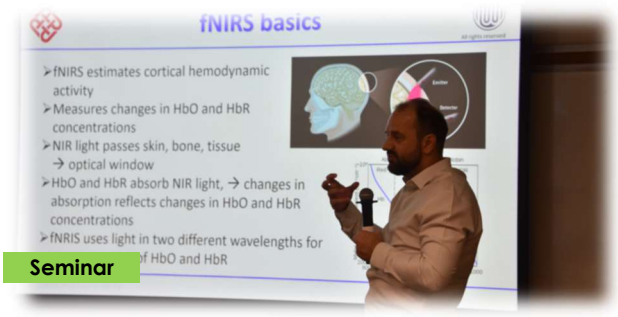
Recent events at UBSN

In June, UBSN had the joy of receiving visitors from Changchun University. We had a seminar titled "Imaging Therapeutic Brain Stimulation with fNIRS", cover basics as well as insights of how functional near-infrared spectroscopy (fNIRS) can be used in a research setting. UBSN thanks Dr. Georg KRANZ for his continuous support.



Lab Visit

Visitor from Changchun University



Seminar

fNIRS Seminar and Lab Visit
Speaker: Dr. Georg KRANZ

In July, UBSN had a seminar titled " Transcranial Magnetic Stimulation (TMS) in Poststroke Rehabilitation ", introducing the current research on application of Transcranial Magnetic Stimulation (TMS) in stroke patients. UBSN is grateful for Dr. Jack Jiaqi ZHANG for his comprehensive talk.

Seminar

TMS Seminar and Lab Visit
Speaker: Dr. Jack Jiaqi ZHANG

In August, UBSN hosted a seminar on "Geodesic HD EEG and Transcranial Electrical Neuromodulation" by MagstimEGI. UBSN also had the privilege of welcoming Dr. GU Xiao (Shawn) to visit our facility.
We also had great pleasure to receive TMS Navigator TS with MRI training by Dr. Patrik KUNZ from Localite.

Seminar

Geodesic HD EEG and Transcranial Electrical Neuromodulation Seminar
Instructor: MagstimEGI

Lab Visit

Visitor from University of Oxford
Dr. GU Xiao (Shawn)

Workshop

TMS Navigator TS with MRI Training
Instructor: Dr. Patrik KUNZ from Localite

At UBSN, we hope to bring users useful knowledge regularly and inspire more innovative research at PolyU.
If you have any requests or suggestions on an equipment, drop us a message!
For more UBSN news and events, visit our website:
https://www.polyu.edu.hk/ubsn/news-and-events/

Upcoming Events at UBSN

A selected piece of UBSN equipment is featured every few months.

Starting the next bimester, UBSN will host more seminars and workshops featuring **EEG and MRI**.

Stay tuned by checking out our website:
https://www.polyu.edu.hk/ubsn/news-and-events/

Follow on Instagram:

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Have any questions? Interested in using our equipment? Please contact us!
Website: https://www.polyu.edu.hk/ubsn **E-mail: ubsn.enquiry@polyu.edu.hk**