Relationship between Athletes' Mental State and Brain Coordination before Competitions

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ABSTRACT

The aim of the paper is to find suitable ways to reflect the changes of athletes' mental state before competition. Athletes were selected as subjects, and the subjects were statistically analyzed. The results show that although the coordination level of both the left and the right brain declines, the synergistic fluctuations of the left frontal lobe and the right frontal lobe are different. This suggests that under the external stress condition, the left and right parts of the frontal lobe are more stable. According to the comparison of the good group and the general group, the conclusion is that the coordination level of the good group was lower than that of the general group one week before and after the game, but before the game, the coordination level of the left and right brain of the athletes in the good group was always higher than that of the general group.

Key Words: Athletes, Pre-competition Psychology, Brain Coordination

Introduction

Mental state is an exploratory title put forward by some psychologists after in-depth study and repeated reflection on a series of psychological phenomena. In reality, people's psychological activities are not as simple as theoretical understanding. Psychological activity at a time often includes various psychological processes, and often changes under the influence of personality. They are far more complex than psychological processes in terms of composition, but not as stable as personality in time dimension. This kind of psychological phenomenon is the Moreira et al., 2002). Psychological state refers to the existence of all human mental activities. It is not only the manifestation of psychological process and personal psychological characteristics, but also the middle link of the transformation of psychological process to personality (Babloyantz et al., 1988). Without mental state, many mental activities of human beings cannot be carried out (Bellido et al., 2003). Therefore, it is common in all fields of all human psychological activities including education, medical, judicial, sports, literature and art, and is most obvious in competition.

The mental state of the athletes in the competition is directly related to the success of the sports performance. The higher the level of the sports competition is, the greater the influence of the psychological state on the performance (Brown et al., 2004). Sports psychology can be divided into various kinds, among which pre-competition psychological state is the most important. Numerous facts on the Olympic Games show that, whether in a personal event or a collective event, a physical event or a skill event, the pre-competition psychological state is the key for the athlete to obtain excellent sports performance. It has been a major concern...
of athletes in failing the competition, thus drawing attention from senior athletes, coaches, and sports officials (David et al., 2003). From the material basis, any mental activity is the function of the nervous system, especially the function of the brain. All mental activities of human beings are the reflection of the brain on objective reality. Therefore, the pre-competition mental state can be seen as a reflection of a variety of comprehensive information on the competition situation and the body environment of the previous brain. It is the result of the synergistic activity of the cerebral cortex and subcortical nerve center. The formation of the pre-competition psychological state is the activity of the whole organism's internal organs and effectors, in which the neural processes and biochemical processes join together to achieve the integration of the nervous system on multiple levels (Lin et al., 2003). If the internal or the external environment changes, pre-competition mental state as well as the activity of the central nervous system will change accordingly.

Since the occurrence of pre-competition psychological state has its profound neurophysiological basis, pre-competition mental state of athletes have characteristics corresponding to its central activity (Lin et al., 2003). From the perspective of physiological psychology, it is possible to study the changing rule of mental state before competition. Therefore, it is necessary to first review and analyze existed researches on pre-competition mental state to get some enlightenment. Based on the above factors, this study used SET as the research means to detect the neurotransmitter activity of 20 elite swimmers one week, one day, and three points before the game, so as to understand the relationship between the mental state of the athletes and the brain coordination. At the same time, the pre-competition mental state questionnaire was used, and the physical activity records of one day before the game and the coaches’ evaluation were combined. The athletes were divided into groups according to their mental states, and the athletes who had good pre-competition mental state were tested one week, one day and three time points after the game (Parfitt et al., 1993).

### Methods

#### Subjects

According to the results of the consultation, 22 athletes (11 men and 11 women) were selected, of which 1 male athlete and 1 female athlete did not participate in the post-game test for some reason. Therefore, only 20 subjects were analyzed statistically. Before the formal experiment, the subjects were asked to provide the latest physical health examination records in one year, mainly to check the brain and other diseases that may affect electroencephalography; the subjects were banned from drugs and excitatory drinks within 24 hours before the experiment; hair-wash is required on the day before the test so that to guarantee the experiment will not be affected. The basic information of the subjects is shown in Table 1.

<table>
<thead>
<tr>
<th>Gender</th>
<th>The number of</th>
<th>Age</th>
<th>Professional number of years</th>
<th>Righthand number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>10</td>
<td>22.8±2.66</td>
<td>13.3±3.92</td>
<td>10</td>
</tr>
<tr>
<td>Women</td>
<td>10</td>
<td>19.7±1.70</td>
<td>12.6±2.99</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Experimental design

The results of this experiment involve two parts: neurotransmitter parameters and brain synergy parameters. The neurotransmitter parameters include the average neurotransmitter data of the whole brain and the neurotransmitter data of 12 brain regions. The neurotransmitters in each brain region are INH, 5-HT, ACh, DA, NE and EXE respectively. Brain synergy parameters include the coordination parameters of each region, attractor correlation coefficient and the number of interconnected brain regions. Figure 1 shows brain topographic maps of the distribution and the name of the brain region.

![Figure 1. 12 brain topographic maps of the distribution and name of the brain region](image)

Note: F3 and F4 are left and right frontal lobe; C3 and C4 are left and right central regions; P3 and P4 are left and right parietal lobe; O1 and O2 are left and right occipital leaves; T5 and T6 are left and right anterior temporal lobes; T5 and T6 are left and right posterior temporal leaves.

#### Experimental procedure

The brain wave super slow fluctuation was tested 3 times, each of the test time lasted for 35 minutes. The time of brain wave super slow...
fluctuation of each subject was 105 minutes, and the test time of 20 subjects was 35 hours in total. The test time is one week before the game, one day before the game and 24 hours after the game. The first test was carried out a week before the race, and the oral instruction was given before each test. The average time of the test was 35 minutes per person. The electrode wear time was about 15 minutes. The time to record the basic information of the subjects was about 3 minutes, and the official record time was 17 minutes. Second tests are carried out a day before the game. The competition events and time of the competition are taken into consideration to ensure that each subject took the second test within 24 hours before the competition, and the test time is as told above.

The third test time is scheduled within 24 hours after the game. Since each participant participated at least one competition. Therefore, the third test should be carried out after the athlete’s last competition. During each test, the tester should observe the whole process in order to distinguish pseudo waves and eliminate accidents. After the competition, the psychological state of the subjects before the competition was evaluated by the review questionnaire before the game, and the coaches' evaluation form was combined to carry out comprehensive evaluation. According to the evaluation results, the athletes (good-state group and general-state group) were divided into two groups.

According to the results of retrospective surveys and coaches' comprehensive evaluation, the subjects were divided into good-state group and general-state group, the basic information of which is shown in Table 2:

<table>
<thead>
<tr>
<th>Group</th>
<th>The number of</th>
<th>Age</th>
<th>Professional number of years</th>
<th>Right hand number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good state</td>
<td>10</td>
<td>21.6±3.06</td>
<td>13.3±4.24</td>
<td>9</td>
</tr>
<tr>
<td>State of</td>
<td>10</td>
<td>20.9±2.38</td>
<td>12.6±2.50</td>
<td>10</td>
</tr>
</tbody>
</table>

The age and training years of the two groups were statistically recorded, and the results showed no significant difference. The differences in age and training years between the good-state group and the general-state group were not significant, which indicates that there is no interaction between the mind state and the age as well as training years.

Results and discussion

Factors affecting the state of brain function

The effect of competition on brain cooperative activity: brain activity contains complex neurophysiological mechanisms. Only the basic mental functions associated with simple perception and movement are located in a single cortical area while more complex intellectual functions are the result of a number of functional parts interacting with each other, which means tasks can only be successfully completed on the basis of the synergistic activities of various parts of the brain. Therefore, the overall coordination of the brain, especially the coordinated activities in various brain regions, is of great significance.

Swimmers showed a decrease in the overall coordination level of the brain one day before the competition. The reason is related to the imminent occurrence of the event. From the point of view of system theory, brain activity constantly produces dominant fluctuations with the effect of order parameter. They play a dominant role in other oscillatory components according to the "dominant principle", and constantly change from one order parameter to another order parameter, in order to achieve diverse changes in brain function. In the normal state, the brain can be regarded as a self-organizing system, which constantly exchanges material and information with external substances to form a very complex nonlinear interaction. Competition stress can be regarded as an external input parameter, which changes the coordination of the whole neural network of the brain and forms a new ordered structure under new conditions. However, compared with the previous structure, the entropy value increases, and the whole neural network is reduced in order, resulting in the decrease of the overall brain synergy level.

Although the coordination level of the left and right coordination pairs decreased, there was little synergetic fluctuation between the left frontal lobe and the right frontal lobe. This suggests that under the external stress condition, the left and right synergy of frontal lobes is relatively stable. Frontal lobe, also known as the neocortex, is the latest-evolution brain region. Therefore, frontal lobe is also closely related to the advanced functions of the brain. It involves many complex psychological activities. The fluctuation in the frontal lobes was small one day before the race may indicate that the synergy of
the frontal lobes is not easily affected by external stress activities, and is related to some stable and more advanced intellectual activities. Figure 2 is a brain synergetic schematic diagram.

Figure 2. Brain synergetic schematic diagram

**Analysis of representative case**

Regular spatial configuration changes occurred in the region 5-HT, ACh and DA of the cortical center one day before the competition. In the personal test results report, researchers found that some athletes had very typical changes in the brain's central transmitters one day before the competition. A team member was selected respectively from the good-state group and the general group to be analyzed.

Member of good-state group: the test results showed that the distribution of the 3 kinds of transmitters highly coincides with that of the good psychological state before the competition. The details are shown in the following Figure 3:

Figure 3. State good group specific conditions

Member of the general-state group: the test results show that the distribution of the 3 kinds of transmitters highly one day before the game coincides with that of the good psychological state before the competition. The details are shown in the following Figure 4:

Figure 4. The general state of the state group

**Conclusions and prospects**

According to the comparison between the good group and the general group, the coordination level of the good-state group was lower than that of the general-state group before and after the game, but short before the game, the coordination of the right and left brain in the good-state group was higher than that of the general-state group. The higher coordination level of the left and right brain in the good-state group shot before the competition reflects the rational distribution and balance of the brain cortex excitatory process and the inhibition process of the members in good-state group. The results may also indicate that the left and right coordination level of the brain of the good-state group does not appear at normal situation, and the potential synergy is activated before the competition, which results in the coordination between the positioning capabilities of the left brain and the right brain, such as cognition and emotion, in the special stress situation of the competition. As for sports training, this synergy is the result of the adaptability of the members of the good-state group reflected by the temporary neural connection of the cerebral cortex during long-term exercise. This change in the member of the general-state group shows that the temporary neural connection has not been established or failed to be established in daily training. The decline of coordination level before competition is a reflection of the disorder of brain self-organization activity under the condition of competition stress.

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