

บทความปริทัศน์

(Review article)

A review of brain mapping performance-based neuroergonomic evaluation for Thais

การทบทวนแผนที่สมองวัดความสามารถอิงการประเมินประสาทการยศาสตร์สำหรับ คนไทย

Winai Chatthong, Supalak Khemthong*

วินัย ฉัตรทอง, ศุภลักษณ์ เข้มทอง*

Division of Occupational Therapy, Faculty of Physical Therapy, Mahidol University

สาขาวิชากิจกรรมบำบัด คณะกายภาพบำบัด มหาวิทยาลัยมหิดล (supalak.khe@mahidol.ac.th)

*ผู้รับผิดชอบหลัก

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ABSTRACT: A novel test called "brain mapping performance" (BMP) was developed by psychosocial occupational therapists to encourage explicit learning throughout the lifetime. For those who have not been convinced of the benefits of emerging neuroergonomics, the evaluation of job readiness appears to be challenging. Each person's level of intrinsic brain capacity for leadership BMP can be explained by encouraging soft skills, culminating in eustress and empathy engagement. This article aims to provide how the BMP-based neuroergonomic evaluation is interpreted on social comprehension and enhancement of mirror neuron morality (MNM). This article contributes an integrative approach of MNM which has been further compared between the pre- and post- evaluation of the BMP-based neuroergonomics for improving the job readiness and leadership of those Thai people linked to a healthy workplace and well-explicit learning organization.

Keywords: Moral mapping; Neuroergonomics; Explicit learning

บทคัดย่อ: การทดสอบหนึ่งที่แปลกใหม่เรียก “แผนที่สมองวัดความสามารถ หรือ *brain mapping performance (BMP)*” ถูกพัฒนาโดยนักกิจกรรมบำบัดจิตสังคมในการเรียนรู้ที่ชัดเจนตลอดช่วงชีวิต สำหรับหลายคนที่ไม่ยอมเชื่อในประโยชน์จากการเกิดขึ้นของประสาทการยศาสตร์ก็ยังคงเป็นเรื่องท้าทายในการประเมินความพร้อมของงานจริง แต่ละบุคคลจะมีระดับสมรรถนะของสมองภายในสำหรับแผนที่สมองวัดความสามารถด้านสถานะผู้นำที่อธิบายได้โดยการกระตุ้นอารมณ์ทักษะ หรือ *soft skills* เน้นการบรรลุถึงการเข้าร่วมแสดงความคิดบวก และความร่วมรู้สึกเอาใจใส่ผู้อื่น บทความนี้มุ่งหมายให้แนวทางเข้าสู่สังคมและเสริมสร้างคุณธรรมผ่านเซลล์กระจกเงาโดยการแปลผลของแผนที่สมองวัดความสามารถอิงการประเมินประสาทการยศาสตร์สำหรับคนไทย บทความนี้มีส่วนช่วยเป็นหนึ่งแนวทางการบูรณาการคุณธรรมผ่านเซลล์กระจกเงาที่ต่อมาได้เปรียบเทียบผลก่อน และหลังของแผนที่สมองวัดความสามารถอิงการประเมินประสาทการยศาสตร์เพื่อพัฒนาความพร้อมของงานจริงและภาวะผู้นำของคนไทย อันจะนำไปสู่การเชื่อมโยงองค์กรแห่งสุขภาวะ และองค์กรแห่งการเรียนรู้อย่างแท้จริง

คำสำคัญ: แผนที่คุณธรรม; ประสาทการยศาสตร์; การเรียนรู้ที่ชัดเจน

1. INTRODUCTION

Neuroergonomics is defined as a multidisciplinary field that combines neuroscience, cognitive psychology, and human factors engineering to optimize the design of technology interfaces to enhance user performance, comfort, and safety by using neuroscientific methods e.g.,

electroencephalography (EEG), event-related potentials (ERPs), functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG), near-infrared spectroscopy (NIRS), positron emission tomography (PET), transcranial doppler sonography (TCDS) and eye tracking ¹. The idea was initiated by the Biocybernetics and Brain-Computer Interfaces project to study the assessment of human mental load and the resulting response of physiological processes ¹ and to understand how the brain responds to different types of stimuli, including visual, auditory, and tactile ^{2, 3}. Consequently, It can be used to develop training programs that enhance cognitive and motor skills, reduce fatigue and stress, and improve decision-making ⁴.

Brain's mapping performance (BMP) non-invasive assessment is available as a standard Quantitative Electroencephalography (QEEG). The electro-cap was placed over the 19-relative delta (1-4 Hz), theta (4-8 Hz), alpha (8-12), beta (12-25), and high beta (25-30) following the protocol of the international 10-20 system. The key results included brain wave activity that provide information about the distribution, amplitude, and frequency of different brain wave patterns. In addition, functional connectivity can provide information about the functional connections between different regions of the brain, which can help to identify areas of the brain that work together while the client is performing a few specific tasks or activities.

Four results of visualized BMP are performed in the context of the client's neuroergonomic principle and application of neuropsychophysiology and interpreted by a qualified clinician or neuroscientist (Fig 1). The topographic maps tell us about a spatial distribution of brainwave activity amplitude at different frequency bands of various locations. The coronal segmentation reveals a visual representation of the relative activity levels in different frequency ranges across the brain. The three-dimensional brain models describe a synchronization between different brain regions. The Brodmann area plot reports a strength of connectivity (pairs of electrodes) and a degree of functional connectivity of different brain areas ^{5, 6}.

The BMP based neuroergonomic evaluation may be one startup for analyzing how different tasks are affecting personal well-being related mental, cognitive, and physical health as seen in the following studies ^{4, 7-11}. Alyan, et al., 2021 ⁴ confirmed desynchronization in alpha brainwave and decreased functional connectivity in the prefrontal context indicating cognitive stress with non-ergonomic chair and incorrect posture among healthy non-smoking adults (n = 23). Dehais, et al., 2020 ⁷ measured the BMP at workplace and conceptualized the neuroergonomic prediction of work performance and neuro-adaptive solution of mental workload. The benefits of understanding whether their intrinsic capabilities are performed inadequately and then their needs are justified consulting for mental practices of individuals. For instance, inattentional phenomena has addressed failure of auditory attention so an adaptive automation-based solution should use

neurofeedback practices to justify between high arousal (effort withdrawal) and low arousal (mind wandering).

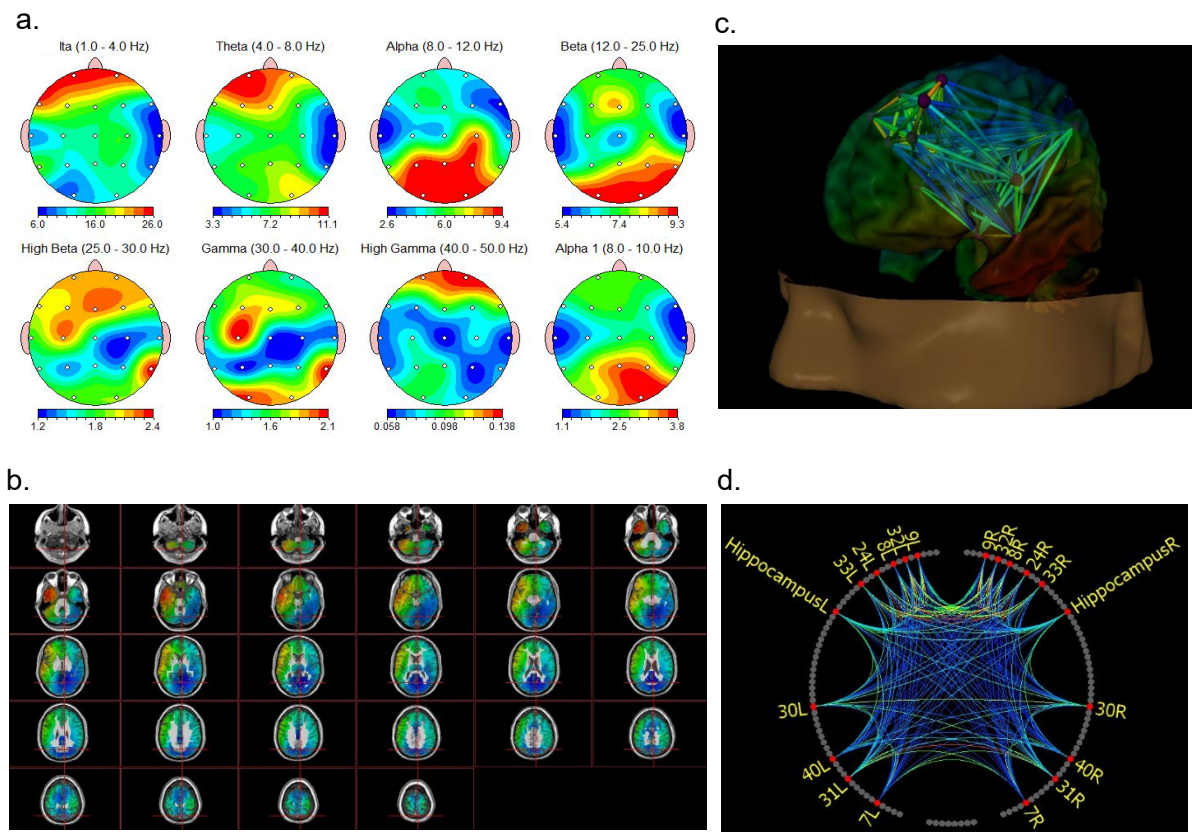


Fig. 1 Topographic maps (a.), Coronal segmentation (b.), Three-dimensional brain models (c.), and Brodmann area plot (d.)

DePaul, 2022⁸ also used the BMP to evaluate moral leadership in employee according to mirror neuron morality (MNM) which is defined as an idea that mirror neurons may play a role in moral decision-making and empathy by allowing individuals to simulate the experiences of others in the own brain. Previously, Nardi, 2011⁹ summarized the MNM in young adults which is located in frontal regions (F3 and F7), temporal regions (T3), and parietal regions (C3, C4, and Cz). Additionally, Ohreen, 2021¹⁰ and Thanyawatpornkul, et al., 2022¹¹ confirmed cognitive empathy for active engagement in three brain locations which are F3, F7, and T3 through silent short film as an external simulation of emotional empathy. So that the BMP based neuroergonomic evaluation were demonstrated to optimize their team members' needs assessment in corporate with their organizational missions while employees are being effectively trained into some specific responsibilities including budgets and resources matched with their organizational gold standards especially for evaluating employee performance¹². However, conducting an effective training program remains problematic challenges on human brain evaluation tool that quantitatively linked within their insights of MNM.

To evaluate the neuroergonomics, a design thinking of the BMP is importantly issued by addressing neurobehavioral factors: physiological, cognitive, psychological adaptation of personal environments and their contextualization¹³. Reducing negative impacts of impulsive and distressful environment may improve productivity with graded enhancement of the MNM leading to eustress and empathetic engagement¹⁴. For instance, introvert conflict of a team management cause emotional burnout among employees. Talented employers take steps to resolve mental workload by prioritizing eustress activities¹⁴. This review article aims to explain an important implication of the BMP based neuroergonomic evaluation from the global perspective as well as to discuss on its utilization in Thai context.

2. THE GLOBAL IMPLICATION OF THE BMP BASED NEUROERGONOMIC EVALUATION

As known the BMP is a scientific technique used to visualize the brain's structures and functions in order to understand how it optimize mental workload as seen in the previous research⁵ 1) examining specific frequency bands as markers as auditory or visuomotor trigger of mental workload; 2) neurofeedback of task allocation to ensure desensitization of mental workload; and 3) adaptive automation to monitor an individual's mental workload of individuals.

These are involves measuring, collecting, and analyzing a variety of neurological data points to capture the intrinsic pattern of cognitive processing activity. The quantitative electroencephalography (QEEG) is one type of brain mapping technique used to measure electrical activity in the brain¹⁵. To examine QEEG, record the electrical activity of the brain electrodes and QEEG software, remove noise and artifacts, and compare the client's brainwave patterns to a normative database to identify any deviations. Interpret the results with the help of a qualified/trained assessor and develop an individualized development plan¹⁶. However, various methods e.g., behavioral and physiological measures, neuroimaging, and neurofeedback can be used to monitor the BMP. The choice of method will depend on the specific goals of the organization's needs and economic cost-effectiveness¹⁵.

Reporting the BMP's result is helping Thai employers and employees to improve explicit learning in a practical solution¹⁷. The BMP based neuroergonomic evaluation is combined to improve design of workspace to relax cognitive overloading and reduce thinking risk of job stress. This evaluation is also used to identify neurophysiological areas that are involved in different task with cognitive and psychomotor measurement outcomes to support productive livings and neuroergonomic workplace¹¹. For instance, the BMP enables health maintenance of postural balance under ergonomic environments including an optimized equipment in eustress activities.

An individual habit must be identified positively to create neuroergonomic evaluation of safety and efficiency. This contributes a further assessment conducted by an occupational therapist or certified ergonomist¹⁸. The assessment includes examining the human postural control to be fit in workspace layout and equipment used, physical strength and cognitive flexibility. However, this comprehensive assessment may focus only problems underlying physical or psychological issues discomfort or inefficiency. To fill the gap the BMP such as based neuroergonomic evaluation assists to improve neurobiological factors related psychosocial when the middle managers and reduce the risk of burnout¹⁹. Additionally, the brain that are involved in social emotional regulation which have known promotes positive work-life balance. Moreover, incorporating natural light, plants, and calming colors may reduce stress and restore creative states²⁰. Therefore, the BMP based neuroergonomic evaluation helps to optimize neuropsychological functions and prevent the risk of mental workload at the workplace. Using this evaluation to identify workload cognitive the brain areas lead the middle managers would tailor workspaces and equipment to support mental practice as well as enhance psychosocial and physical well-being.

3. UTILIZATION OF THE BMP BASED NEUROERGONOMIC EVALUATION IN THAI CONTEXT

In a previous study¹¹ conducted in Thai middle manager (n = 6) of one corporate, the brain wave frequency of alpha, beta, and theta from QEEG was selected to examine the validity and reliability of the BMP based neuroergonomic evaluation. During the consecutive assessment of resting and voice-recording there were five outcomes significantly correlated with a work readiness plan for talented leadership: empathy and leadership (Sr = 0.880-0.943); creativity and flexibility (Sr = 0.886); eustress engagement and growth mindset (Sr = 0.943); flexibility and positive thinking (Sr = 0.926). This is a preliminary transformative strategy to optimize human-centered performances; a comprehensive understanding of cognitive empathy, vicarious learning, and participant engagement behavior¹¹. Although unique non-standardized job has been customized by selecting change agents for each corporate and allowing talent management to be followed in leadership moral purposes aligned with human-centered performance²¹. This is consistent with how learning to be more adaptable at work-life balance²². Currently, the neuroergonomic strategies have been reviewing for understanding personal and professional life in connection to gain the BMP of soft skills training^{11, 23}.

The BMP based neuroergonomic evaluation seems to be a new topic in Ergonomics society in Thailand. This article contributes the knowledge about upskilling the talented leadership BMP from the four brainwaves in combination with the three BMP based neuroergonomic evaluation. All trial results were analyzed in one Thai company (Fig. 2).

Preliminary research may identify positive symptoms of mental health issues therefore to create coping strategies and practical solutions to improve productive BMP among Thais ^{9, 22}. Importantly, the BMP based neuroergonomic evaluation seems to be a powerful tool when it is combined with two analyses: Power Spectral Density (PSD) and Low Resolution Electromagnetic Tomography (LORETA) for measuring the certain effects of explicit learning environments on the mental workload adaptation and psychosocial capacity building of individuals ²⁴. By measuring and analyzing the brain's activity in relation to the physical environment, researchers can develop strategies and solutions to improve worker safety and productivity ^{10, 11, 23}.

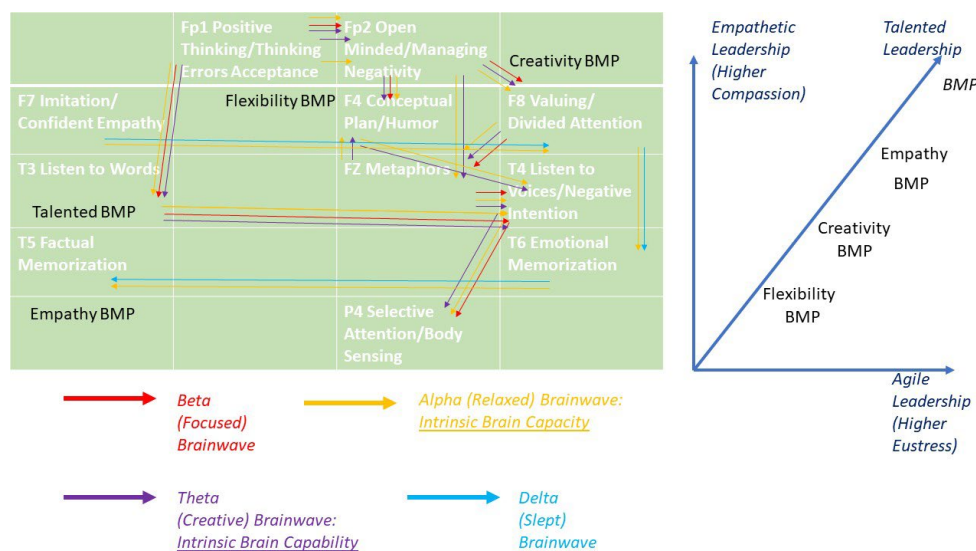


Fig. 2 Knowledge translation of the four brainwaves into the four BMP leadership styles

The data from the BMP based ergonomic evaluation can be used to identify potential areas of improvement in the working environment, such as UV-free LED light, relaxing sound, and 20-22 degrees Celsius temperature which have been used in previous studies in relation to the neuroadaptive training system ^{25, 26}. For instance, task restructuring is identified near a real time during physical and cognitive work cases of overload to loss of vigilance and to gain fatigue ²⁵. Other example is a resourceful utilization about operator's cognitive activities to support functional allocation in the multisensory context of human-automation cooperation could reduce mental workload of situational awareness ²⁶. The BMP has been shown in term of neuroergonomics that the brain in action at work. This field of neuroergonomics which aims to better understand the neural basis of human performance in work environments. The brain mapping-based techniques can be used to evaluate workplace ergonomics and to design work environments that optimize cognitive performance ^{25, 26}.

Another area of research that has seen advancements is the use of brain-computer interfaces (BCIs) in ergonomic assessment and intervention. BCIs are systems that use brain activity to control external devices, such as computer displays or robotic exoskeletons. By using brain activity to control external devices, BCIs can provide a more direct and intuitive interface between humans and machines, which can help reduce the risk of ergonomic injuries (e.g., repetitive strain injuries, cognitive impairment, stress, fatigue) and improve performance in various tasks ^{27, 28}. There has also been increasing interest in the use of virtual reality (VR) and augmented reality (AR) technologies in brain mapping-based ergonomic assessment and intervention. The VR and AR can provide more immersive and realistic environments for testing and training ergonomic interventions, as well as provide new opportunities for real-time monitoring and feedback of brain activity during tasks ²⁹. One of the key benefits of using brain mapping-based ergonomic assessment is that it provides a more objective and accurate way of evaluating the effectiveness of ergonomic interventions. By using the latest technologies and techniques, researchers and practitioners can continue to improve our understanding of ergonomic injuries and interventions and design better workspaces and equipment that optimize physical and mental function including health prevention and promotion.

Even though the BMP based neuroergonomic evaluation is a rapidly evolving field, and there are likely to be many new developments and advancements in the coming years. However, moral mapping was hardly evaluated on everyday settings of the workplace since the previous studies typically rely on subjective self-report surveys and postural/movement observations.

The BMP based neuroergonomic evaluation enables a specific location of the MNM at the frontal, temporal and parietal regions that represented emotional intelligence.¹⁶ Those components are connected to empathetic learning process in a combination of feeling, sensing, and caring other people ³⁰. For example, the MNM may be involved in the learning and adoption of ergonomic postures and movements. Observing others performing tasks in an ergonomic way may activate the mirror neuron system in the observer's brain, allowing them to understand and imitate the movements more easily ³¹. Additionally, the MNM may be involved in the social aspects of neuroergonomic design. When designing products or systems, it is important to consider the needs and preferences of the people who will be using them. The MNM, which is involved in social cognition and empathy, may play a role in understanding and anticipating the needs of users, and in designing products and systems that are more supportive of their well-being and productivity ^{32, 33}.

In conclusion, this review study may provide insights into the ways in which people interact with their physical work environment, and how neuroergonomic design can be optimized to support their psychosocial needs, intrinsic capacity, and functional abilities. However, some

limitations of utilizing the BMP include individual variability, no causal relationship between brain activity and behavior, not fully capture complexity and rapid changes of the brain functioning.

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