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Research paper

Effects of Demographic Factors on Performance Strategies and Brain Wave Quality on Performance among Athletes

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Abstract

The purpose of this research is to investigate the effects of demographic factors and brain wave quality on performance strategies among athletes. The demographic factors such as gender, years of study, and years of involvement in sports play an important role in the use of performance strategies in determining their performance strategies in sports. The instruments used for this research is the Test of Performance Strategies (TOPS) to measure the performance strategies. The findings have revealed that there were significant differences in the performance strategies by the demographic factors as follows; gender at t (21) = 13.75; p < .05; years of study at t (21) = 9.46; p < .05, and years of involvement at t (20) = 11.37; p < .05. In addition, there were also significant differences in the sub factors of the performance strategies such as goal setting, relaxation, activation, imagery, self-talk, attentional control, emotional control, and automaticity. Based on the finding from the qEEG application, in the stroop effect tasks, the Beta and Gamma wave had the tendency to dominate the Frontal region (Fp1,Fp2), somatosensory area (C3,C4) which related to the development of the psychomotor skills and visual spatial area (P3,P4) and O1 and O2. The athletes have less thought process in seconds prior to the shot and have quieter mind than the non-athletes. It could be inferred that the athletes needed to be calm and relaxed while facing their challenge so that they could focus on their target and performance. The implication of this research includes the brain wave quality and effect on the performance strategies. The improvement in the brain quality (Alpha, Beta and Gamma) wave would assist the athletes to perform.

Keywords: *Athletes; brain wave quality; demographic factors; effects; qEEG; performance strategies,*

1. Introduction

The demographic factors play a huge role in identifying performances among athletes. Demographic factors such as gender, years of study, and years of involvement of athletes. According to [1], there were no significant differences in the measures of psychological coping skills between the players of youth and junior age category. The senior have different mechanisms from junior athletes based on their experiences. However, the findings in this research were dissimilar.

Previous literatures have reported that the demographic factors, psychological strategies and brain wave quality were connected with each other in determining performance among athletes.

2. Demographic

In previous research, the gender showed the difference in performance between male and female. According to [19]a major factor on measured the performance of athlete through the impact of height, weight, body fat, muscle mass, aerobic capacity or anaerobic threshold as a result of genetic and hormonal differences. Through this literature the gender obviously difference in determining the level of performance among athletes.

Result from previous research mentions the gender gap also occurred in Olympic game. There is clearly described the performance between male and female are different. The gender gap has been established since 1983. Due to this condition, the body of sports' management determined the measurement on performance among male and female should be differenced.

Research proof the level of performance between male and female was not at the similar level. In other word the women's performances at the high level will never match those of men and this stabilization is the reflection of a significant to reduce gaps for all events [20].The performances improved according to gender differences. Stability appears through all of the parameters studied: coefficients of variation, slope coefficients, coincident breakpoint dates between world records and ten best performances [21]. The external stimulant such as doping can provide the stability and it will become the challenges to the athletes.

According to [22], the gender and ranking do not significantly different on coping strategies. Finding from this research showed the gender and ranking have no significant difference with coping strategies which is consistent from the above finding. Thus, the age is not being dominant factor in determining the coping strategies among them.

Due to the struggle of making the stability of male and female athletes in term of performance the alternative strategies should be investigated. The researcher has done a research in trying to find the psychological strategies for performance improvement.

[23] the finding described the age showed the difference coping strategies between male and female. This is obviously describe there is difference between coping strategies on male and female athletes. Then, according to[1]there is no statistically significant age and positional differences in coping skills. This is different

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from the first research finding where the result showed there is no difference between age and coping skills.
Previous research also mentioned the young female volleyball players did not showed the differences in coping skills although their experiences in sport are different [1]**.** Age doesnot make any differences for athlete in developing their coping skills in performance. They developed their coping skills based on their competency and ability.
Finding determined there is no difference between young or senior player in coping strategies. In this research finding, they also considered the lower level of somatic and cognitive anxiety and a higher level of self-confidence in juniors as opposed to youth players to be expected and explained it by greater experience of junior players and their generally higher level of technical-tactical skills as a consequence of a longer period of training and competing [1]. From that, we understand the period of being involved in sports giving different exposure and experiences among athletes.
From the similar research finding they described the junior players have better performance of volleyball elements especially in training sessions. It is probably increased their self confidence level and decrease their anxiety [1]. This finding extends the above idea that the young athletes have more energy in performed. They enable to increase their ability and competencies in coping strategies while sustain their performance.
Research by [24]; found the gender differences in psychological skills among elite athletes, with females displaying less effective emotional control and relaxation. Findings also explained the differences between athletes of different gender and level could be considered from coaches and sport psychologist in order to assist them in improving their performance [24]. From this finding, it is obviously explained the gender performs differently in the psychological skills.
Other than that, finding in previous research found there were no significant differences in the level of psychological coping skills between the players with different player roles in their teams, in spite of the differences in characteristics of tasks they perform during a match or a training session [1]. The athletes has not performed differently in psychological which are goal setting, relaxation, activation, imagery, self-talk, attentional control, emotional control and automaticity. These skills and strategies are measured in practice. This test were used for athlete who performed at national or international level that showed the more use of psychological skills and strategies and less negative thinking [25].
According to [25] the international athletes more applying this skills and strategies compared local athlete. International athletes whether male or female have similar skills and strategies in enhancing their performance. Discussing on psychological strategies are related to the ability of cognitive and emotions of athletes in managing their competency.
Maintaining the performance among athlete causes cognitive distress among them. So that, the psychological coping skills and strategies are importance in assisting athletes to be calm and relax. This statement has been supported by [26] there is a significant main effect for performance climate and perceived ability. Those who have low perception on their ability so they will rely on coach and team to be more distress compared athletes who have high perception on their ability. Those findings showed the positive perceptions on their ability and competency enhanced their performance. This statement is consistent with psychological strategies and skills, which become importance component in reducing negative thinking among athlete who aim to achieve higher performance.
According to [27], the underlying neuro mechanism of motoric actions and decisions made in facing the challenges in different field of sports activities such as darts' throwing and pistol shooting. The kinesthetic moves required quick decisions because it is part of a dynamic strategy to face the continual mix of intricate challenges. Sometimes a slight movement of one arm requires quick adjustments in other parts. In most of the sports, athlete's actions are part of a dynamic strategy to deal with an ever changing mix of intricate challenges. For example, raising a gun resulted in a new calculation of movement for a precise shooting. Athlete should be in the state of calm and relax in order to achieve good performance.

3. Brain Quality

To find out the associated brain regions related to detailed motor actions and decision during the task, researchers from John Hopkins University, and John Krakauer of Columbia reviewed studies related to scanning of the brains of healthy and brain-damaged patients who have problems with their movement [18]. Their research revealed that that the brain continue on updating the solution and calculation to adjust body movement. Athletes mind are sharp in finding better solution when faced with conflict in decision making.
In other experiments, athletes and non-athletes were given the same tasks while qEEG were used to record their brainwaves. In a study by Del Percio, the brain waves of karate champions and ordinary people were recorded with their eyes closed, and differences between the waves were compared. The research team has also measured the brain waves of athletes and non-athletes in actions. It was found that the athlete generate stronger alpha rhythm in as restful state. Percio's study on pistol shooters that fired 120 times and fencers balance on one foot showed that the brains were quieter than the non-athletes. The results suggest that the athletes' devoted less brain activity on motor tasks. The findings suggest that an efficient brain does a better job in sports to improve the cognitive functioning of human brain. When people were involved in running, walking or exercises, these could help to improve their focus and performance in mental activity [28]. Thus, more practices are needed to develop the efficient brain of an athlete. As one's start to practice new skills in sport, the neuroscience started to communicate change to develop extra gray matter in the some of the related area indicating brain plasticity during the duration of the practices. It will continuously change with more practices for peak performance. In this state of mind, the experienced athletes demonstrate big bursts of alpha wave activity compared to novice athletes that shows less alpha brain wave activity.
According to [29], exercise can produce and increase a number of neurons or neurogenesis. Rebirth of new neurons and its activation on the other hand depends on the exercise or brain exercise done by the individual involved. In this research, the research highlights the dominant wave to boost the intelligence of athletes during a quick decision making while performing the task in stroop effects, the similar task while making the movements during sports activity.

4. Method

4.1. Participants

The research participants were 21 UNIMAS students who involved in any sports (athletes) while in the university and 20 were not involved in sports (non-athletes). This is a quasi-experimental research design. The non-athletes were assigned as control group for the qEEG test. The qEEG test involved both group athletes and non-athletes. The participants were given tasks to perform and the brain frequencies and waveform were recorded for analysis of different sub-bands. The Stroop test was presented with series of color words. These words appear in different colours and sometimes matching the word. Meanwhile, the Test of Performance Strategies (TOPS) measures the psychological strategies.

4.2. Data Collection

The Test of Performance Strategies (TOPS) was used in order to evaluate the differences between the demographic factors (gender,

age, years of study, and years of involvement). There are eight (8) subscales in the Test of Performance Strategies (TOPS) which include goal setting, relaxation, activation, imagery, self-talk, attentional control, emotional control, and automaticity. Answers were given on a 5-point Likert scale ranging from 1(never) to 5 (always). The internal consistencies for eight (8) subscales are (Cronbach's α values at 0.88). The qEEG measures the brain quality during eye open and eye closed among athletes.

Athletes have volunteered to answer the questionnaires and involved in the qEEG test. They were briefed before answering the questionnaires and brain training. They were also required to complete the informed consent provided by the researcher.

5. Theoretical Framework

This theory describes the self-determined behaviours that reflect on choice and pleasure, because they allow the performance of significant goals and coherent with one's value [30]. It focuses on the intrinsic motivation as well as integrated and identified regulations. Self-determined forms of motivation relate to how a person deals with stressful situation and use adaptive coping process [30]. Based on the theory, athletes with high self-determination will work hard in achieving their goals. However, sometimes the internal motivation of performing is low and they need the adaptive strategies for sustainability. The adaptive strategies might be the psychological strategies and skills to maintain their ability and competency. The understanding of this theory is related with the brain quality. As mentioned above, athletes with low ability often rely on couch or team members; which is different from athletes who have high ability. They will use their alternative strength such as intrinsic motivation in increasing their performance. The ability of brain to understand the situation where the athlete has to perform is essential.

Most research has associated self-determined forms of motivation with positive behavioural, cognitive, and emotional outcomes [31]. The researchers have identified two outcomes such as performance related goal attainment and affective states as achievement situations [30]. Self-determination was associated with performance among athlete. However, there were little empirical evidences on the relationship between self- determination and performance in the context of sport. Self-determination is often associated with positive well-being indicators, even in stressful situation. Although less research made on self - determination and performance among athletes, the principal and concept in this theory is appropriately related to psychological strategies and skills which become the main component in this research. The self-determination should be consistent with the brain quality, where the performance of athlete could be increased. Aims and goals targeted by the athlete may boost their ability of brainto be in thestate of calm and relax in order to focus on competition or tournament.

6. Result

6.1. Demography for TOPS' Participants

There were 20 respondents in this study that consist of student athletes in UNIMAS. 50.0% female and 50% male respondents participated in this study. Details showed in Table 1.

Table 1: Respondents Based on Gender

Gender	Frequency (n)	Percentage (%)
Male	10	50
Female	10	50

6.2. Descriptive and Differences between Gender and Performance Strategies

The descriptive data for gender and performance strategies were as follows: means (M = 1.50) and variance at (SD = 0.51).

Table 2: Means Values of Gender and Performance Strategies

Gender	Means (M)	Variance (SD)
Gender	1.50	0.51

***p < 0.05**

The result has revealed that there were significant differences in TOPS by gender at t (21) = 13.75; $p < .05$. This can be inferred that there was a significant difference between respondents' gender and psychological strategies used in sports.

Table 3: Differences between Gender and Psychological Strategies

Gender	*t*	Df	Sig.
Gender	13.75	21	0.00
TOPS	55.44	21	0.00

***p < 0.05**

6.2. Differences between year of study and performance strategies

The descriptive data for years of study and performance strategies, at means of (M = 2.54) and variance at (SD = 1.26), and the result showed that there were differences in the practice of psychological strategies among respondents by the years of study, at t (21) = 9.46; $p < .05$.

Table 4: Means Values of Years of Study and Performance Strategies

Years of Study	Means (M)	Variance (SD)
Years of study	2.55	1.26

***p < 0.05**

Table 5: Differences between Years of Study and Psychological Strategies

Years of Study	*T*	df	Sig.
Years of Study	9.46	21	0.00
TOPS	55.44	21	0.00

***p < 0.05**

6.3 Descriptive and differences between years of involvement and performance strategies

The means for years of involvement were (M = 6.90) and variance at (SD = 2.79), and the result showed that there were differences in the practice of psychological strategies by years of involvement among respondents, at t (21) = 11.37; $p < .05$. There was a significant difference between years of involvement and psychological strategies among respondents in sports.

Table 6: Means Values of Years of Study and Performance Strategies

Years of Involvement	Means (M)	Variance (SD)
Years of involvement	6.90	2.79

***p < 0.05**

Table 7: Differences between Years of Involvement and Psychological Strategies

Years of Involvement	*T*	df	Sig.
Years of Involvement	11.37	21	0.00
TOPS	55.44	21	0.00

***p < 0.05**

Table 8: Differences in the Performance Strategies based on Demographic Factors for each Subscale (Self Talk, Emotional Control, Automaticity, Goal Setting, Imagery, Activation, Relaxation and Negative Thinking)

Demographic Factors	T	df	Sig.
Self-Talk	36.2	21	0.00
Emotional Control	20.9	21	0.00

Automaticity	42.2	21	0.00
Goal Setting	39.9	21	0.00
Imagery	34.0	21	0.00
Activation	33.4	21	0.00
Relaxation	26.0	21	0.00
Negative Thinking	45.1	21	0.00

Table 8 described there were differences in the psychological strategies for the demographic factors (sex, age, years of study and years of involvement) such as self-talk (t (21) = 36.2; $p < .05$), emotional control (t (21) = 20.9; $p < .05$), automaticity (t (21) = 42.2; $p < .05$), goal setting (t (21) = 39.9; $p < .05$), imagery (t (21) = 34.0; $p < .05$), activation (t (21) = 33.4; $p < .05$), relaxation (t (21) = 26.0; $p < .05$), and negative thinking (t (21) = 45.1; $p < .05$). In conclusion, the demographic factors clearly showed there is significant difference on psychological strategies among athlete.

6.4. Demography of qEEG participants

Table 9: Demography of qEEG Participants

	Male	Female	Total
Athletes	10	10	20
Non-athletes	2	19	21
Total	12	39	41

6.5. Brain Waves Pattern

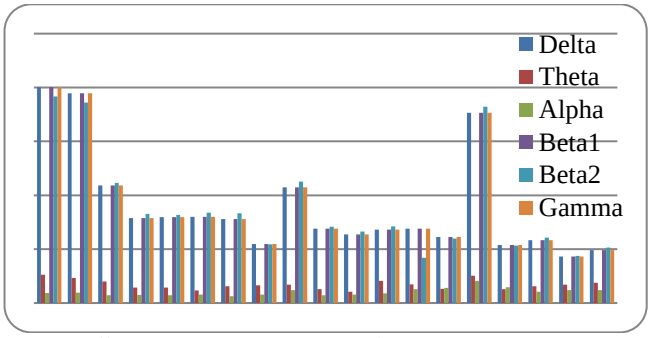

Fig. 1: Difference in brainwave pattern of athlete versus non-athletes in Eyes Closed (EC) and brainwave pattern of athlete during Stroop effects Task

In Figure1, we can see higher Beta1 wave at the Frontal region (Fp1, Fp2), somatosensory area (C3, C4) to reveal the development of the psychomotor skills and visual spatial area (P3, P4) and O1 and O2. Beta wave and Gamma tends to dominate in these areas during the stroop effects tasks. These are the visual spatial area highlighted during the stroop effects. According to [27] research indicated that athletes have less thought process in seconds prior to the shot and have a quieter mind than the non-athletes. It could be concluded that the athletes needed to be calm and relax while facing their challenge so that they can focus on their target. Alpha brainwave is associated with a completely relaxed body and mind from all of tension and nervousness [36].

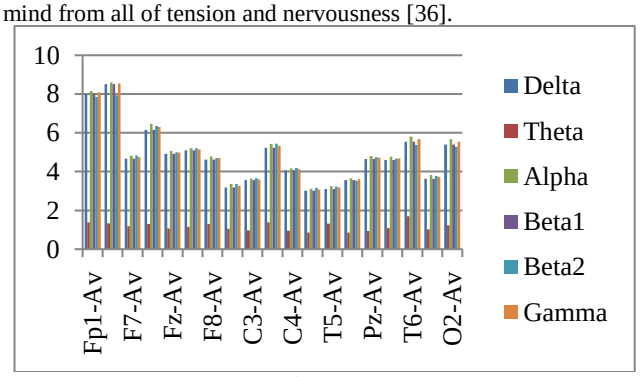

Fig. 2: Brain wave pattern of athlete during the Eyes Close (EC)

With practice and exercise, different regions of the brain communicate with each other to strengthen their connections [34]. Neurons in the frontal part of the brain (the prefrontal cortex) are active. The prefrontal cortex or the executive functions region is vital for the decision making task and focus to enable the athletes to perform well in sports. Researchers such as [35] suggested that increased alpha activity was related to an increased accuracy. With practice, the frontal cortex grows and the athletes' calculation and movement becomes accurate. The response becomes automatic as their brain becomes more efficient in adapting and tuning in to make sense of new situation sooner [26].

In Figure 1 and 2, Alpha waves seem to dominate the frontal, central region and temporal area. It is revealed that even during the Eyes closed conditions or during the resting state conditions, Alpha wave increased in the temporal area to show the state of mind among athletes. In this study, the researchers offered a glimpse of what interventions would be like for the athletes.

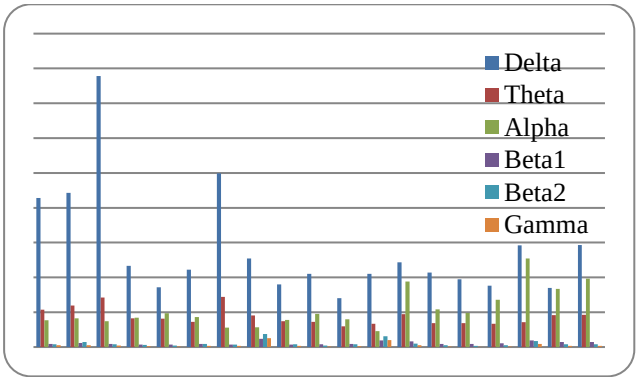

Fig. 3: Brainwave patterns of non - athletes during the performance of Stroopeffects

The above figure (Figure 3) showed various brainwave patterns of Non-athletes during the stroop effects task. Delta dominated the Frontal region (F7), central region (C3, Cz), Temporal region (T3, T4, T5 and T6) and Occipital area (O1, Oz). Overall the brain waves showed slow cortical activity compared to alpha and beta.

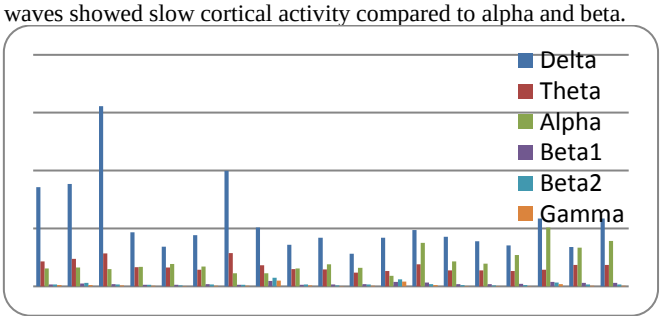

Fig. 4: Brainwave patterns of non-athlete during the eyes closed conditions

The brainwave pattern of non-athletes (Fig.4) appeared similarly to the conditions during the stroop effect tasks during the Eyes closed resting condition with higher alpha at temporoparietal area and occipital lobe, which is normal for any subjects in a relax and closed eyes conditions.

6.5.1. Brain Wave Pattern of Athlete during Stroop task versus Eyes Closed (EC) conditions

In different perspective, discussion about the brain quality involved the brain wave. In this situation, researchers describe the information on delta wave, which focus on attention. In Figure 1, we can see higher delta and Beta1 wave at the Frontal region (Fp1, Fp2), somatosensory area (C3, C4) to reveal the development of the psychomotor skills and visual spatial area (P3, P4). As discussed in [32], Harmony's review (2013), this area is collectively called Fronto-Parietal attentional control network area that engaged in attentional allocation in humans and non-human primates. It was identified as supporting cognitive control and decision-making processes, including the lateral prefrontal cortex, the anterior cingulate cortex, and the inferior parietal lobule [32]. Another

executive attention sub-function is the interference control primarily based in the orbito-medial prefrontal cortex. Other than delta wave, gamma also increases correspondingly throughout the attentional allocation over the frontal, parietal and visual areas. The Athletes group performed the stroop effects tasks where they are required to allocate visual spatial attention to the left and right visual field for the detection of stimuli. We can conclude that athletes need to be calm and relax while facing their challenge so that they can focus on theirtarget. The results highlighted the role of EEG delta and beta2/Gamma in the mechanism of coordination and attention within the Fronto-parietal area (Figure 1)Interactions within or between these bands such as high gamma and delta have been proposed to serve asmechanisms for coordinationwithin and between brain networks engaged in cognitive processing [33].

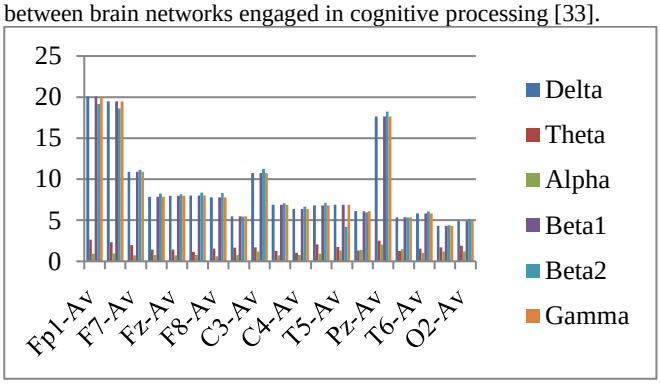

Fig. 5: Brain wave pattern of athlete during the performance of Stroop effects

With practice and exercise, different regions of the brain communicate with each other to strengthen their connections [34]. Neurons in the frontal part of the brain (the prefrontal cortex) are active. The prefrontal cortex or the executive functions region is vital for the decision-making task and focus to enable the athletes to perform well in sports. [35]suggested that increased alpha activity was related to an increased accuracy. With practice, the frontal cortex grows quiet and the athletes' calculation and movement becomes accurate. The response becomes automatic as their brain becomes more efficient in adapting and tuning in to make sense of new situation sooner [34]. EEG Delta was still dominant in Eyes Closed conditions among athletes. Beta2 and Gamma were almost not visible (Figure 6). Alpha naturally increases in most of the EEG studies.

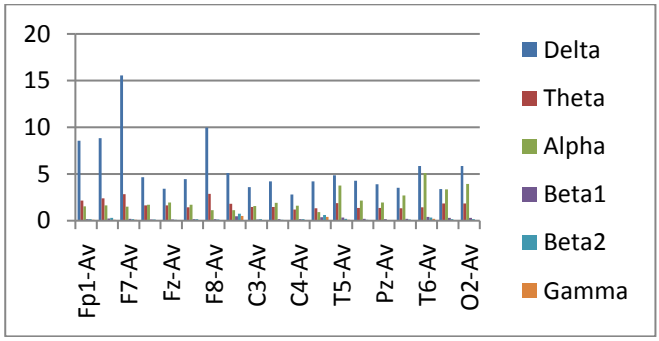

Fig. 6: Brain wave pattern of athlete during the Eyes Close (EC)

The above brain activity obviously related to the improvement of performance among athletes. They have opportunity to increase their brain ability in order sustain their performance through their performance strategies. Optimum the brain wave such as delta may increase their attentional in competition which ensuring their better performance. Through this performance strategy, athletes can avoid using the external stimulant such as doping. They may increase their internal ability compared to external

7. Conclusion and Implications

Findings have revealed that the demographic factors (gender, years of study and involvement) have differences with the performance strategies among athletes in UNIMAS. They were also different from each sub-scale such as goal setting, relaxation, activation, imagery, self-talk, attentional, emotional control, and automaticity. The previous research has described the differences between gender and performance strategies; however there were little empiricalevidences to show the significant differencein the year of study and involvement with performance strategies.
Hence, the brainwave patterns of athletes were dominated by the alpha wave which indicates the importance of focus and attention not only during the sports but for the importance of health and intelligent quotient. This study would contribute to the development of a training protocol for neurofeedback training for the athletes in preparation for training for peak performance in any sports activity. In this context, elevating the theta/alpha ratio is the best protocol which was validated in our present study and other researchers. Alpha protocol was originally developed to produce a hypnogogic state for the purpose of enhancing creativity when benefits were found in enhanced well-being and psychic integration stage. From these two discussions on the psychological strategies and brain quality, it could be inferred that these two alternative strategies were able to assist athletes in improving their performance regardless of their gender, age, years of study, and years of involvement.
The future researcher can increase the number of participants of the research among professional athletes or in Higher Education Institution in Malaysia.

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