



Sports Situation-Based Neural Mechanism of High-level Volleyball Players' Decision-making Behavior

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ABSTRACT

The paper studies the neural mechanism of advanced volleyball players' decision-making behavior based on sports situations. In this study, the author adopts behavioral test and to try to systematically explore the sports situation-based neural mechanism and its plasticity. The study finds that the volleyball decision-making test system can test players' decision-making behavior at different sports levels with a high validity. There is a significant difference in the decision-making behavior of players at different sports levels, and high level athletes achieve high accuracy rate and possess quick reaction. The brain gray matter volume near lateral occipital lobe responsible for visual information process in the right cerebral hemisphere and the thickness of the cerebral cortex of the high-level volleyball players and those of the ordinary are significantly different.

Key Words: Sports Situation, Movement Decision-making, Neural Mechanism

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Introduction

There are open technologies and closed technologies in sports, and most of the volleyball technologies can be divided into these two types. Closed technology mainly depends on the players' internal adjustment technology, and it is a coordinated independent performance in an appropriate exercise sequence. Serving a hook-float can be classified as closed technology because the success of a serve depends entirely on the athletes' individual ability (Folstein *et al.*, 2008). Open technology also depends on the external adjustment factor. Blocking is an open technology because successful blocking depends on the attacker's spike speed, the spiked volleyball, the blocking players' take-off and his adjustment ability. The player's blocking behavior is consistent with the arrival of volleyball (Charlton, 1966). At the same time, the sports field also provides a great opportunity for research on decision making. Among the research topics on

sports decision-making, there are many different decision-making behaviors can be studied in the sports situation, such as decision-makers, coaches, referees and team members' decision-making behavior. The athlete's decision-making behavior on task ball distribution, attack, defense and so on, and the decision-making on technology to be adopted in the pre-game, mid-game and timeout in the game provide researchers with a large number of opportunities to test many interesting decision-making researches. The sports process contains rich sports situations. Therefore, it is very important to study the sports decision-making in sports situations. In the sports situation, the players in the game can, based on task information or the changing clues, consider when to make decisions on the distance to the defense player, the player's hit rate, etc. The player should decide to select a player to pass the ball with the goal to win scores.

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Researchers often use physical indicators such as ERPs and EMGs to measure the effect of representational training and the electromechanical delays in response when they try to describe psychological phenomena in sports. Physiological indicators and physiological mechanisms are two important aspects that sports psychology must undertake to study certain important issues (Aichouni *et al.*, 2015). The combination of the three main factors including sports, psychology and physiology may bring many new discoveries to sports psychology. After cognitive science and cognitive psychology, a new science has come to the fore, namely cognitive neuroscience. With the rapid development of high and new technologies, cognitive psychology has widely applied the event-related potential (ERP) to study the relationship between human cognitive function and the brain. This new technology makes it possible for humans to more directly observe in the corresponding structure and function changes appearing in the brain during various cognitive activities (Harle *et al.*, 2011). It can be expected that in the coming decades, the research in cognitive neuroscience may become one of the most powerful research directions in cognitive science. At present, research in the field of sports has already discussed in this aspect, where the physiological indicators used mainly includes ERPs, EMGs, galvanic skin figures, heart rate and blood pressure to monitor the effects of psychological skills training. Obviously, there are more deep issues in the sports field waiting for researchers to develop.

This study applies the magnetic resonance brain imaging analysis method and provides new methods and means for the study of volleyball player's sports decision-making from the perspective of cognitive neuroscience. It also provides a new perspective and a new view for the further study of the volleyball player's sports decision-making. The study is an in-depth and exploratory attempt in the magnetic resonance brain imaging analysis method and it is hoped that some research results will be applied to training practice and serve the practice of sports psychological training.

Methods

In recent decades, there has been little progress in the study of the first route and that of the third route. Nowadays, the most significant contribution of cognitive neuroscience should be

the development of brain imaging technology. The advantage of brain imaging technology is that we can observe the human brain in a real-time, non-invasive manner performing certain cognitive functions (Orgs *et al.*, 2008). A large number of experiments on humans and animals have shown that the function of the brain is modular. The cerebral cortex can be divided into many small functional areas, and each area participates in certain specific functional processes. However, every cognitive function is achieved in one or more specific areas (Loze *et al.*, 2001). The development and maturation of brain imaging technology has made it possible for researchers to directly observe changes in brain activity when the tested subject completes a specific task.

The subjects of the study included three major groups including sports elite level volleyball players, national volleyball players and ordinary college students, with 15 men and 15 women in each group. In order to deeply study the high-level volleyball player's decision-making behavior and neural mechanism, this research adopts a variety of research methods and conducts a comprehensive research with the experimental method being the core, including the method of documentation, investigation & interview method, experimental research method, Software production method, software testing method and mathematical statistics method.

Through referring to relevant data on cognitive psychology, sports psychology, cognitive neuroscience and motor skills learning, the author learns about the research dynamics and development of information processing and cognitive fields in cognitive psychology in recent decades, as well as the new research progress of magnetic resonance technology in cognitive nerves science.

Results and discussion

Brain neural mechanism of blocking decision-making behavior

This experiment tests the blocking decision-making behaviors of subjects at different sports level, and the test results are shown in Table 1.

The average accuracy rate is an indicator that reflects the accuracy of the decision. This study tests the subjects of different genders and sports levels. The test results are shown in the table. There is not much difference in the accuracy rate of decision-making between male and female test subjects, indicating that the blocking decisions accuracy of male and that of female are

nearly the same. The blocking decisions accuracy of different sports level test subjects is different, and the accuracy rate for the expert-level subject is the highest, indicating that the accuracy of expert group decision making was best, and the decision-making accuracy of subjects at intermediate level is good and the accuracy of the primary level is the lowest. This study develops a statistical analysis of the multivariate variance on the accuracy of blocking decisions as shown in Table 2.

Table 1. Blocking decision behavior test weft fruit

Groups	Gender	n	Correct rate	Response time ms
Expert level	Man	15	76.30±6.87	1063.78±150.53
	woman	15	76.30±6.11	1199.55±162.15
Intermediate level	Man	15	68.89±6.98	1303.68±215.67
	woman	15	68.52±8.38	1204.39±198.31

Table 2. Analysis of the variance of the accuracy of blocking decisions

Source of variation	sum of square	df	Mean square	F	P
Sports level	25235.314	2	12617.657	220.676	.000
gender	3.099	1	3.099	.054	.816
Product of the two	14.393	2	7.179	.126	.882

Table 2 shows that among the three factors studied, the main effect of sports level is significant, the main effect of gender is not significant, and the inconsistency of sports level and gender is not significant. The estimated marginal mean of the blocking decisions accuracy is shown in Figure 1.

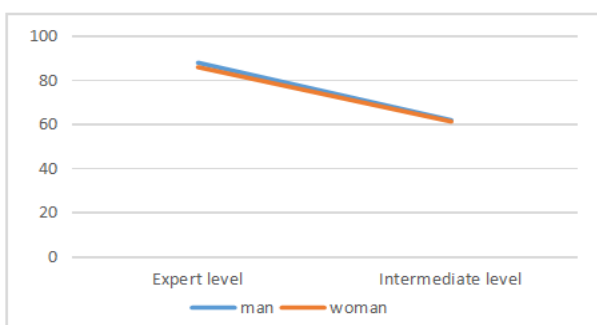


Figure 1. Blocking decision accuracy rate to estimate marginal mean

Figure 1 shows that the blocking decisions accuracy increases significantly with the increase of sports level, which indicates that the higher the sports level is, the higher the decision accuracy will be. The results of variance analysis show that the sports level is the main factor affecting the decision-making correctness of the subjects.

The results of multiple comparisons among different sports levels show that the difference between experts and primary level is significant in terms of correctness, the difference between expert and intermediate levels is significant, and the difference between intermediate and primary level is also significant. This result supports the hypothesis of this study. The research shows that the expert-level volleyball players' block decision-making accuracy takes obvious advantages. It not only has a highly significant difference from the primary level, but also has a highly significant difference from the intermediate level. It shows the trend that the decision-making accuracy is improved with the increase of sports level. The higher the sports level is, the higher the blocking decisions accuracy will be.

At the same time, it can be seen from the blocking decision-making strategies of different sports level subjects that the primary participants can not grasp the main clues in blocking decision-making, and their attention is scattered. Therefore, it can be inferred that they may have less experience and special knowledge in volleyball. In the memory of the primary subjects, the memory capacity is relatively large and disordered and they don't concern the major information, affecting the primary participants' information processing accuracy and speed (Di-Russo *et al.*, 2002). Experts in the processing blocking decision-making information show high speed and accuracy. Intermediate level subjects are between the two, and they can grasp some of the major clues, their attention scope is also relatively concentrated, and they possess certain special knowledge. Therefore, their decision-making information processing speed and accuracy is higher than those of the primary level and lower than those of the expert level.

Athlete's brain nerve in sports decision-making

See Table 3 for the test results of the athletes' and ordinary people's blocking decision behavior.

As shown in Figure 2, when the ball is touched, the blocking decision accuracy rate of the group of athletes is 67.22% and their response time is 1233.84ms; the blocking decision accuracy rate of the group of ordinary people is 36.95% and their response time is 1391.43ms. After the ball is touched, the blocking decision accuracy rate of the group of athletes was 77.22% and their response time was 938.88ms; the blocking



accurate rate of the group of ordinary people was 58.33%, and the response time was 1279.02ms.

Table 3. Blocking decision behavior test results

Groups	n	Touch accuracy	Correct rate after touching the ball
Athlete	20	67.22±8.09	77.22±8.34
Ordinary people	20	36.95±10.12	58.33±13.37

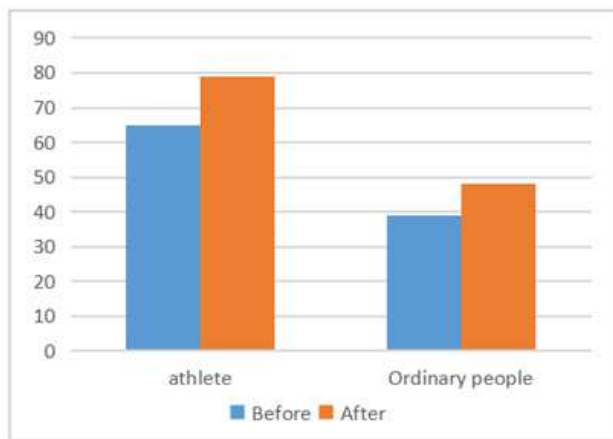


Figure 2. The accuracy of the basketball before and after the player touches the ball

This study makes a one-way ANOVA of the blocking accuracy rate and response time under the two conditions. The results shows that the block decision accuracy rate under the condition of “touch the ball” is $[F(1,39)=28.775, P<0.01]$ and the blocking decision-making response time is $[F(1,39)=13.038, P<0.01]$. There was a significant difference in both the block decision accuracy rate and the response time under this condition, and the blocking decision accuracy rate under the “after touching the ball” condition is $[F(1,39)=102.218, P<0.01]$ and block decision-making reaction time is $[F(1,39) = 4.265, P<0.05]$, and they show significant differences in this condition.

The brain regions activated by athletes during the blocking decision task are mainly the mass activation and local activation centers (Vine *et al.*, 2010), and in which the mass activation is mainly located in the center of the athlete's right brain. The results of magnetic resonance imaging of athletes and ordinary people in blocking tasks are shown in Figure 3. There is a significant difference in brain activation between the athletes group and the ordinary people group on some brain regions. There is a significant difference in the activation brain area between the athletes group and the ordinary person group, and the main difference is in the occipital and occipital fusiform gyri areas which is activated in the

ordinary people group but not activated in the athletes group. The study shows that the ordinary people group requires more brain-function activities to process visual information during the blocking decision-making task, while the athlete group uses less brain-function activities for visual information processing.

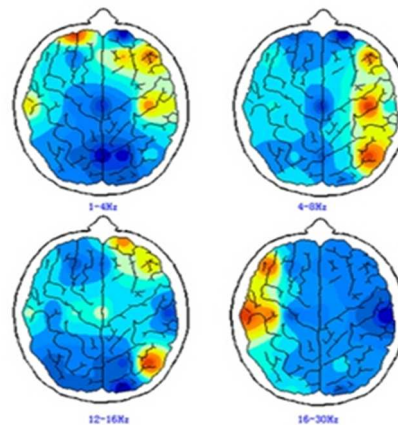


Figure 3. Normal human brain activation diagram during the block decision task

Conclusion and outlook

Decision-making test results show that there is a significant difference in the level of decision-making among subjects at different sports levels. The decision-making test results show that the decision making accuracy of expert athletes is significantly higher than that of the intermediate-level athletes, and also significantly higher than that of the primary level. On the decision-making speed, expert athletes also possess obvious advantages. There is certain difference in the speed of decision-making compared with the primary level. This shows that expert athletes have obvious advantages in sports decision-making behavior, which verifies the hypothesis of decision-making behavior in this study.

The study found that in the athletes group the cerebral cortex on the lateral occipital lobe responsible for the visual central system is significantly thicker and the volume of gray matter significantly increases. The functional imaging studies results have confirmed that individuals can experience changes in the brain structure after taking a certain training. Obviously, it is training that leads to this result. The main brain area where the difference occurred is the lateral occipital area of the occipital lobe responsible for visual processing. Ordinary people need more brain function

activities to perform visual information processing when they complete blocking decision tasks, while athletes use less brain function activities to process visual information processing. Therefore, the athlete's neural efficiency is economical.

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