Activation Process of Brain Perception during the Serve Action of Table Tennis Players

Jiang An*

ABSTRACT

With a view to consolidating and strengthening the sports level of Chinese table tennis players, this study focuses on the activation process of brain perception in serving. Based on the principles of kinematics and sports biomechanics, 3dsMax2012 software is used to simulate pictures, and active coaches and second-class athletes are asked to screen out pictures showing the actions could be employed to send out side back spin. The composition characteristics in this study indicate that the number of athletes' activated neurons that are sensitive to stimulus features is larger. In the perception stage of information with a single feature, table tennis athletes have a higher degree of activation of the cerebral cortex, and are very sensitive to the physical characteristics of the stimulus related to the specific sports.

Key Words: Table Tennis, Brain Perception, Activation Process

DOI Number: 10.14704/nq.2018.16.6.1614 **NeuroQuantology 2018; 16(6):195-199**

Introduction

The pattern recognition feature proposes that in the process of pattern recognition, the features of the stimulus are first analyzed, and then the extracted features are combined and then compared with the stimulus features in the long-term memory. Once the best match is obtained, the external stimulus is identified. Patterns are composed of several elements or components in relation to each other and which may be referred to as features (Abernethy, 1988). In sports, the essence of a complete technical action is a complete information structure pattern, thus the judgment of the action is actually the recognition of the information structure pattern of the action (Abernethy *et al.*, 1999).

At present, the following problem still exists in the researches on recognition of action pattern of sports techniques. Action pattern recognition of sports techniques is a continuous process including feature extraction, feature merging (integration), feature comparison, match recognition, and reaction output, etc. The analysis of only one or several of these processes obviously cannot fully reveal the cognitive processing mechanism of pattern recognition (Abernethy, 1994). Actions of sports techniques are almost the collection of spatial information and temporal information. The pattern recognition of spatial information alone is inconsistent with the perceptual representation of technical actions in long-term memory of athletes, resulting in inconsistent research results (Akiyama *et al.*, 2000). In addition, action pattern recognition of sports techniques has an implicit feature, thus it is difficult to determine the perceptual representation of a technical action in athletes' long-term memory without taking effective research paradigm (Allard *et al.*, 2010). Therefore, with the help of the task of the athletes' brain perception activation process of the ball serve rotation, this study focuses on the components of the sports information pattern structure and the brain perception activation

Corresponding author: Jiang An
Address: Northwest University, Xi'an 710075, China
e-mail ✉ anjiang12893@163.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 4 March 2018; **Accepted:** 1 May 2018

process of the athletes' perception of the pattern structure.

Based on the current researches on recognition of action pattern of sports techniques, and according to feature integration theory, pattern recognition feature theory, inhibition control theory, and activation diffusion theory, this study proposes the following hypotheses. 1. In sports, the essence of a complete technical action is a complete information structure pattern, and the judgment of the action is actually the recognition of the information structure pattern of the action. 2. With sports experience, athletes simplifies the original information pattern and extract one or some of the features from the fast and complete information flow, and perform information processing based on the objects composed of these eigenvalues or limited eigenvalues to complete the judgments, decisions, and reactions to athletic information. The specific operation process adopts the "expert-novice" research paradigm, the experimental paradigms of "Oddball Go/No Go" and "Cuing", and the research methods of laboratory experiments (Marslen-Wilson *et al.*, 1989). In this study, the mechanics foundation of table tennis rotation is analyzed from the perspective of kinematics and sports biomechanics. 3D technology is used to simulate the picture of table tennis serve information structure with object composed of from single feature to three features. With the process of brain perception activation on serve rotation of table tennis of second-class athletes and sports major college students as the main content, E-prime2.0 psychological experiment software, 64-channel Event-Related Potential (ERP) record analysis system and 16-channel electromyography (s EMG) testing system are used to compare the differences in in response time, electromyography (s EMG) activity value of response accuracy, ERP activity value, and other indexes, between the two groups of subjects in judging the serve rotation mode of table tennis ball by using object information composed of from single feature to three features. The above hypotheses are verified through three studies and six experiments, and then the information structure pattern used by the table tennis players in their brain perception activation process of the serve rotation is explored so as to reveal and the neural mechanism of the pattern recognition process.

Methods

Subjects

A total of 15 table tennis major college students are selected as subjects, who are divided into expert groups and novice groups according to their sports levels. The former includes the national second-class athletes (Age: 21.20±0.77; Exercise duration: 7.80±2.30), while the latter consists of the subjects without any specific sports levels (Age: 20.60±1.05; Exercise duration: 1.73±0.88). All the subjects are male, right-handed, with normal visual acuity or corrected visual acuity. All of them volunteer to participate in the experiment, and are given the corresponding reward after the experiment.

Experimental materials

According to the principles of kinematics and sports biomechanics, and with reference to the self-photographed table tennis serve video, the action spots of force are selected and the computer 3dsMax 2012 software is used to simulate the information structure pattern picture of the hitting position of the table tennis ball serve, as shown in Figure 1. Table tennis is made strictly according to the specific parameters of the original entity (Table Tennis Competition Rules, 2011) 82. At the positions of 0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°, and 360°on the surface of the table tennis body, the hitting parts are marked with black shadows in sequence, and a total of 8 3D pictures with a size of 1360×768 are rendered (all pictures exemplify the forehand serve with the right hand). 2 coaches and 2 second-class athletes on active service are asked to screen out pictures that can be used to send out side back spin. Experts all agreed that positions of 135° and 225° in the picture are most likely to send out side back spin, with a 100% of consistency.

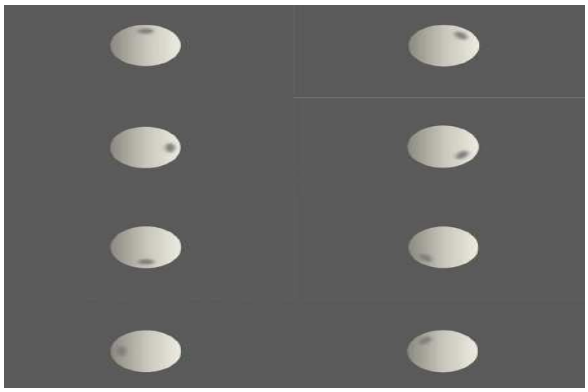

Figure 1. 3D picture of table tennis ball

Experimental process

In the process of the experiment, as shown in Figure 2, a sign "+" appears first in the center of the screen, and then appears a picture of table tennis, with the black shadow on the surface indicating the hitting position by the opponent at the moment of hitting the ball. The subjects are asked to identify the picture that can be used to send out the side back spin, without pressing the key.

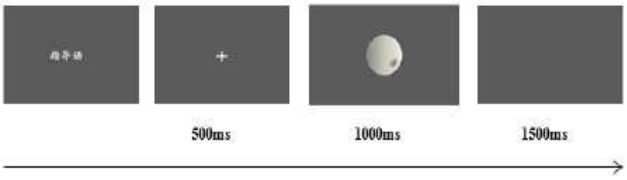

Figure 2. Experimental process

Results and discussions

Experimental results

Figures 3, 4, 5, and 6 show the electrical coherence of electrode pairs, P3-C3, P4-C4, P3-F3, P4-F4, P3-01, P4-02, P3-T7and P4-T8, in different frequency bands, including low frequency al-pha, high frequency alpha, low frequency beta, and high frequency beta. It can be seen from the Figure that the coherence of most electrodes to sports experts is lower than that to novice. The analysis is as follows.

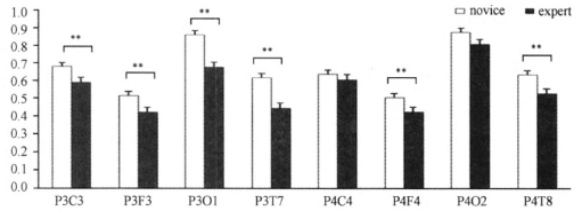

Figure 3. Schematic diagram of interaction between electrodes and electroencephalography coherence between experts and sports novice in hemisphere low frequency motion

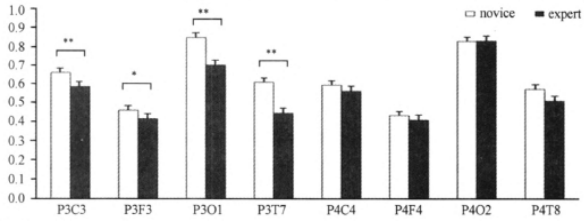

Figure 4. Schematic diagram of interaction between electrodes and electroencephalography coherence between experts in the hemisphere and high frequency sports experts

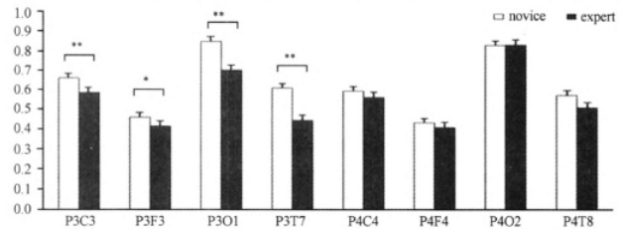

Figure 5. Schematic diagram of interaction between electrodes and electroencephalography coherence between experts and sports novice in hemisphere low frequency motion

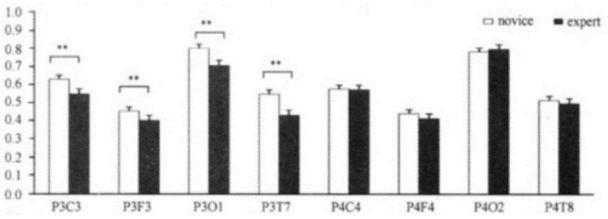

Figure 6. Schematic diagram of interaction between electrodes and electroencephalography coherence between experts in the hemisphere and high frequency sports experts

C1 component

Taking C1 component latency as dependent variable, three factors of 2 sports levels (expert, novice)×2 stimulation types (positive stimulation, negative stimulation)×12electrode points (Fz, Cz, Pz, Oz, etc.) are analyzed by variance analysis. The results show that the main effect of sports levels is significant; the main effect of the types of stimulation is not significant; the main effect of the electrode points is significant; the interaction edge between sports levels and stimulation types are significant; the interaction between sports levels and electrode points are significant; the interaction between stimulation types and electrode points is significant. The interaction of sports levels, stimulation types and electrode points is significant.

Analysis of ERP characteristics of table tennis players in the perception stage of judging serve rotation using single feature information

The results of the ERPs in this experiment show that more obvious C1 and P1 components are induced in the cerebral cortex occipital region, during the process of table tennis player's rotation determination using single feature information (hitting position of the ball). Compared with the sports major college students, the athletes have the C1 with a shorter latency and larger amplitude, and the P1with a longer latency and larger amplitude. The C1 component

is a unique component of visual evoked potentials, with the greatest amplitude on the midline or both sides of posterior part of the scalp. Its wave usually appears 40-60 ms after stimulation and reaches the peak at 80-100 ms after stimulation. It is sensitive to stimulus parameters such as contrast and spatial frequency. The present study shows that the latency of C1 component of table tennis players is shorter than those of sports major college students, and the amplitude larger. It believes that athletes has such ERP physiological characteristics due to plasticity changes in the primary visual cortex (V1) of the brain responsible for early sensory processing during long-term exercise training (Vyazovskiy *et al.*, 2007). Brain plasticity refers to the structural and functional changes that occur in the brain as a result of long-term training in professional fields. Previous studies on brain plasticity usually focus on how life experience changes the structure and function of the human brain, particularly, on whether such changes occur during the early perceptual processing. This is mainly because C1 is generally considered to reflect the initial activation of the primary visual cortex. However, these early studies failed to find the attentional regulation mechanism of C1. Recent studies have shown that C1 may be subject to internal processing (e.g., attention) adjustments. Some study reports that C1 is regulated by spatial attention, and there is also evidence that C1 is affected by emotional valence of stimulus. In other words, C1 may not be simply sensitive to the physical characteristics of the stimulus, and it is also likely to be affected by internal processing and experience formation. This study provides evidence for this hypothesis.

The P1 component caused by visual stimulus appears after C1, at 60-90ms after the stimulation and reaches the peak at 100-130ms after stimulation. Its largest peak is located at on both sides of the occipital leaf electrode. The latency of P1 varies with contrast and is sensitive to stimulus parameters. P1 is related to the direction of spatial attention and is influenced by the awakening state of the subject, but does not seem to be affected by other top-down factors. This study finds that compared with the sports major college students, the P1 component latency of table tennis players is longer and its amplitude is greater. Previous studies have revealed the electrophysiological differences between athletes and non-athletes in the processing of simple visual stimulus. For example, tennis players and rowing athletes were found to have a shorter P1 latency than non-athletes. Studies also found the differences in N145 latency and P100 amplitude between volleyball players and non-players. This study is basically consistent with the above results. Previous studies have suggested that P1 has nothing to do with the identification of target stimulus, but its identification process will inevitably affect the characteristics of P1, because the first stage of the entire cognitive process for athletes to determine table tennis serve rotation is the perception of the stimulus features. This study finds that the P1 component latency of table tennis players is longer than that of novice players, which is inconsistent with previous studies, which may be due to differences in items and stimulus characteristics. The characteristics of the P1 component of this study suggest that athletes have a greater number of activated neurons in perceiving stimulus features.

Conclusions

In this experiment, the “Oddball” paradigm is used to explore the ERP features of table tennis players in determining the serve rotation of the table tennis ball using single feature information. According to cognitive psychology, pattern recognition is the detection, discrimination and confirmation of stimulus patterns. Therefore, this process is divided into two stages, perception and recognition, for discussion. During the process of table tennis athletes determining the rotation of the ball using single feature information, more significant C1 and P1 components are induced in the cerebral cortex occipital area, significant N1 component is induced in central area and P3 component is induced in frontal-central area to parietal-occipital area. The results show that: 1. In the stage of table tennis players’ perception of single feature information, the activation degree of cerebral cortex of is high, and they are very sensitive to the physical features of stimulus related to specific sports; 2. In the stage of table tennis players’ recognition of single feature information, the activation degree of cerebral cortex of is high, the recognition speed is fast, and the amount of input psychological resources is large.

References

Abernethy B. The effects of age and expertise upon perceptual skill development in a racquet sport. Research Quarterly for Exercise & Sport 1988; 59(3): 210-21.

Abernethy B, Neal RJ. Visual characteristics of clay target shooters. Journal of Science and Medicine in Sport 1999; 2(1): 1-19.

Abernethy B, Neal RJ, Koning P. Visual-perceptual and cognitive differences between ERT, intermediate, and novice snooker players. Applied Cognitive Psychology 1994; 8(3): 185-211.

Akiyama S, Nishihira S, Hatta Y, Fumoto M, Takeshi K, Shinichirou T, Masahiro S. Event-related potentials (ERPs) and long-term physical exercise. Japanese Journal of Physical Fitness and Sports Medicine 2000; 49(2): 246-76.

Allard F, Graham S, Paarsalu ME. Perception in sport: Basketball. Journal of Sport Psychology 2010; (1): 14-21.

Andrew. F Parallel coding of conjunctions in visual search. Perception & Psychophysics 1998; 60(7): 1117-27.

Marslen-Wilson W, Zwitserlood P. Accessing Spoken Words: The Importance of Word Onsets. Journal of Experimental Psychology: Human Perception and Performance 1989; 15(3): 576-85.

Vyazovskiy VV, Delogu A. The neural basis of inhibition in cognitive control. The Neuroscientist 2007; 13(3): 214-28.