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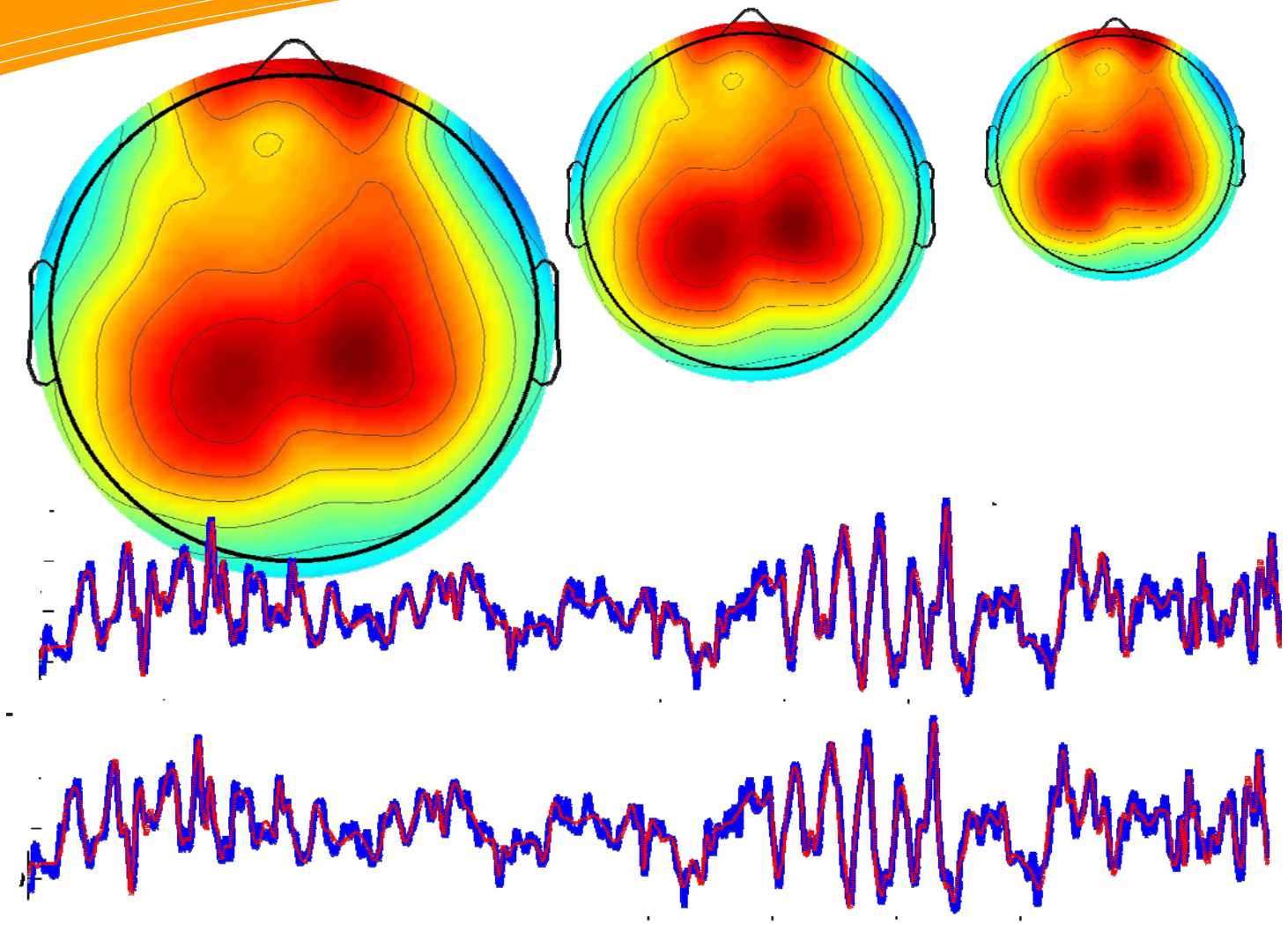

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EDITOR-IN-CHIEF'S NOTE

Assoc. Prof. Dr Ibrahima Faye

The Editor-in-Chief, NEURO-EASTERN

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This is the 10th issue of NeuroEastern, the biannual newsletter of Asia Pacific Neurofeedback Association. The current issue covers the period from January to June 2018.

To start with, I would like to invite all of you to attend the 4th APNA Annual Conference which will be held at Chiangmai Grandview Hotel & Convention Center, Chiang Mai, Thailand, from 6 to 7 September 2018. The announcement of this event is highlighted at the end of this issue.

Apart from the announcement of the upcoming conference and this note, this issue contains one article.

In this article, Dr. Subhasis outlines the basic elements of infant learning. He then describes how the two fundamental components of learning in infants – feedback and feedforward – are used in a natural learning model. He highlights the limitations of the model for stroke patients. He, then, suggests an improved model that could help to overcome the deficits through the learning route. The article shows very well how the current biofeedback and neurofeedback practices could be updated with the emerging knowledge of neuroplasticity.

We look forward to your contributions to the next issues.

Ibrahima Faye

Asia Pacific Neuro-biofeedback Association (APNA)

President's Message

Prof. Dato Dr. Susie CM See

It is my sincere pleasure to welcome you to join APNA.

APNA was established to provide an oversight of the field of neurofeedback and biofeedback, so as to promote and expand it, as well as to safeguard consumer interests.

I would like to express my deepest gratitude to the practitioners and researchers who have come together to help make the establishment of APNA possible. With that, I also want to extend my warmest invitation to anyone who is passionate about this field to come join us and grow this field, hand in hand, with the community for the benefit of mankind.

Brief Description

APNA is a non-profit organization for the purpose of joining the expertise of clinicians and researchers who are involved in health care research, and the clinical applications of neurofeedback and biofeedback for serving society. There is a growing number of professional clinicians, and biomedical and computing engineers, who have expertise in medicine, psychology, therapy, engineering, and the development of new advanced computing solutions to biomedical problems.

These diverse experts started sharing their expertise, joint research collaborations, organizing joint events, and developing their professional networks, under the umbrella of APNA. These activities are at initial stages and expected to peak in the future, including all the countries in the Asia Pacific region. It is very encouraging that the growing network of these professionals is promoting the clinical use of neurofeedback and biofeedback interventions to the general public for maximum benefits. Consequently, it will help people consult certified practitioners of neurofeedback rather than non-certified consultants.

VISION

1. To deepen our understanding of Asian mindfulness and meditation techniques and its health benefits with rigorous science
2. To promote its application in society to improve health, performance and quality of life

MISSION

1. To promote research collaboration between researchers, clinicians and the community
2. To promote professional clinical use of neurofeedback and biofeedback in the AP region
3. To promote awareness of the benefits of neurofeedback and biofeedback to the general public

Lessons from Infant Learning to Enhance the Effect of Feedback Modalities in the Treatment of Disability

By: Dr. Subhasis Banerji
Email: subhasis@synphne.com

Background

Biofeedback and neurofeedback have been used for several decades in the treatment of various disabilities and developmental delays in humans. While there is widespread evidence of such treatment resulting in the reduction of impairments, success in translation to function and independence is relatively lower, in both paediatric and adult populations. While the fundamental principle for rehabilitation has been repetitive practice – prolonged exercise for physical difficulties, operand control training for neuro difficulties, or a combination of both – it is seen that infants learn in a somewhat non-repetitive, iterative manner, each trial or attempt being different from others. This article outlines the basic elements of infant learning and suggests how these could be implemented within biofeedback and neurofeedback to bring these practices in better alignment with the emerging knowledge of neuroplasticity.

Learning in Babies

There is now a growing understanding about how the body affects learning. The embodiment hypothesis proposes that sensorimotor activity of the person, as it interacts with the environment is central to the development of intelligence [1]. In this field of study, the six principles of learning that babies instinctively follow can be summarized as below [1]:

1. Being multi-modal
2. Being incremental
3. Being physical
4. Exploring
5. Being social
6. Learning a language (symbolic representation)

1. Being Multi-Modal

A multi-modal experience of the world is achieved in humans through the sensory system which is made up of a vast array of sensors to provide vision, audition, touch, smell, balance, and proprioception. Any single function can be accomplished by more than one signal configuration from the neurons and different neuron clusters need not be limited to a single function. This type of redundancy ensures continuity in function where parts of the network can learn from each other without an external teacher.

The second characteristic is the time-locked correlations between several simultaneous inputs, which is a powerful tool for representation, both singly and in combination with various events and objects in the environment [2]. In real-time, these activities are mapped to each other to discover "higher order regularities", for example, using a combination of touch and vision to understand texture or transparency.

2. Being Incremental

In non-incremental learning, the entire training set is usually fixed and then, presented in entirety or randomly sampled. However, it seems that systematic changes in the input patterns and their overlapping occurrence in time play a large part in determining the development process. As a child grows, the vision starts to couple with the hearing and helps organize attention. In hearing-impaired babies, we see disorganized attention and a consequent slower learning (This is common in stroke cases, where patients experience sensory overload and cognitive deficiencies). Co-ordination is a form of mapping of multi-modal learning and the way they map changes over the development time, using either changing patterns or additional sensory inputs, which the infants are now able to voluntarily provide themselves through physical exploration. Shifts in inputs thus result from the infant's own behavior. Using the body and moving from one place to another presents new spatio-temporal patterns and alters the infant's perception of "objects, space and self". Experimental studies show that one of the factors that strongly influence biological intelligence is "ordering the training experiences in the right way" [3].

3. Being Physical

Experiments by Ballard et al. [4] and Baldwin [5] show that children off-load short term memory to the world by linking objects and events to locations, using attention to selectively point to the world. It is an easy way to build coherence in the cognitive system and to keep contents of different information clusters separate from each other.

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4. Exploring

Initially the baby does not know what there is to learn. Babies can discover both the tasks to be learned and the solution to those tasks through exploration or non-goal directed action. One of the ways of exploration is spontaneous movement and exploration of the space around themselves by flaying of arms and legs. As they make contact with objects in the environment, they progress from non-reaching to reaching. Thus, they seem to move from arousal to exploration to a selection of solutions from whatever space they are capable of exploring, which initially is limited. This type of learning is possible because of the multi-modal sensory system that builds maps from time-locked correlations, starting with smaller spatial maps and expanding to larger ones.

5. Being Social

In early interaction with mothers, infants learn from a pattern of activity that tightly couples vision, audition, and touch to behavior. Mother and infant imitate each other to reinforce this coupling. A mature social partner or parent can also build a cognitive framework by weaving their own behavior around the child's natural activity patterns. This is done by automatically selecting those patterns which they consider meaningful and helpful for the baby. They also serve to direct attention to an object or event to strengthen the coupling. This is done in the spatial as well as temporal aspects. The baby frequently looks for physical and directional support to manage the risks around exploration, to rest when tired, and to crystallize goals through such imitation and coupling.

6. Learning a Language

Language can be a regularity that is a "shared communicative system". It is also a symbol system where the relation between the symbol and events in the world are mainly arbitrary e.g. there is no relation between the word "dog" and what it actually represents, by knowing the word we cannot know the animal. DeLoache [6] demonstrated the way children use scale models and pictures as symbols which are not too life-like. Children first learn subtle regularities from the words they absorb, and slowly it creates in them the ability to learn a word in one trial and do higher-order generalization. Efficient learning through a form of language itself becomes learned behavior.

While new born babies have non-goal directed exploratory behavior, they soon graduate into a more goal-directed behavior. These goals are a result of their decision-making process which takes inputs from their emotions, knowledge, intelligence, and social partners (in this case maybe parents or elder siblings). The mature partner moderates the child's emotions and value system and, therefore, his or her early decisions during the learning process. This may be done through instruction, dialogue, feedback, and body language.

Moving from Exploratory to Goal Directed Learning

When this is considered in the context of patients with neurological and movement deficits, the goals they set for recovery would be influenced by the same factors and more so, with increasing disability and physical and emotional dependence. If we break down the learning process into its two broad components, exploratory and goal-directed, then one can line up the two components as an illustration shown in Fig. 1. The patient formulates a goal (as in recovery of a specific function, such as eating) and can begin exploratory learning in that specific context. However, there may exist cognitive as well as physical and social constraints, due to existing disability. If a technology could augment these aspects so that constraints are reduced through an appropriately designed user interface, it may facilitate such a patient re-booting some of the methods, partially if not fully, of how infants learn.

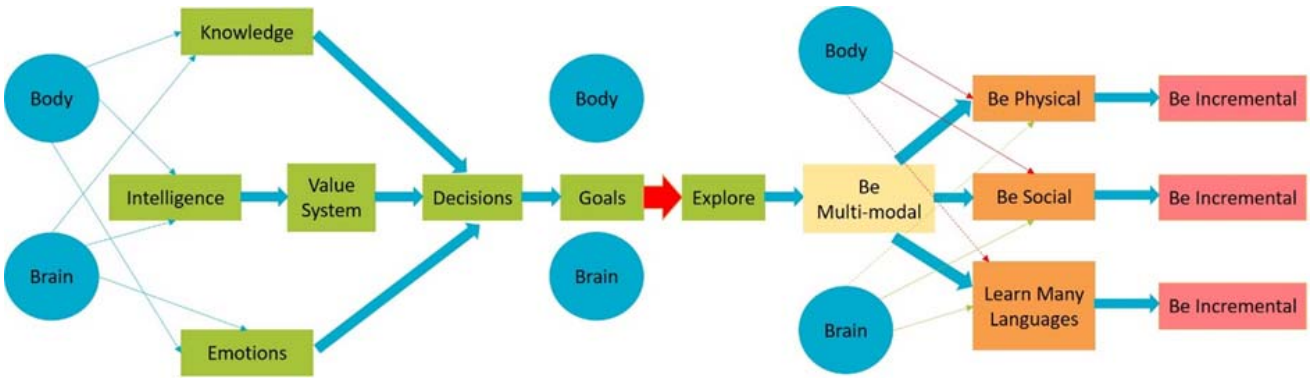

Fig.1: A composite learning behavior using the mind and physical body in a multi-modal fashion for goal-oriented exploration

NEXT

The goal dictates the quality, direction, and extent of the exploration. In stroke patients, the immediate and longer-term goals that the patient sets for themselves could significantly affect extent and speed of recovery [7]. Behavior generation is built around a distributed network of responses, such as approach, play, avoidance of obstacles and attention requisition, all of which may be affected adversely after stroke or from birth. Behaviors may excite or inhibit each other, where non-conflicting behaviors fire motor commands with the brain and muscle complementing each other in real-time.

Integrating Learning into Functional Recovery

In a learning environment which requires multiple repetitions, not all of which are identical, as in re-learning a skill, Fig. 1 forms the basic element of the learning iterations. Several iterations will be required as part of the exploratory strategy over time, which may be represented by a cyclic model as shown in Fig. 2. In this figure, the feedback and feedforward loops drive subsequent iterations, which may be similar or dissimilar. Goals and decisions, as a feedforward, drive multi-modal exploration. Incremental changes, or achievements, seen at brain and body levels, through measurable and quantifiable feedback drive modifications in belief systems, thus impacting goals and decisions for further learning.

However, such faculties of learning available to a normal person, may or may not be available to a stroke patient. A typical stroke model adapted from Ito, et al. [8] of how stroke affects the human system, resulting in motor function impairment is shown in Fig. 3 with an augmentation of such impaired feedforward and feedback superimposed. In this figure, the pathways for motor commands from the motor cortex and proprioceptive feedback from the musculo-skeletal system are disrupted and hence, some alternate pathway is recommended, shown by the "motor intention" and "motor actuation" blocks. This is a popular model implemented by the rehabilitation robotics community and those adopting the stimulation approach. Motor intention is usually sensed by a brain-computer interface or artificially induced by stimulation methods, such as transcranial magnetic stimulation. Motor actuation is achieved by either electrical stimulation or mechanically driven robotic movement. Intention and Actuation are bridged typically by some adaptive algorithm, which may be based on feature extraction, a control strategy, and a feedback loop. Current technology, however, is not able to address the complex issue of hand function, which involve overlapping neurophysio strategies and multiple degrees of freedom. At most, simple movements may be possible [9] which has been shown to not adequately impact function for the highly heterogeneous stroke affected population. Gross movements can be expected to improve with a very high number of repetitions, thus enabling the brain to rewire itself in a limited way. However, there is poor evidence that such gross movement practice translates significantly into function. Therefore, the modification to the above model is proposed, incorporating the feedforward and feedback elements modelled in Fig. 2 as a form of augmentation to help overcome the deficits through the learning route.

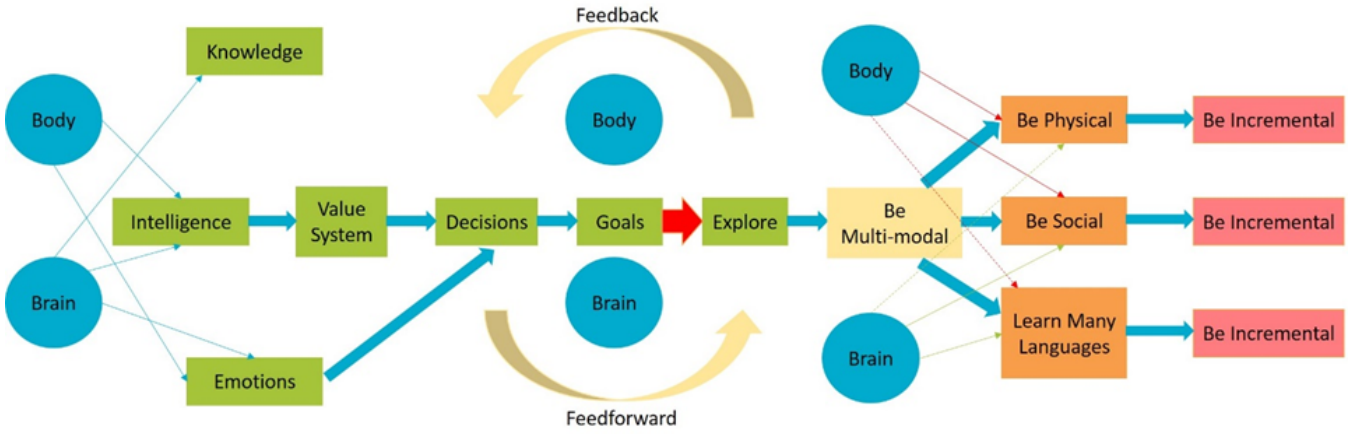

Fig. 2: The proposed natural learning model using iterative, incremental changes

NEXT

The augmented feedback may be delivered visually via a muscle-brain-computer interface. The feedforward, in the form of appropriate audio-visual inputs which leads the human to attempt a series of desired actions through imitation, is known to facilitate recovery [10]. Moreover, there is evidence of perception transferring to action, and more importantly, from action to perception [11]. The augmented feedback is expected to drive motor intention and exploration, while the feedforward is expected to prime the brain for motor actuation and goal directed learning through imitation. The brain and the body are inseparably linked, and both contribute significantly for neuroplasticity to occur and health parameters to improve [12].

Conclusion

Based on this understanding of how human learning may be applied practically in the context of rehabilitation, we find that out of the two fundamental components of learning in infants – feedback and feedforward - the element of task specific "Feedforward" has been conspicuous by its absence in traditional biofeedback and neurofeedback practice. This may be because traditional methods used exploratory, sensory learning during treatment, but did not give sufficient weightage to goal-directed learning, moving away from acual functional task execution in three dimensions to a computer screen based gamification instead. Incorporating elements of feedforward within neurofeedback and biofeedback practice in various, appropropriate ways may help enhance and accelerate the effects of such modalities in the treatment of disability.

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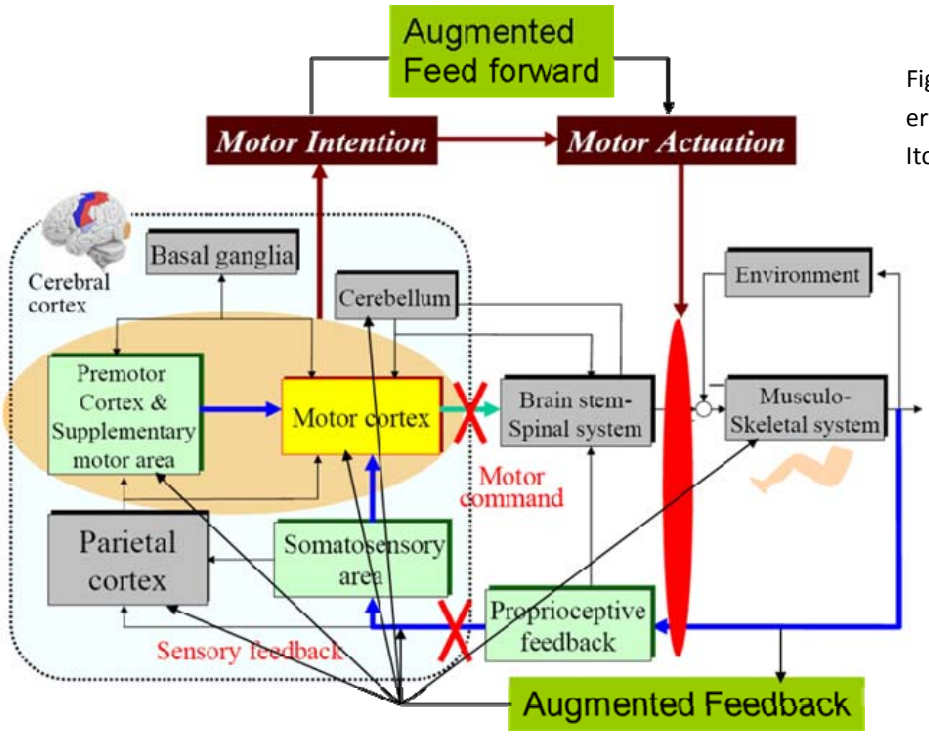

Fig. 3: The self-regulated model of recovery of function after stroke adapted from Ito, et al. [8]

NEXT

Neurofeedback Applications

- Attention Deficit Disorder
- Autism
- Anxiety & Post Traumatic Stress Disorder
- Bipolar Disorder
- Chronic Fatigue Syndrome
- Chronic Pain
- Cerebral Palsy
- Dissociative Disorders
- Depression and Mood Disorders
- Epilepsy
- Head Injury
- Hyperactivity Disorder
- Learning Disorders
- Myoclonic Dystrophy
- Obsessive-Compulsive Disorder
- PMS
- Peak Performance
- Sleep Disorders
- Stroke
- Substance Abuse and Addiction
- Violence

Upcoming Events

The Asia Pacific Neuro-biofeedback Association (APNA) and the Rajanagarindra Institute of Child Development (RICD) is organizing the 4th Asian Neurofeedback/Biofeedback Conference which will be held from 6th to 7th September 2018. This year's conference will be joined with The International Child Development Mental Health Forum. The venue of the conference is at Chiangmai Grandview Hotel & Convention Center, Chiangmai, Thailand.

APNA and RICD are pleased to invite Dr. Tim Hill to be one of the keynote speakers for the conference. He will also be conducting a workshop titled "Using QEEG to develop Neurofeedback Protocols" during the conference which will benefit the conference participants.

There will also be a pre-conference tour on 5th September 2018 at RICD, Suanprung Psychiatric Hospital and a few tourist attractions.

You can visit the conference webpage (http://www.apna.asia/nfbconference2018.html) for more information on the conference and to register your interest.

Prior to the conference, the Spectrum Biofeedback Certification Institute of Asia (SBCIA) is conducting a 2-Day Fundamentals of Neurofeedback Course from 4th to 5th September 2018. Interested participants can email SBCIA (admin@spectrumlearning.com.sg) for more information on this course.

- **Asia's 4th Neurofeedback/biofeedback Conference**

Asia's 4th Neurofeedback Conference

6th to 7th September 2018 at Chiangmai Grandview Hotel & Convention Center,

Chiangmai, Thailand.

For more information kindly visit the conference website:

http://www.apna.asia/conferences.html