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The Autonomic Regulation of Heart Rate of Athletes with Different Levels of Sensor Motor Response

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Abstract

With increasing sports qualification of Athletes, the speed of visual response is increased in order of the magnitude. In the competition conditions, the manifestation of neural and psychomotor abilities of athletes depends on the functional state of the organisms. The main physiological adaptation to sport activity is the requirements to psycho physiological functions and to the heart rate regulation system. The aim was to study the features of autonomic regulation of heart rate of athletes with different levels of sensory-motor response. 24 elite athletes (Greco-Roman Wrestlers) were examined. The age of the athletes was 20-25. The peculiarities of sensory-motor response were studied on individual-typological characteristics of nervous system. The autonomic regulation of the heart rhythm was performed using cardio monitor «Polar-S800» with the registration of the spectral characteristics of heart rate. The results show that the growth rate of sensory-motor response of elite athletes is accompanied by psychomotor stress, which leads to the stability of visual reaction. The rate of sensory-motor response has communication with the tension of regulation of heart rate at the expense of parasympathetic tone, which is consistent with a decrease in the duration and frequency of the oscillations cardio intervals of athletes with high speed of sensory-motor response. The presence of a stochastic organization of the functional system of regulation of heart rate in athletes with high speed sensory-motor response reflects the ability of an athlete to adapt to the intense muscular activity.

Keywords: Heart rate; Athletes; Sensor motor response

Introduction

One of the main properties of psycho physiological functions of athletes is the perception of sensory information [1]. Several factors which characterize the efficiency of sporting activity: afferent component of information processing (reception and perception of information), central component (information processing) and efferent component of information processing which are influenced to the psycho physiological response of athletes [2,3].

With the increasing of qualification of athletes the speed of visual response is increased in order of the magnitude [4,5]. At the same time, in the competition the manifestation of neural and psychomotor abilities of athletes depends on the functional state of the organisms [6,7].

The system of vegetative regulation of heart rate is one (один из) или (the one -как было написано-единственный из) of the key components of functional states of human in tension muscular activity. The results of investigation of relation between psycho physiological reaction and vegetative regulation of heart rate during extremely activity are presented in the literature [8-10].

One of the popular Olympic sports is Greco-Roman Wrestling, as ancient and spectacular kind [11,12]. The modern Greco-Roman Wrestling is characterized by higher intensiveness and tension of the wrestling bout.

Thus, the wrestling match is characterized with hard-coordination structure and intensity. Due of this fact, the main physiological adaptation to sport activity are the requirements to psycho physiological functions and to system of regulation of heart rate [13-15].

Despite the existence of different methods of estimation of peculiarities of cardio intervals response to external loads, poorly understood is relationship between autonomic regulation of heart rate and the level of sensory-motor response in sports (wrestling).

The aim was to study the features of autonomic regulation of heart rate of athletes with different levels of sensory-motor response.

Materials and Methods

24 elite athletes (Greco-Roman Wrestlers) were examined. The age of the athletes was 20-25. All of the athletes were the members of Ukraine National Team of Greco-Roman Wrestling.

The peculiarities of sensory-motor response were studied on individual-typological characteristics of nervous system by computer complex (Multipsychometer-05). The optimal regime and regime of imposed rhythm were used. The methods: functional mobility and balance of nervous process by response to a moving object and tapping-test were used. The parameters: frequency of touches, labiality, stability, accuracy and excitation were studied.

The functional labiality of nervous process was estimated by parameters: dynamics, capacity of visual reception and information processing speed, impulsiveness.

All of the athletes was divided in two groups depending on level of sensory-motor response:

- First group athletes with higher level of sensory-motor

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response, with the value of the latent period of a simple visual-motor response from 120 ms to 240 ms, this group was joined by 10 people.

- The second group - the athletes with an average level of sensory-motor response speed, with value of latent period of a simple visual-motor response of 240 ms and over. This group was of 14 people.
- Analysis of the success of competitive activities of athletes revealed that the first group of athletes with high-speed sensory-motor response at the time of the study and had the best indicators of the effectiveness of technical actions (by video analysis) [11].

The estimation of autonomic regulation of the heart rhythm was performed using cardio monitor «Polar-S800» with the registration of the spectral characteristics of heart rate.

The analysis of non-stationary transient system of regulation of heart rate analysis the scatter grams as a non-parametric method of analysis was used [16,17]. Determine the parameters SD1 (display a periodic fluctuations of heart rate) and SD2 (slow oscillations of the heart rhythm).

The experimental study was approved by the Ethics Committees for Biomedical Research with accordance the ethical standards of the Helsinki Declaration. Consents for research in writing form were given by the athletes according to the recommendations to Ethics Committees for Biomedical Research.

Statistical significance was assumed for $p < 0.05$. Statistical analyses were performed with STATISTICA 6.0 software (Stat Soft Inc., USA).

Results and Discussions

The meanings of latent period of simple visual reaction of athletes with different level of sensory-motor response are presented in Table 1.

Data of the analysis revealed significantly more quality characteristics of visual reaction of athletes with higher level of speed of sensory-motor response (Table 1).

Low meanings of stability of reaction of athletes with higher level of speed of sensory-motor response are related with increasing tension of psychomotor regulation in comparison with athletes with low level of sensory-motor response.

Thus, increasing speed of sensory-motor response provokes the increasing of tension of psychomotor regulation and relate with stability of reaction in athletes.

The data of psycho physiological and neurodynamics functions of athletes with different level of sensory-motor response are presented in Table 2.

The results of the study by the method of tapping-test showed that athletes with a high level of sensory-motor response speed has more qualitative characteristics compared with athletes with low-level sensory-motor response.

The same difference is observed in the increase of frequency of touches in athletes with a high level of response rate. This fact indicates the improvement of the functional state of the neuromuscular system and the speed of nerve impulse (Table 2).

Moreover, the presence of the best values labiality and duty cycle of athletes with a high level of sensory-motor response were revealed. .

The presence of higher absolute values of the coefficient of variation of athletes with low speed sensorimotor responses indicates deterioration in the stability of frequency of touches during the tapping-test.

This phenomenon reflects the stochasticity psycho physiological organization as a result of the formation of a functional system

Speed of response	latent period of simple visual reaction. ms			Stability of reaction. %		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
Higher	259.85	246.01	272.50	14.03	10.30	16.50
Low	300.45*	280.43	325.05	17.05*	13.30	24.30

*- $p < 0.01$. for concerning of athletes with higher average speed of response

Table 1: Meanings of latent period of simple visual-motor reaction in athletes with different level of sensory-motor response (n=24).

Parameters	Higher speed of response			Low speed of response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
Tapping-test						
The frequency of touches. secret unit	6.76	6.30	7.18	6.05*	5.55	6.65
Labiality. secret unit	51.40	49.20	58.15	37.45*	36.75	53.10
Duty cycle. secret unit	2.80	2.55	3.08	4.20*	3.09	4.50
Stability. %	9.85	9.17	16.55	11.75*	10.80	17.05
Balance of nervous process						
Accuracy. secret unit	3.40	2.70	3.60	3.05	2.65	3.90
Stability. %	2.70	2.60	4.02	4.60*	3.00	6.45
Excitation. secret unit	-1.20	-3.18	-0.39	-0.93	-1.60	-0.61
Trend on the excitation. secret unit	-243.70	-442.30	-11.80	-303.10	-427.55	-188.40
Functional mobility of nervous process						
Dynamism. secret unit	68.00	61.70	84.00	69.01	62.40	80.70
Throughput. secret unit	1.70	1.50	1.90	1.60	1.50	1.90
Boundary speed of information processing. ms	350.00	320.00	440.00	380.00	350.00	440.00
Impulsiveness. secret unit	0.03	-0.12	0.47	-0.13*	-0.15	0.07

*- $p < 0.01$. for concerning of athletes with higher average speed of response

Table 2: Parameters of neurodynamics and psycho physiological functions in athletes with different level of sensory-motor response (n=24).

responsible for perception and processing of information, and the possibility of finding and attracting new functional elements of the system under extreme conditions [18].

Thus, the decline in the rate of sensor motor response of athletes relates with the deterioration of the functional state of the neuromuscular system.

The increase in stochasticity psycho physiological organization of athletes is a compensatory mechanism which observe with the reduced of decline of sensory-motor level response.

The study of the balance of nervous processes revealed that in athletes with a high level of sensory-motor response the balance of nervous processes has tendency to excitation, compared with a group of athletes with a low level of sensory-motor response (Table 2).

The study of heart rate variability has made it possible to differentiate the athletes with different levels of sensory-motor response speed, in terms of autonomic regulation.

The results of the studies of heart rate variability in athletes with different levels of sensory-motor response speed are presented in Table 3.

The data of Table 3 indicated that statistically difference is observed between both groups of athletes by the mean duration of R-R intervals and SD2 parameters, which characterizes the periodic frequency of cardio intervals.

Thus, the rate of sensory-motor response of athletes has mediated relationship with the duration and frequency of the oscillations of heart rhythm.

Table 3 presents the tendency to increasing of a periodic frequency of cardio intervals (for SD2 parameters) of athletes with higher level of sensory-motor response.

This result is consistent with the data of E.P. Iljin that point to more pronounced changes in pre-start condition in experienced athletes, heart rate, tremors, variability of indices tapping-test and attention concentration [19].

The revealed fact reflects a growth of level of psychomotor regulation in athletes with a high level of sensory-motor response.

The data of spectral characteristics of heart rhythm in athletes with different level of sensory-motor response are presented in Table 4.

The presence of significantly higher values of high frequency oscillations cardio intervals in athletes with low levels of sensory-motor response indicates the activation of parasympathetic tone of the autonomic regulation of heart rate in this group of athletes (Table 4). This fact is also indicated by the ratio of Total Power spectrum of oscillations cardio intervals (Table 4). The increase of autonomic balance (LF / HF) of athletes with high-speed response indicates a growing intensity of autonomic regulation of heart rate at the expense of activation of parasympathetic tone.

Thus, the rate of sensory-motor response has mediated relation with the regulation of the heart rate tension at the expense of parasympathetic tone, which is consistent with a decrease in the duration and frequency of the oscillations cardio in athletes with high speed sensory-motor response.

This result is consistent with the our data [20,21] which showed a reduction in the accuracy and speed of movements according to the tapping-test with activation of sympathetic nervous system.

To study the characteristics of the formation of a functional system which responsible for regulating heart rate, we used the approach evaluation of information-entropy characteristics of heart rate variability in athletes with different levels of sensory-motor response speed (Table 5).

Analysis of Table 5 showed the presence of significant differences by parameter of approximate entropy, which is significantly higher in athletes with a high level of sensory-motor response.

The resulting fact indicates the presence of a stochastic functional organization of the system of regulation of heart rate in athletes with a high level of sensory-motor response speed. This result is consistent with our previous studies in which it was shown that the increase in entropy of the system autonomic regulation of heart rate reflects the ability of an athlete to adapt to the intense muscle activity.

Conclusion

1. The results are showed the increasing of duration a periodic

Parameters	Higher speed of response			Low speed of response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
Mean RR- ms	967.45	917.20	1083.05	1159.50*	1008.70	1221.40
STD- ms	96.45	61.95	138.35	110.10	99.40	123.40
RR triangular index- secret unit	17.61	12.88	24.37	20.57	16.16	23.55
SD1- ms	72.45	38.35	100.20	64.40	55.00	66.30
SD2- ms	130.85	82.500	180.65	167.40*	141.10	168.90

*- p<0.01for concerning of athletes with higher average speed of response

Table 3: Statistical parameters of heart rate variability in athletes with different levels of sensory-motor response.

Parameters	Higher speed of response			Low speed of response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
VLF- ms ²	5275.00	1267.50	10095.00	7088.00	4802.00	10398.00
LF-ms ²	2444.50	1674.00	3704.50	2428.00	2395.00	2767.00
HF-ms ²	1092.50	600.00	3512.50	2373.00*	1959.00	2586.00
Total	9668.00	3541.50	17312.00	12979.50*	11575.00	16710.00
LF/HF	1.91	1.308	2.65	1.41*	1.01	1.51

*- p<0.01for concerning of athletes with higher average speed of response

Table 4: Spectral characteristics of heart rhythm in athletes with different levels of sensory-motor response.

Parameters	Higher speed of response			Low speed of response		
	Median	lower quartile	upper quartile	Median	lower quartile	upper quartile
Determinism. %	98.820	97.920	99.04	98.98	97.28	99.46
Shannon Entropy- secret unit	3.124	2.918	3.31	3.29	2.87	3.46
Approximate entropy	1.13	0.981	1.15	1.00*	0.87	1.10
Sample entropy-secret unit	1.504	1.44	1.64	1.53	1.19	1.66

*- p<0.01 for concerning of athletes with higher average speed of response

Table 5: Evaluation of information-entropy characteristics of heart rate variability in athletes with different levels of sensory-motor response.

oscillation of RR-intervals in athletes with higher level of sensory-motor response.

- The observed of reducing the speed of sensory-motor response in athletes are related to the deterioration of the functional state of the neuromuscular system. As a compensatory mechanism for psychomotor impairment in athletes with reduced levels of sensory-motor response, there has been an increase of stochasticity of psycho physiological organization of the organism.
- The increasing level of sensory-motor response has communication with the tension of regulation of heart rate at the expense of parasympathetic tone.
- The presence of a stochastic organization of the functional system of regulation of heart rate in athletes with high speed sensory-motor response reflects the ability of an athlete to adapt to the intense muscular activity.

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