TRAINING METHODS FOR ATHLETES' NEUROLOGICAL REACTION TIMES

MÉTODOS DE TREINAMENTO DO TEMPO DE REAÇÃO NEUROLÓGICA DE ATLETAS

MÉTODOS DE ENTRENAMIENTO DEL TIEMPO DE REACCIÓN NEUROLÓGICA DE ATLETAS

Original Article
Artigo Original
Artículo Original

Junxiong Zhang[1]
(Physical Education Professional)

1. Xiamen Academy of Art and Design, Fuzhou University, Xiamen, China.

Correspondence:
Junxiong Zhang
Xiamen, China, 361024.
JunxiongZhang6@126.com

ABSTRACT

Introduction: By observing the characteristics of the development of competitive tennis in the world, it is not difficult to find that tennis requires extremely fast reaction times from players. Objective: To explore the relationship between athlete's reaction time and different training methods. Methods: 48 outstanding female tennis players were selected. They received four weeks of regular training (from March 2 to March 28, 2020) and two weeks before the competition (from June 8 to June 20, 2020). After the training, the Omega Wave system was used for testing, and urine samples were taken for catecholamine testing. Results: In the test of 48 people before the competition, 30 people experienced central fatigue, from which 24 people (80%) were in the regular training stage, and only six people (20%) were in the training stage before the competition. HRV indicators: In the regular training stage, the results of time-domain indicators such as SDNN (NN interval standard deviation), SDSD (NN interval difference standard deviation), RMSSD (NN interval difference root mean square), and frequency-domain indicators such as LF (low frequency) and HF (high frequency) in the second and third week of the athletes were lower than those in the first and fourth week, showing the characteristics of first falling and then rising. However, there was no significant change. Conclusion: Different training methods can improve athletes› competitive level and reaction speed. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Tennis; Reaction Time; Training; Method.

RESUMO

Introdução: Observando-se as características do desenvolvimento do tênis competitivo ao redor do mundo, não é difícil perceber que o tênis exige reações extremamente rápidas de seus jogadores. Objetivo: Explorar a relação entre o tempo de reação de atletas e diferentes métodos de treinamento. Métodos: 48 jogadoras de tênis de alto nível foram selecionadas. Elas receberam quatro semanas de treino regular (entre 2 de março e 28 de março de 2020), além de treinos nas duas semanas antes da competição (de 8 de junho a 20 de junho de 2020). Depois do treino, o sistema Omega Wave foi usado para examiná-las, e amostras de urina foram recolhidas para análise de catecolaminas. Resultados: No teste das 48 pessoas antes da competição, 30 sentiram fadiga central, dentre as quais 24 (80%) estavam na etapa regular de treinamentos e apenas 6 (20%) na etapa de treinamentos pré-competição. Indicadores HRV: na segunda e na terceira semana da etapa de treinamento regular, os atletas apresentaram resultados mais baixos nos indicadores do domínio tempo, tais como SDNN (desvio padrão do intervalo NN), SDSD (desvio padrão das diferenças no intervalo NN), RMSSD (valor eficaz da diferença do intervalo de NN), e nos indicadores do domínio frequência, tais como FB (frequência baixa) e FA (frequência alta). No entanto, na primeira e quarta semanas, os resultados foram mais altos, demonstrando uma queda seguida de aumento. Contudo, as mudanças não foram significativas. Conclusão: Métodos de treinamento diferentes podem melhorar o nível competitivo e o tempo de reação de atletas. ***Nível de evidência II; Estudos terapêuticos – investigação do resultado de tratamentos.***

Descritores: *Tênis; Tempo de reação; Treinamento; Método.*

RESUMEN

Introducción: Observando las características del desarrollo del tenis competitivo alrededor del mundo, no es difícil percibir que este deporte exige reacciones extremadamente rápidas de sus jugadores. Objetivo: Explorar la relación entre el tiempo de reacción de atletas y diferentes métodos de entrenamiento. Métodos: 48 jugadoras de tenis de alto nivel fueron seleccionadas. Ellas recibieron cuatro semanas de entrenamiento regular (entre 2 de marzo y 28 de marzo de 2020), además de entrenamientos en las dos semanas anteriores a la competición (del 8 de junio al 20 de junio de 2020). Después del entrenamiento, el sistema Omega Wave fue usado para examinarlas y fueron solicitadas muestras de orina para el análisis de catecolaminas. Resultados: En la prueba de las 48 personas antes de la competición, 30 sintieron fatiga central, entre las cuales 24 (80%) estaban en la etapa regular de entrenamientos y solo 6 (20%) en la etapa de entrenamientos pre competición. Indicadores HRV: en la segunda y en la tercera semana de la etapa de entrenamiento regular, los atletas presentaron resultados más bajos en los indicadores del dominio tiempo, tales como SDNN (desvío estándar del intervalo NN), SDSD (desvío estándar de las diferencias en el intervalo NN), RMRSSD (valor eficaz de la diferencia del intervalo de NN), y en los indicadores del dominio frecuencia, tales como FB (frecuencia baja) y FA (alta frecuencia). Sin embargo, en la primera y cuarta semanas, los resultados fueron

más altos, demostrando una caída seguida de aumento. No obstante, los cambios no fueron significativos. Conclusión: Métodos de entrenamiento diferentes pueden mejorar el nivel competitivo y el tiempo de reacción de atletas.
Nivel de evidencia II; Estudios terapéuticos – investigación del resultado de tratamientos.

Descriptores: *Tenis; Tiempo de reacción; Capacitación; Método.*

DOI: http://dx.doi.org/10.1590/1517-8692202228022021_0454 Article received on 11/03/2021 accepted on 12/23/2021

INTRODUCTION

Tennis, as a skill - oriented competition, has developed rapidly in China in recent years. Looking at the development characteristics of competitive tennis in the world, it is not difficult to find that tennis has a high demand on the reaction speed of players.[1] Reaction speed refers to the speed at which athletes respond to various stimuli. In tennis matches, the serving speed of high-level athletes can reach more than 200km/h, this means that the receiver only has a reaction time of less than one second, and good reaction speed is required for volley at the net and players' quick prediction of the incoming line and landing point in the fast-paced confrontation.[2] Tennis players are in the sensitive period of speed quality development. Studies have found that central nervous and effector excitability increases the speed of our response by increasing the sensitivity of the receptors (excitation threshold). In simple reactions, the reaction speed can be increased by 10%-20%, and in selective reactions, the reaction speed can be increased by 30%.[3] However, through literature review, it is found that there are few influencing factors and training methods on the reaction speed of tennis players, and a complete theoretical system has not yet been formed. Therefore, we can analyze the factors that affect the reaction speed of tennis players, combine the physiological and psychological characteristics of players, and take problems as the guidance, the reaction speed training method in line with the special characteristics of tennis is proposed, so as to improve the competitive level of tennis players.[4]

METHOD

Research Objects

Eight women tennis players were the subjects of the study, considering the gender of the subjects, the menstrual cycle of the athletes was normal during the test. See Table 1 for the basic information of the athletes.

Research Methods

(1) Literature method

Refer to the Chinese literature on cnKI in recent 30 years, whose topics are sports training monitoring, central fatigue, heart rate variability, etc. Review the Chinese and English literature and doctoral theses related to heart rate variability, urinary catecholamine and reaction rate.[5] Literature related to this study was collected through English databases such as Pubmed and Internet search, so as to obtain experience and enlightenment from the consulted data, thus providing reference basis and theoretical support for this study.[6]

Table 1. List of basic information of research objects.

Name	Age	Height	Weight	Years of training	Sports level
A	25	180	68	11	Athlete
B	27	188	71	13	Athlete
C	24	189	82	11	Athlete
D	24	181	75	12	Athlete
E	23	170	58	9	Athlete
F	21	178	66	4	Athlete
G	21	187	70	7	Athlete
H	28	180	86	11	Athlete
X±SD	24.13±2.53	181.63±6.3	72.00±8.9	9.75±2.9	

(2)Experimental method

Select different training periods before the 2020 women's tennis championship to conduct relevant research, and use the OmegaWave system to test 8 women's tennis players. According to the coach's training plan, make test plan: 4 times in the regular stage (3 intensity weeks plus 1 adjustment week: March 2 to March 28, 2020) and 2 pre-competition stages (2 weeks pre-competition and 1 week pre-competition.[7] June 8 to June 20, 2020). According to the actual schedule, OmegaWave system test should be conducted within one hour after the end of the training, with 8 people per week for 6 times in total; The content features are shown in Table 2.

Mathematical statistics

SPSS20.0 professional statistical analysis software and Microsoft Excel2010 software were used for statistical processing of the test data, and the mean and standard deviation of all test index data were calculated, all test results were expressed by mean ± standard deviation (X ±SD), and the comparison between groups was performed by anova at the significant level ($P<0.05$) and very significant level ($P<0.01$).

RESULTS

In this study, 8 elite female tennis players were tested with Omega Wave system for a total of 48 times at different training stages and weeks before the competition, the results of basic potential values of the athletes at rest are shown in Table 3.

Statistics of the test results found that a total of 30 people appeared different degrees of central nervous system fatigue, among them, 24 people around the routine stage, accounting for 80%, mainly manifested as low excitement. Further analysis of the results shows that the occurrence of central fatigue of athletes in different training stages and weeks before the

Table 2. Characteristics of training arrangement of athletes in different training stages.

The stage of training	Week of testing	Characteristics of training Contents
Conventional around	The first three weeks	In the last week, the training time was 6 hours per day with high intensity
	The fourth week	Adjustment week, training time at 3 hours a day, the intensity is low
Two weeks before the game	Two weeks before the game	Tactical drills, a little bit of simulated game training
	The week before the game	The training time is short and the load is small

Table 3. Quiet potential values of athletes in different training stages and weeks.

Week of testing	Quiet potential
Routine week	-8.20±5.97
Conventional two weeks	-11.94±7.60
Conventional three weeks	-17.85±11.3
Conventional around	1.96±6.73
Two weeks before the game	5.85±9.02
A week before the game	6.28±10.49

competition has certain characteristics: Compared with the two weeks before the competition and the four weeks after the regular stage, the athletes were more prone to central fatigue in the second week and the third week, and some athletes also had central fatigue in the first week and the fourth week.[8] In the two weeks before the competition, although the training intensity is low and the training duration is short considering the upcoming competition, some athletes will also suffer from central fatigue. (Figure 1)

Athletes in different training stages and weeks before the competition

Results of time domain method of athletes in different training stages and weeks before the competition

The time-domain method is the simplest method to analyze heart rate variation signals, the results of this study are obtained through systematic analysis of 5min heart rate information collected by Omega Wave system under the quiet and stable state of athletes, which belongs to short-term analysis. The detailed results are shown in Table 4.

According to Table 4, it is found that SDNN, RMSSD, SDSD, PNN50 and other time domain indexes of athletes of different weeks in the routine stage and the pre-competition stage have no significant changes. The results of time domain indexes in the conventional stage generally showed the characteristics of "decrease first and then increase" (Figure 2, 3, 4 and 5), and the results in the two weeks before the competition were generally higher than those in the conventional stage, but there was no significant difference between the test results in each week.

DISCUSSION

In sports training monitoring, the reaction speed of athletes is generally evaluated by measuring the time for athletes to respond to specific signal stimuli.[9] In the process of sports training, appropriate training load can have a good influence on the stability of athletes' central nervous system, after long-term professional systematic training, athletes' reaction speed may reach a relatively stable level. However, if the training load exceeds the endurance of the athlete's body, it is easy to cause sports fatigue, which has a certain influence on the reaction speed of the athlete. When the central fatigue occurs, the athletes mainly show the slow reaction speed, the increase of reaction time and the unstable reaction state. This study found that in the regular stage, because the first three weeks are intensity weeks, tennis players need to complete some training intensity and amount in order to improve their special ability, the training time is longer and the intensity is greater, the athletes' body

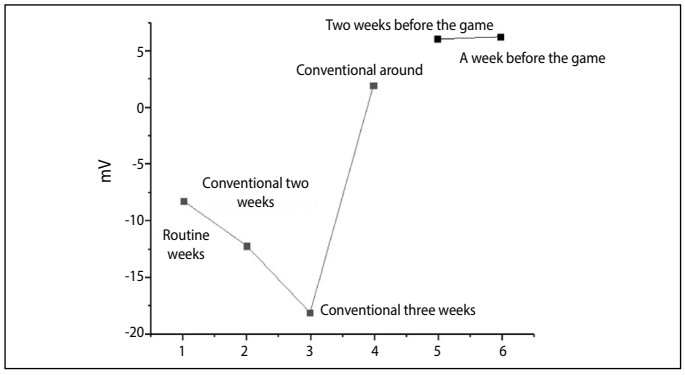

Figure 1. Variation trend of quiet potential of athletes in different training stages and weeks.

Table 4. HRV0 results of Athletes in different training stages and weeks (Time domain method).

Week of testing	SDNN	RMSSD	SDSD	PNN50
Routine week	57.63±16.43	67.13±32.39	84.50±37.47	17.34±9.60
Conventional two weeks	51.75±21.42	54.38±32.04	68.88±37.93	14.43±7.26
Conventional three weeks	55.13±31.23	62.38±53.35	79.13±67.41	13.48±8.39
Conventional around	69.63±20.51	67.00±30.87	84.63±40.35	15.94±11.24
Two weeks before the game	71.50±16.41	86.00±32.38	98.86±40.61	25.33±9.78
A week before the game	65.88±29.45	68.63±34.62	87.65±44.71	16.04±9.93

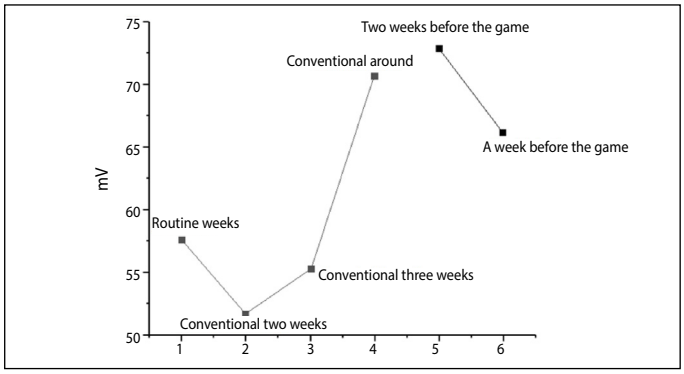

Figure 2. Variation trend of SDNN values of athletes in different training stages and weeks.

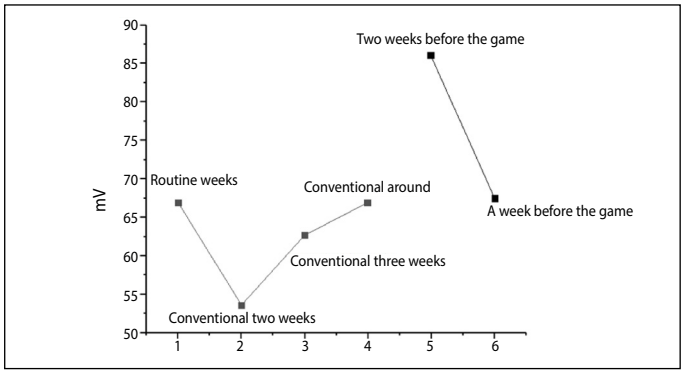

Figure 3. Variation trend of RMSSD value of athletes in different training stages and weeks.

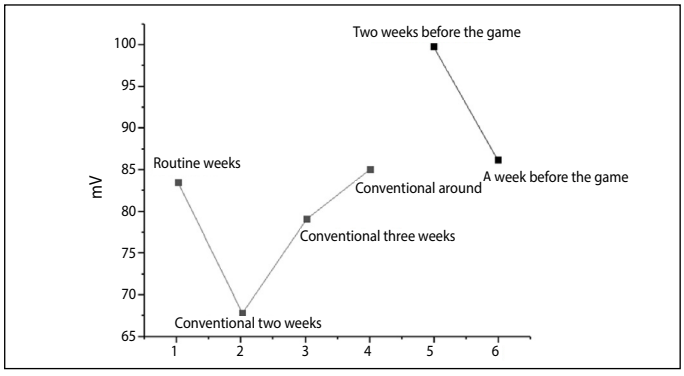

Figure 4. Changes of SDSD values of athletes in different training stages and weeks.

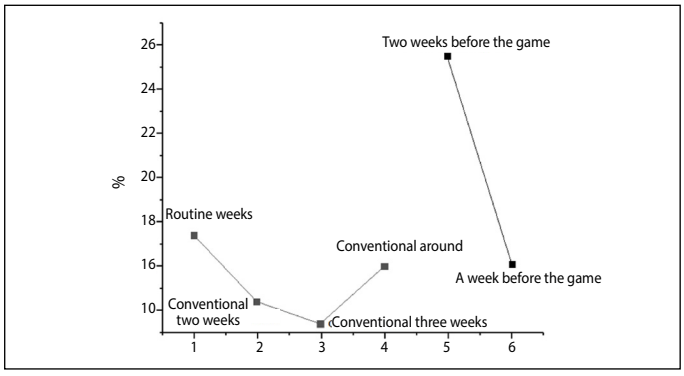

Figure 5. Variation trend of PNN50 values of athletes in different training stages and weeks.

is stimulated significantly, leading to central fatigue, which leads to the reduction of central nervous system function, during the test, the mental state can not continue to concentrate, the reaction speed is slow, and the average reaction time increases. The fourth week is the adjustment week.[10] Compared with the first three weeks, there are fewer training tasks, and the training content is mainly adjustment and recovery, with low training intensity and short training time, after rest, the fatigue of the athletes was relieved, and their mental state was stable, their reaction speed was average, and the average reaction time was reduced.

CONCLUSION

In the design of training means, multiple stimuli should be given at the same time, visual stimuli should be given as the main type of stimulation, while tactile and auditory stimuli should be supplemented, at the same time, the intensity and frequency of punishment can be appropriately increased to improve the reaction speed of athletes.

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

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

REFERENCES

1. Ge B, Chen B, Li L. A DFT study on the relationship between local microstructure and oxygen reduction reaction activity over Fe-N4 graphene. Materials Today Communications. 2020;25(12):101524.
2. Hao Z, Zhou Z, Pan Y. Experimental study on the relationship between coal stress and drilling rotation speed. Caikuang yu Anquan Gongcheng Xuebao/Journal of Mining and Safety Engineering. 2019;36(1):158-65.
3. Dai Z, He M, Lv D. Study on The Relationship between Vegetation Index And Bird Diversity in Beidagang Wetland. IOP Conference Series: Earth and Environmental Science. 2021;791(1):012176.
4. Fan D, Mao W, Wang G, Shi H, Wu Z, Xie J et al . Study on the relationship between sex hormone changes and erectile dysfunction in patients with chronic prostatitis/chronic pelvic pain syndrome. Annals of Palliative Medicine. 2021;10(1):24.
5. Dong M, Deng Q, Zhang Y, Hang T, Li M. Study on the relationship between Cu protrusion behavior and stresses evolution in the through-silicon via characterized by in-situ μ-Raman spectroscopy. Microelectronics Reliability. 2020;115(2):113949.
6. Etinba M, Cumhur H, Butar S. Determination of late spring frost effects on Monroe peach cultivar in different training systems, planting intervals and height of flower. Ege Üniversitesi Ziraat Fakültesi Dergisi. 2021;58(2):193-201.
7. Kim YD, Kim HM, Chae SH. A Study on the Relationship between the Prices of Fisheries Products at Different Levels of Distribution: Focused on Level of Production Area and Wholesale Market. Journal of Industrial Economics and Business. 2020;33(1):33-57.
8. Johne M. The impact of fencing training symmetrisation on simple reaction time. Biomedical Human Kinetics. 2021;13(1):231-6.
9. Hu Z, Fan C, Song G. A novel quantization method combined with knowledge distillation for deep neural networks. Journal of Physics: Conference Series. 2021;1976(1):012026.
10. Uchida T, Komiyama O, Iida T, Okamoto Y, Muramori J, Wakami M. A study on the relationship between Axis I and Axis II diagnoses of DC/TMD: A cross-sectional survey of dental students. Journal of the Japanese Society for the Temporomandibular Joint. 2019;31(2):106-14.