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PRACTICALITIES OF EVOKED POTENTIAL IN EXERCISE AND SPORTS SCIENCE

Bhattacharya P.[1], Chatterjee S.[2*]

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[1] Puneet Bhattacharya, Assistant Professor, Department of Physical Education, Jadavpur University, Kolkata , W.B, India.

[2*] Sridip Chatterjee, Associate Professor, Department of Physical Education, Jadavpur University, Kolkata , W.B, India.

Evoked Potential (EVP) is an electrophysiological tool to measure sensory conduction from the eyes, ears and somatosensory areas in clinical settings since, computer assisted neurological techniques became readily accessible. First stimulus-based EVP on human scalp was recorded by Pauline Davis in 1939. However, EVP as a measure of neurocognition through sports performance and habitual exercise is a novel area of research. EVP appropriately measures the sensory pathways. Thus, making its application a worthy mention to understand cognitive growth among the players and practitioners. The objective of the study implicates the applications of evoked potential in exercise and sports to understand its practicality over other electrophysiological tools. Anatomical considerations along with Vedic literature references were considered to understand the sensory and muscular coordinates and the impact of regular exercise and training on sports players. Handful of available related literatures were gathered and presented in this conceptual study. Practicalities of evoked potential measures to portray three domains of exercise and training effects which include; Ball games, mind body exercise and graded training. Research is few and needs more study in this area, however available evidence clearly indicates that evoked potential is a direct measure of the sensory pathways represented as graphical wave recordings which are easy to interpret. Thus, EVP being a simple direct neurocognitive tool is recommended over the other techniques to establish the role of exercise in the development of sports players and practitioners.

Keywords: Neurocognition, Sports Performance, Habitual Exercise, Mental Wellbeing, Sensory Pathways

Corresponding Author

Sridip Chatterjee, Associate Professor, Department of Physical Education, Jadavpur University, Kolkata , W.B, India.

Email: sridipchatterjee.ped@jadavpuruniversity.in

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Introduction

The pertinence of sense organs in all higher order living organisms is extremelysubstantial. There areanatomical evidences and Ayurvedic textual references to explain the importance of sensory pathways and their role to associate the body and mind with movement. Movement Neurocognition is a growing area of research in the field of games and sports, it basically deals with the intellectual and emotional brain development through exercise enriched environments.

Practice of physical exercise for good health or participation in sports and games for competition all compliment in development of a sharpened brain and stress-free mind.These physical movements are coordinated through sensory pathways which with regular practice enhance neurocognition and brain health. The measurement of these neurocognitive pathwaysin athletes and sports practitioners has been studied through many methods. Themain method types include neuroimaging techniques, neurochemical measures and electrophysiological instrumentations. These measurements help in understanding the effects of particular training interventions, develop new training methodologies and improve elite performances.

This conceptual article highlights the applications of evoked potentialin a physically active setting; it is a non-invasive electrophysiological measureof neurocognition for different formsof athletes, mind body exercise practitioners and graded exercise trainees. The paper attempts to highlight the need and importance of evoked potential as a viable neurocognitive tool in sports science and physical exercise.

Method and Acquisition of Evidence

Sensory System and Exercise: Its AnatomicalOrigin and Vedic Reference

With the evolution of filter feeding chordates, vertebrates developed complex cranial sense organs and their corresponding receptors. Several ecological and behavioural changes evolved and led to the formation of complex paired sensory organs such as eyes, inner ears and olfactory extensae. These organs are associated with the part of the nervous system responsible for Processing sensory information and are collectively called the sensory nervous system. It comprises the sensory receptor cells, the neural pathways and the lobes of the brain which receive these signals involving neuro perception. The common recognised sensory systems are those for vision, hearing, touch, taste and smell.

Exercise enhances this sensorimotor control which is regarded as a series of transformations between sensory inputs and motor commands. The receptive field is the area of the body or environment to which a receptor organ and receptor cells respond. For instance, the ball coming towards a batsmen's eye from the bowler's hand in cricket or the sound of the gun shot reaching the athlete to release out from the starting block and sprint to the finish line are all based on time to reaction stimulus. The light or sound that each rod or cone can see or the cochlea can hear, is its receptive field. Receptive fields have been identified for the visual system, auditory system and somatosensory system.

According to Vedic literature and Ayurvedic classic texts; sense organs (called Indriyas in ancient Indian texts) are the apparatus to attain knowledge for enlightenment. The sensory faculties (called Gyanendriya in ancient Indian texts)present within the body conjoin with the mind (called mana in ancient Indian text) which unites with soul (called atma) and thereafter knowledge is perceived.In Charak Samhita an ancient Ayurvedic text there is elaborate mention of pancha-panchaka which means the five and groups of five; it describes the sense organs the aspects of their five senses in the chapter -Indriyopakramaniya Adhyaya in Charak Samhita. The pancha-panchaka system reveals that senses are the instruments for knowledge of material in external world. All things are constituted by the five elements of nature (called pancha mahabhuta in ancient Indian text) their senses and their representations. Similarity in origin and action (called tulyayonitva)causes specific sense to develop and perceive the object related to its own basis constituents. E.g. the eyes can see external element of fire or light (called tejas mahabhuta) and perceive the visual sensation of it as vision. Thus, there is a continuous interaction between the external materialistic world and internal world present within the body which includes the sensory perception, mind, intellect and soul. This age old concept highlights specificity

Of the receptors and their respective pathways and neural generators for perception of knowledge and action. The details about sense organs and their interaction with mind and regular exercise also have mention in Charak Samhita as section of anatomy and physiology (calledSharira Sthana) and impact of light exercise (called Vyayama) when performed regularly as a part of the daily routine called dinacharya leads to improvement in the working of the panch-panchaka.

Figure 1: Indian Traditional Concept of the Sensory Five

Enclosed as Annexure 01

Electrophysiology and Movement Neuroscience Research

Sensory nerve cells communicate using electrical and chemical signals. Electrophysiology is a branch of neuroscience which investigates the electrical activity of living neurons, their molecular and cellular processes involved in signalling. On the other hand, Neuroscience research is a study to examine the entire process of encoding and decoding intercellular and intracellular messages which give rise to neurocognition. The interpretation of intensity and frequency of these pathways is performed through graphically recorded wave forms which are further quantified into metric units measuring latency and amplitude.

Exercise-Cognition is an area that involves sensory perception, motor control, memory, attention, other executive functions and their relations to exercise and training. There are various far field and field based electrophysiological instruments and tools to measure neurocognition.

Current functional neuro scientific techniques to directly measures acute and chronic relation of physical exercise on the brain include; Electroencephalography (EEG), magneto encephalography (MEG), near infrared spectroscopy (NIRS), magnetic resonance imaging (MRI), positron emission tomography (PET), and evoked potentials of different types to distinct data on brain functionality. Evoked Potential has fathomed as an efficient tool to measure sensory pathways. It was first introduced in human brain studies by Pauline Davis in 1939. She was already working on sleep-EEG studies and then experimented on changes evoked by peripheral stimulation

In the waking brain which then developed into Evoked Potential. These are far field measurements and are of three type; Visual evoked potential, Auditory evoked potential and Somatosensory evoked potential. The evoked potentials directly supply a constant stimulus to the sensory pathways to achieve graphical wave recordings that can be quantified numerically to obtain the speed of transfer of the stimulus from the receptor cells through the respective pathway to the respective lobe of the brain. Figure 2 below gives the schematic relation of Evoked Potential and the sense organs.

Findings

Evoked Potential as a Neurocognitive measurement tool

All electrophysiological methods provide distinctive information and have their specific pros and cons. In this paper we have already drawn a very specific relation between sensory pathways and physical exercise and evidently puts evoked potential technique above others. Evoked potential measures the NPN-Complex of the visual pathway, the acoustic stimulus and its brainstem auditory pathway right through the thalamus to the occipital lobes with the mid and long latency evoked potential, in the very same way the somatosensory pathways are also depicted as shown in Figure 2.

The setting up of this instrument is very simple using specific instrumentation, software and artefact elimination processes. The electrode leads to be arranged are minimal in evoked potential instruments in comparison to electroencephalographic instrument setting where 16 or 32 or even more elaborate set ups are required. However, for evoked potential based on 10-20 system of electrode placement only three electrodes have to be placed for measurement. [11]Once the machine amplifier and software sync is accomplished the maintenance and data extraction processes are quite modest and not very time consuming in comparison generally to psychophysiological research procedures. Cost of set up of the procedure is a onetime affair while the cost of maintenance is also minimalistic. Machines are readily available as they are basic instruments in diagnostic clinics, cognitive therapeutic hospitals and departments thus having a high demand. Being invasive techniques, the electrode placement

Is simple and the associated risk for the subjects are nil. Also, these techniques are being widely used even on new born babies and thus can be used at any age group without any associated side effects and are safe for any age category among athletes and sports players.Evoked potential measures provide an unprecedented potential to unravel the neurobiology of human exercise and its relation to the sensory pathways and the brain. It is a direct measurement of acute and chronic relation of physical exercise with the human brain.

Figure 2: Importance of Evoked Potential Measures in Sensory Pathways of Audition, Vision andTouch

Enclosed as Annexure 02

Evoked Potential and Physical Exercise and Training

Research on evoked potential and exercise is very scanty and few studies have been highlighted in this section which will make realise a better understanding of its applicability; Delpont et al, 1991 contributed the first elaborate study on visual evoked potential to measure the initial reaction time to a visual stimulus; and concluded that physically active players have shorter time to reaction compared to their sedentary counter parts. Delpont et al, gave an elaborate result that acyclic sports such as tennis showed shortest latencies than cyclic sports like rowing in which there is more focus on endurance and strength. While in ball games like tennis, anticipation and focus plays a key role. Similar results were shown by Shete et al, 2019 among 20 volleyball practitioners and 20 sedentary control subjects concluding that volleyball practitioners had shorter visual latency in the P-100 wave due to rapid visual demand on the central nervous system. A mind body exercise study by Liao et al, 2006 drew a comparison between 11 Zen meditation practitioners and 11 control subjects and concluded that since the subjects focussed on the Zen Chakra around the third ventricle; the central cortex, frontal cortex and primary visual cortex get more developed with practice and time and thus the latency of the external stimulus is improved.

Similar references in auditory evoked potential studies were seen among meditation practitioners in both yoga and qigong reported by Singh et al, 2013 and Lui et al 1990; the mid latency and long latency potentials measure showed significant changes to prove high order neurocognitive Development after practice of mind body exercises like meditation and qigong a regular basis for many years. While sports players and athletes are tested through the Brain stem Auditory evoked potential as these wave forms have shorter wave potentials that can be detected from the brain stem and the mid brain region.

A study by Mudrich et al, 2022 on somatosensory evoked potential being used as a neurocognitive marker to measure functional neurological development in athletes, the study indicates superior somatosensory cognitive processing in sports that require high levels of attention, rapid initiation of motor responses, and response inhibition. Most importantly the researchers mention that training age is a very important aspect and changes in latency could be visible with minimum four years of regular diligent practice.

Graded exercise training also showed significantly shorter results in Visual evoked potential latency of the P-100 wave after regular practice for eight weeks by healthy university volunteers but qigong practise showed no significant differences in any of the wave latencies pre and post intervention among another group of volunteers girls. This indicates that not just time duration but type of exercise, nature and its acuteness also play an important role in determination of visual evoked potential. Transverse and Longitudinal studies on evoked potential can help realise specific training plans and develop better mental focus, attention perception skills among elite players, mind body exercise practitioners and graded exercise.

Another very important role of EVP is as a sensory injury detector or diagnostic tool for combative sport players and contact games. A study on rugby players to diagnose sports related concussion among them through VEP measurement as a point of care study. Injuries in combative sports are a common occurrence and functional integrity of the visual and auditory system among amateur boxers was maintain by detecting normal and abnormal visual evoked potential patterns.

Recommendation of Evoked Potential measures in Exercise and Sports Science

Exercise and Sports Science are multifaceted areas and these induce extensive adaptations in the central nervous system, leading to improvement in sports performance, robust mental

Wellbeing and better health status; best measured with evoked potentials. Thefew research results discussed above explain the importance of evoked potential in depicting the effects of various types of physical exercise and mind body exercise in movement neuroscience research. With increasing competition in the field of sports and a race to get selected in top class teams;achieving the performance and status of an elite player is a dream sought for by many young athletes. Evoked potential can thus be used in the grass root level to decipher and identify talent which can be harboured into a world class player. Evoked potential can well be used as diagnostic measure to understand the correct neurocognitive status of young athletes. This information can help in grading and proper training of these beginners in the right direction to develop better high class players and athletes.

This tool can be used to understand ones improvements in performance to the very minute detail in relation to their training age, regularity and focus. Based on their motor and cognitive ability new training protocols can be prepared more scientifically with specificity.

Mind body exercises have become popular practicesworldwide to remove stress and develop quality of life to maintain a mentally and physically balanced sports performance. The execution of these exercises on a regular basis helps in the development of neurocognition and a stress free resilient athlete. Thus the effects of such mind body interventions can be closely monitored through Evoked Potential on high order athletes and realize their specific effects on them. Based on which, some novel adjunct mindfulness protocols can be developed to achieve better performance and provide stress busters to the athletes.

Evoked Potential can be used to realize the exercise induced functional neuroplasticity of the sensorimotor system and compare it with different types of athletes, different levels of athletes, cohorts of athletes and with those practising unorganised games that is active controls. Neurosensory processing is enhanced with physical training is known and can be measured with imaging or other electrophysiological fields. But, evoked potentials precisely point out the corresponding neuroanatomical generators which perform better through the corresponding wave latency results. By this evoked potential

Specifically pick out specific structural and functional relationships in the athletes brain and quantify them to numerical and graphical representations.

Evoked potential can be used as active neurocognitive markers and monitoring sensors for ball games, acyclic sports and team game performances. And as a focus building and concentration development marker for mentally stable games like archery and shooting which can also be monitored to improve performance of the respective players of such games.

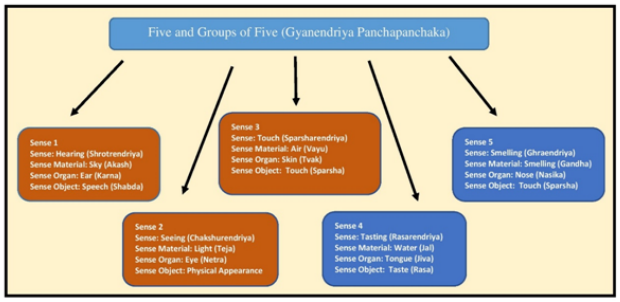
As a post-concussion and brain related injury cognitive monitoring tool for contact and combative sport players. To keep check on neurosprouting and development of their cognitive reserve by regeneration of their fragmented neural circuits. Evoked potential measurements may help assess their sensory pathway working and recovery with their sports performance.

Conclusion

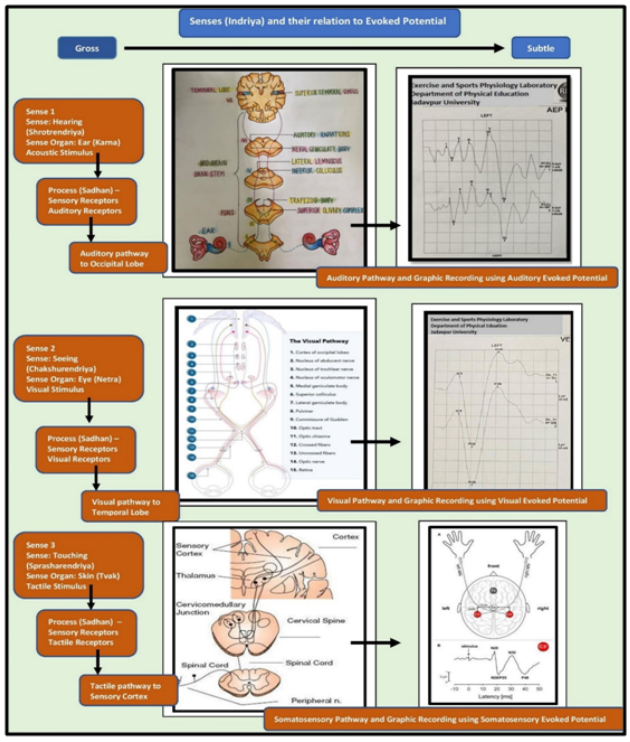
Thus, we recommend the use of Evoked Potential to establish the role of exercise and training in the neurocognitiveadvancementof the sporting fraternity. The reference of sensing pathways and motor movement has been scripted since the ages and with technological advancement evoked potential measurements are one such electrophysiological response which can enunciate novel avenues in performance monitoring and progress. Identification and classification of neurocognitive set up among young generation players, development of neuroscientific training protocols, neurofunctional sensitivity, improvement of the sports performance of elite players, to highlight the use of yoga, taichi, qigong, karate and other mind body exercises as enhancers of neurocognition through the practice of their focus and concentration techniques can all be implicated through Evoked Potential measures through visual, auditory or tactile pathways. Thus we have endeavoured to put forward the pertinence of evoked potential as a simple neurocognitive measurement tool to understand and apply perception and cognition in exercise and sports science today.

Annexure

Annexure 01



Annexure 02



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