EEG AND CENTRAL NERVOUS SYSTEM TRANSMITTER ON ATHLETES TRAINING

EEG E TRANSMISSÃO DO SISTEMA NERVOSO CENTRAL EM ATLETAS EM TREINAMENTO

EEG Y TRANSMISIÓN DEL SISTEMA NERVIOSO CENTRAL EM ATLETAS EN ENTRENAMIENTO

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ABSTRACT

Introduction: Modern EEG technology can evaluate the current level of an individual's central functioning after analyzing the frequency of brain waves (II). The A wave (8 ~ 14Hz) of brain waves (EBG) is one of the most important index parameters in diagnosing the brain's central functioning level. Objective: To explore the effects of different training loads on the brain function of elite archers and provide an objective basis for improving the scientific level of archery training. Methods: The effects of EEG information and central nerve transmitters on athletes' regulation and training were analyzed by testing and statistical methods. Results: Both HL-LLI and LL-HLI stages showed a decreasing trend in EEG complexity. Although the differences between the two stages were not significant all of them were considerably lower than the LL-LLI stage. The number of athletes with central fatigue in both stages showed an increasing trend. Conclusions: Athletes in training also need to focus on recovery after training, which requires a view of scientific training and scientific recovery as an organic whole that cannot be separated. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Electroencephalography; Sports; Brain waves.

RESUMO

Introdução: A moderna tecnologia do EEG pode avaliar o nível atual do funcionamento central de indivíduos ao analisar a frequência de ondas cerebrais (II). A onda A (8 ~ 14Hz) de ondas cerebrais (EBG) é um dos parâmetros indicadores mais importantes no diagnóstico do nível de funcionamento central do cérebro. Objetivo: Explorar os efeitos de diferentes cargas de treinamento na função cerebral de arqueiros de elite e fornecer uma base objetiva para melhorar o nível científico de treinamento de arca e flecha. Métodos: Os efeitos de informações do EEG e da transmissão de nervos centrais na regulação e no treinamento de atletas foram analisados através de testes e métodos estatísticos. Resultados: Tanto a fase HL-LLI quanto a LL-HLI demonstraram uma tendência decrescente na complexidade do EEG. Apesar das diferenças entre as duas fases não serem significativas, todas eram consideravelmente mais baixas do que a fase LL-LLI. O número de atletas com fadiga central nas duas fases demonstrou uma tendência crescente. Conclusões: Atletas em treinamento devem também ficar atentos à recuperação após o treinamento, o que exige uma visão de treinamento científico e recuperação cientifica como um todo orgânico que não pode ser separado. ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

Descriptores: *Eletroencefalograma; Esportes; Ondas cerebrais.*

RESUMEN

Introducción: La moderna tecnología del EEG puede evaluar el nivel actual del funcionamiento central de individuos al analizar la frecuencia de ondas cerebrales (II). La onda A (8 ~ 14Hz) de ondas cerebrales (EBG) es uno de los parámetros indicadores más importantes en el diagnóstico del nivel de funcionamiento central del cerebro. Objetivo: Explorar los efectos de diferentes cargas de entrenamiento en la función cerebral de arqueros de élite y brindar una base objetiva para mejorar el nivel científico de entrenamiento de arco y flecha. Métodos: Los efectos de informaciones del EEG y de la transmisión de nervios centrales en la regulación y en el entrenamiento de atletas se analizaron a través de pruebas y métodos estadísticos. Resultados: Tanto la fase HL-LLI como la LL-HLI demostraron una tendencia decreciente en la complejidad del EEG. Pese a que las diferencias entre las dos fases no sean significativas, todas eran considerablemente más bajas que la fase LL-LLI. El número de atletas con fatiga central en las dos fases demostró una tendencia creciente. Conclusiones: Atletas en entrenamiento deben también atentarse a la recuperación tras el entrenamiento, que exige una visión de entrenamiento científico y recuperación científica como un todo orgánico que no puede separarse. ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: *Electroencefalograma; Deportes; Ondas cerebrales.*

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INTRODUCTION

Modern EEG technology can evaluate the current level of central function of subjects after analyzing the frequency of brain wave (Il), and the A wave (8-14Hz) of brain wave (EBG) is one of the very important index parameters in the diagnosis system of central function level of the brain . At present, there are two main methods for evaluating the central nervous function of athletes, subjective evaluation method and objective evaluation method.[1,2] Subjective evaluation method is mainly to collect and analyze the subjective information of athletes' own body, neurofunctional feelings and symptoms through paper-and-pen questionnaire survey, so as to evaluate the central functional state of athletes. Its advantages are fast, easy to operate and can be tested in large quantities, but its disadvantages are that the scoring standard is not easy to be unified and susceptible to the subjective factors of the subjects, therefore, the evaluation of the psychological and physiological state of the athletes when their central function level declines cannot be achieved by objective criteria.[3,4]

METHOD

Subjects

The athletes in the experimental group were athletes from the national archery team training team, and the ordinary people in the control group were college students from Shanxi University. The subjects in both groups were in good health, and no organic brain diseases were observed.[5] (Table 1)

Test instrument and test method

Solar 1848 electroencephalograph produced by Beijing Sun Company was adopted as the test instrument. The central neurotransmitter system developed by Professor Mei Lei was used to conduct ultra-slow fluctuation (SET) analysis on the collected EEG data, the Beckman sterling silver saddle electrode was placed on the top of the athletes' heads in accordance with the International Electroencephalogram Society standard installation method (International 10/20 System Electrode Placement Method). The test was carried out 1h after the end of the training course.[6]

Stage division

The EEG monitoring stage was selected in three training load combination stages: LL-LLI stage (low load + low intensity training), where the training schedule is primarily based on general techniques and physical training, real archery is not more than 200 times a day, and there is no scoring of real archery, mainly to experience the technical movements and restore the special strength; HL-LLI stage (high load + low load intensity training), the training schedule for this stage is mainly technical training with 500 ~ 800 actual archery shoots per day and certain performance requirements for technical training, score real shots, mainly with a large number of real shots to carry out fine training on the overall skills of the athletes.[7]

Mathematical statistics

SPSS14.0 statistical software package was used to carry out multiple comparison of each index of EEG of athletes in each stage, and t test was carried out on the mean value of each index of EEG before and after the special training class in the main stage.

Table 1. List of basic information of research subjects.

	Age (year old)	Fixed number of year of the training (years)	n
Experimental group athletes	22.7±4.4	9.2±2.1	36
Control group ordinary people	23.5±5.1	There is no	36

RESULTS

EEG test results of National Archery Team athletes during winter training

Comparison of central neurotransmitter indexes in the whole brain of elite archers under different load states

Figure 1 showed that the distribution levels of 6 kinds of neurotransmitters in the whole brain of athletes and ordinary people were in line with the characteristics of "flying swallow", and there was no significant difference between the two groups.[8]

DISCUSSION

Changes of routine EEG indexes of elite archers under different training loads

In this study, these two conventional EEG indicators were also compared (Table 2 and Table 3). The results showed as follows: 1) Under the three load conditions, the α-band power value from the sports post area to the occipital area showed a trend from low to high, while the β-band power value did not show abnormal increase, which were in line with the diagnostic criteria of normal EEG in routine EEG examination. It can be concluded that the subjects in this study did not have pathological EEG. 2) The alpha power of the parietary-occipital region in the HL-LLI stage shows a significant downward trend. A decrease in alpha power often indicates a decrease in the intensity of nerve cell firing, a decrease in excitability was similarly recorded in the study of He Yang (2006). That is to say, in the archery training, the increase in the number of actual

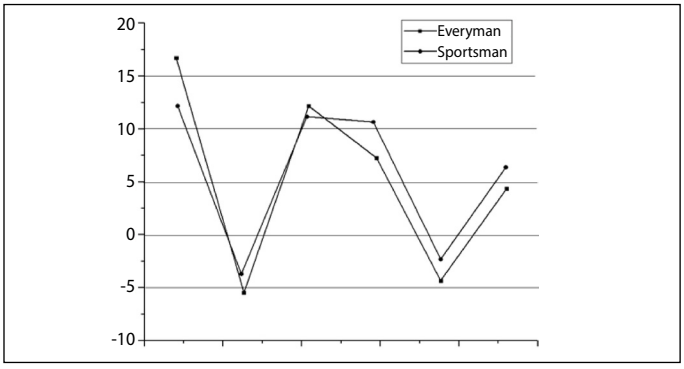

Figure 1. Comparison of the distribution of neurotransmitters in the whole brain between athletes and ordinary people in the LL-LLI training stage in this study.

Table 2. Comparison of power values in α band of athletes' EEG under different load states in this study (μv^2).

Brain areas	LL-LLI	HL-LLI	LL=HLI
Fp1	40.12±23.16	41.42±26.72	42.11±30.35
Fp2	41.17±23.34	42.61±22.65	43.82±28.47
F3	43.31±28.12	45.67±24.16	44.75±26.32
F4	42.45±29.22	41.58±25.42	42.99±27.36
C3	50.74±27.03	49.65±28.72	55.32±26.82
C4	52.61±31.41	53.26±2773	54.41±29.72
F7	55.43±20.53	56.15±18.67	58.49±24.65
F8	56.12±21.41	55.36±20.63	57.41±23.72
T3	60.33±26.73	64.91±27.21	65.33±29.23
T4	62.72±27.44	65.11±28.71	66.13±31.02
T5	70.46±29.71	76.45±28.37	75.34±29.15
T6	72.15±30.54	75.14±30.23	76.41±31.32
P3	88.32±51.71	56.45±28.68	86.41±52.39
P4	82.44±46.22	55.16±30.65	85.66±47.51
O1	162.77±89.88	117.78±91.32	162.29±88.43
O2	168.46±96.11	115.27±93.44	166.38±91.91

Note: * indicates significant difference from LL-LLI stage data, P < 0.05, same as below.

Table 3. Comparison of EEG β-band power values of athletes under different load states in this study (μv^2).

Brain areas	LL-LLI	HL-LLI	LL=HLI
Fp1	20.32±11.56	24.12±12.82	22.51±10.95
Fp2	21.19±10.44	23.41±12.74	24.52±11.77
F3	23.37±11.42	25.97±12.36	40.85±21.42
F4	22.15±11.02	21.51±10.82	42.29±22.37
C3	19.47±10.83	21.45±9.97	20.39±9.85
C4	18.16±10.04	20.16±10.13	19.43±10.22
F7	14.47±7.53	16.45±8.47	15.39±7.45
F8	15.16±7.41	15.16±7.77	16.43±8.42
T3	18.47±8.73	16.45±8.27	15.39±7.45
T4	16.16±8.44	15.16±7.73	16.43±8.28
T5	10.47±6.73	10.45±6.17	11.39±5.55
T6	12.16±6.41	11.16±5.73	12.43±6.02
P3	19.36±10.7	19.86±9.09	19.81±9.58
P4	15.21±7.29	16.95±9.63	17.67±7.99
O1	16.98±9.88	16.78±9.34	16.21±9.28
O2	15.66±8.31	15.57±8.21	15.34±8.97

Table 4. Comparison of neurotransmitters in the whole brain of athletes between LL-LLI and LL-HLI load states in this study.

	LL-LLI	LL-HLI	F	P
INH	12.36±6.73	10.11±5.21	0.599	0.059
5-HT	-3.96±5.43	6.17±3.27*	0.363	0.000
Ach	11.36±9.02	10.46±6.61	0.537	0.315
DA	10.74±5.23	1.63±2.11*	0.163	0.000
NE	-2.28±4.34	-3.52±5.46	1.689	0.150
EXC	6.43±3.89	5.78±3.37	0.751	0.226

Table 5. Comparison of neurotransmitters in the whole brain of athletes between LL-LLI and HL-LLI load states in this study.

	LL-LLI	LL-HLI	F	P
INH	12.36±6.73	11.477.61	1.279	0.300
5-HT	-3.96±5.43	7.964.29*	0.624	0.000
Ach	11.36±9.02	14.539.66	1.147	0.077
DA	10.74±5.23	19.397.21*	1.900	0.000
NE	-2.28±4.34	-2.524.14	0.910	0.405
EXC	6.43±3.89	5.783.41	0.768	0.227

archery branches, which represents the training load, can not improve the excitability of the athletes' central nerves, on the contrary, it reduces their training excitement. This suggests that the greater the load, the greater the benefit, but should be set in a reasonable range of fluctuation.[9]

Changes of central neurotransmitters of elite archers under different training loads

Based on the electroencephalogram (EEG) technique, the ultra-slow fluctuation of EEG is used to analyze the fluctuation of ultra-slow wave in the frequency range of 1 ~ 255MHz. According to the principle that the specific fluctuation frequency corresponds to some chemical neurotransmitters, six kinds of central neurotransmitters in the brain can be detected. These 6 central neurotransmitters are: Inhibitor (INH), 5-hydroxytryptophan (5-HT), acetylcholine (Ach), dopamine (DA), norepinephrine (NE), excitatory mediator (EXC), previous studies have found that the ultra-slow fluctuation parameters of EEG and central neurotransmitters will change with the change of athletes' brain functional state. In this study, EEG ultra slow fluctuation (SET) analysis was performed for three different levels of training load. The results showed that during the LL-LLI training phase, the levels of 6 neurotransmitters in the athletes presented a "swift" pattern (Figure 1), which was not different from the ultraslow fluctuation pattern of normal human brain. Table 5 shows that, on the one hand, the levels of 5- hydroxytryptophan (5-HT), which are the body's endogenous active substances, show a significant upward trend during the HL-LLI phase, which is consistent with previous studies. It has been found by foreign scholars that 5-HT levels of the brain are significantly increased after extremely long distance and low intensity swimming or platform running. After this, Bailey (1993) further found that increased levels of 5-HT in the brain were associated with burnout, lethargy, decreased sleep quality and cortical inhibition. According to Bailey, excess intracranial 5-HT may cause fatigue in the central system of the human body. Thus, this may be another explanation of why athletes are prone to central fatigue during the HL-LLI stage; On the other hand, the levels of dopamine (DA) in the brain at this stage are lower than in the LL-LLI stage.[10]

CONCLUSION

In the training process of National Archery Team, the change of sports load has a certain influence on the level of central nervous function of athletes, the load amount and load intensity of the National Archery Team are arranged in a reasonable range. The fluctuating setting does not have adverse effects on the athletes' central nervous system. There is a significant difference in the power value of the frontal beta band between the LL-HLI stage and the LL-LLI stage in archers. The increased intensity of rapid discharge will lead to increased energy consumption and the central nervous system is more prone to fatigue although its excitability is improved. Athletes in the training process also need to pay attention to the recovery after training, which requires scientific training and scientific recovery as an organic whole can not be separated from the view.

The author declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: The author made significant contributions to this manuscript. Chao Zhu: writing and performing surgeries; data analysis and performing surgeries; article review and intellectual concept of the article.

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