Brain Science and Physical Education-to Promote Harmonious Development of Students with Combination of Left and Right Brain in Physical Education

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ABSTRACT

This article expounds the current positive relationship between brain science and sports in many aspects. Proper aerobic training can optimize the brain structure, improve the brain function, and enhance the concentration and execution ability of the students, and ultimately to promote the development of the learning ability of the brain. Based on the rope skipping exercise experiment, this paper verifies the contralateral control of the brain to limb movement, and probes into the importance of the simultaneous participation of the left and right brain in sports to improve the coordinated development of the students. To a certain extent, the research results of this paper provide evidence for the positive relationship between brain science and limb movement, and emphasize the importance of the coordination of the right and left limbs in sports training for the coordinated development of students.

Key Words: Left and Right Brain, Physical Education, Level of Emotional Cognition, EEG

DOI Number: 10.14704/nq.2018.16.5.1298 **NeuroQuantology 2018; 16(5):146-152**

Introduction

As people's cognition of the world is more diversified, the brain, as the most advanced and complex organ of human beings, attracts more and more researchers' interest in its operating mechanism and cognitive principle. The complex structure and function of the brain constantly emphasize its importance to students' thinking ability, learning ability and physical function (Mestre, 2001). Different from the study of theoretical knowledge which is excessively dependent unilaterally on brain function, sports education and brain structure function can improve each other. As the control center of the movement of the limbs, the brain can send out commands in the form of EEG, and the coordination and control of the limbs depend on the complexity of the structure and function of the brain. At the same time, proper physical training can provide sufficient oxygen supply to the brain through the improvement of cardiopulmonary function, which helps to keep the main functional areas of the brain in a more active state (Gil-Perez *et al*., 1990). Therefore, applying the theoretical basis of brain science to physical education teaching practice can not only promote the development of students' health, but also benefit the exploitation of their brain potential.

Physical education plays an important role in the modern education system, which not only promotes the healthy development of

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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: 14 March 2018; **Accepted:** 4 April 2018

students' body shape, but also plays an active role in improving the mental health of adolescents. In the student's age that covers almost all of the important periods for human growth and development, proper physical training can enhance the ability of bones to withstand stress and promote height growth. At the same time, it can also improves muscle growth, so that limbs can be more dynamic and shape more symmetric, thus to avoid obesity in adolescents. In addition, scientific physical training has an improved effect on many basic activities such as strength, speed, stamina, flexibility, flexility and coordination (Keogh *et al*., 1998).

As the effect of physical education on students' physical and mental health has been recognized by more and more educators, many exploratory researches on physical education with practical significance has been carried out in an orderly manner, among which the influence of brain science on physical education has become a hot topic for the front-line educational practitioners. The brain science theory related to human physical activity is applied to guide students' sports training, arouse students' enthusiasm for sports training through more scientific and interesting sports course design, and to help them to develop scientific exercise habits that they can benefit from for life.

Currently Brain Science Research Outcome About Physical Education

The results of brain science researches in recent decades show that sport can improve the structure and function of students' brains, and enhance their attention and execution abilities. These positive impact runs through the entire life process of an individual. The present research results of brain science not only provide theoretical basis for physical education to promote the development of students' physical and mental health, but also provide thoughts for the in-depth development of brain through scientific physical education. Physical education aims at promoting the development of physical and mental health of students by guiding them into physical activities based on sports. Therefore, physical education, as an important part of modern education, has the same important status as other disciplines. Diagram about How Aerobic Exercise Influence Brain Activity as shown in figure 1.

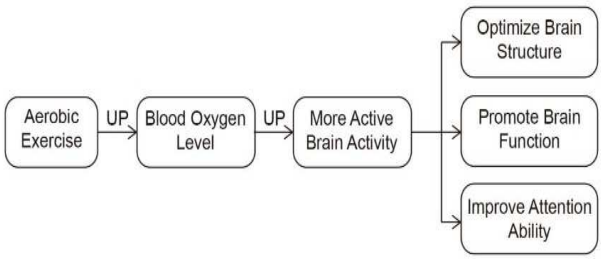

Figure 1. Diagram about How Aerobic Exercise Influence Brain Activity

Sports optimizes the brain structure of students

The learning process is a process of memorization and accumulation of experience of the brain. As a dynamic and complex system, the brain coordinates various body movements, while its structure and functional level are also influenced by physical activities (McDermott *et al.,* 2000). As learning processes, experience accumulation, and other external factors change, the brain may have structural changes or functional reorganizations that have a positive impact. The study has found that the dorsal striatum, which is associated with cognitive ability, is prone to structural changes under higher frequencies of aerobic training. The brain striatum of students with high aerobic fitness is generally larger and has a higher cognitive control ability. At the same time, the memory-related hippocampus is also more prominent among students with better aerobic fitness. Aerobic training enhances students' cardiopulmonary function by increasing oxygen content in the blood per single breath, and adequate oxygen provides energy to the various activities of the brain and helps maintain the cells involved in cognitive memory or related activities in an active state.

Sports improves students' brain function

Functional improvements in the brain mainly include changes in the activation level of the relevant brain regions and changes in brain function network ties. Students with higher aerobic fitness have a better cognitive level not only because they have a larger dorsal striatum, but also because of their higher activation rates in the prefrontal and parietal regions. Relevant experiments show that long-term and fixed aerobic training can reduce the activation rate of bilateral posterior parietal lobe, but raise the activity level of bilateral prefrontal lobe. In addition, a single short-term moderate-intensity aerobic training could also improve the activation level of some brain, and the activation level of

bilateral superior frontal gyrus, bilateral middle frontal gyrus and other brain areas rise significantly before and after training.

Sports enhances students' concentration

Concentration refers to the ability of the brain to work effectively when receiving external information to accomplish cognitive tasks. Frequent and regular participation in long-term sports plays an important role in improving the students' deficiency in attention, and is also beneficial for the students with normal attention level. At the same time, short-term aerobic exercise also has a positive effect on the improvement of attention, in which about 30 minutes of moderate-intensity aerobic training is the best. After moderate-intensity aerobic training, the efficiency and accuracy of students' cognition of external information are obviously improved due to the improvement of attention. The theoretical mechanism lies in that aerobic exercise can induce the changes in brain activity pattern.

The Relationship Between Body Movement and Left/Right Side Brain

Contralateral characteristics of the brain in its control of the limbs

Since the 1960s, the mainstream views on the division of brain functions are based on the contralateral theory of the left and right hemispheres, that is, the left hemisphere controls right-sided physical activities, while the right hemisphere controls left-sided physical activity. The idea dates back to observation of a patient with motor aphasia by Paul Broca, a French neurologist and anthropologist in 1861 (Springer and Deutsch, 1998). The left anterior brain injury was the main cause of the patient's loss of speech function. Thus it was speculated that the language function area was located only in the left hemisphere. However, the experiment only pointed out the possibility of hemispheric features of brain function region, but failed to specify the corresponding functions. In 1961, Sperry, an American neurophysiologist, verified the semi-brain characteristics of brain function through the famous "Split Brain Experiment" and pointed out the different division of labor between the left and right brain. According to the observation of the atient with split-brain, he could accurately described the stimulation information received by the right eye, while he could only give response to the information received by the left eye, suggesting that the left and right hemispheres think in a completely different way (Du *et al*., 2017; Du *et al*., 2018). The left brain is better at handling linguistic information, accepting information through reading, memory and writing, while the right brain, being more sensitive in thinking, is an area for discernment of artistic perception such as music, art and space, and is also better at perception of abstract information, such as images, colors, and geometry.

Difficulties facing physical education at present

For most people, there is a significant difference in the flexibility of the left and right hands, and most people are right handed, which means, the left brain signals and receives stimuli more frequently in daily life. In view of the status quo of education in China at the present stage, the heavy academic burden has compressed the exercise time that is inadequate itself, and students cannot afford to put down the study pressure to dedicate themselves to physical education, which is a major challenge facing physical education. Physical education shall focus on guiding students' interest and teaching scientific sporting methods. The cause of dislike physical exercise and the attitude of physical exercise as shown in figure 2 and figure 3.

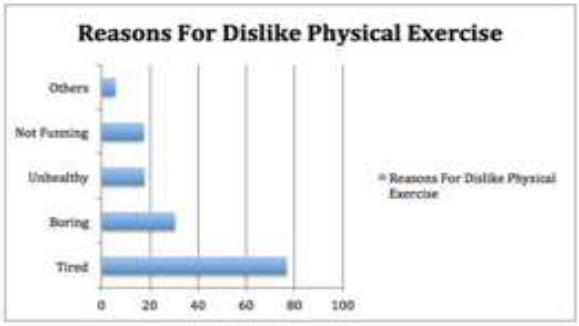

Figure 2. The Survey Outcome Of Reasons For Dislike Physical Exercise

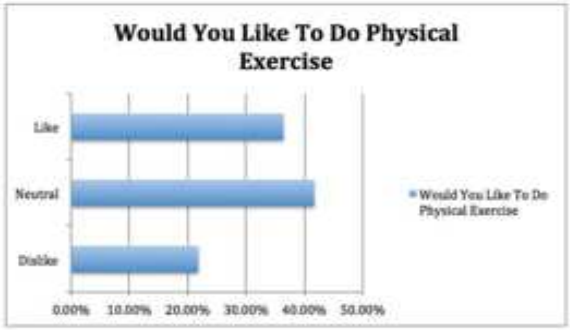

Figure 3. The Survey Outcome Of Attitude Toward Physical Exercise

In addition, logical thinking and language expression shall be emphasized in both liberal arts and sciences. What's more, whether the mechanical recitation of examination-oriented education or the understanding and memory of quality-oriented education, are all closely related to the activity of the left hemisphere of the brain. The accumulation of knowledge is surely important, but the cultivation of creativity associated with right brain activity cannot be ignored either. Physical education plays an important role in improving the overall coordinated development of the brain.

Effects of rope skipping on left and right brain activities

A group of 10 junior middle school students with similar physical conditions are divided into two groups to participate in the rope skipping experiment, in order to verify the contralateral characteristics of the brain's control of the limb movement and explore the effects of sports on the activity of left and right hemispheres of the brain. By adjusting the rope-skipping posture of the participants, the left and right limbs can participate in exercise to varying degrees, and the EEG energy generated can be used as an important index to evaluate the brain activity. The equipment for collecting EEG signals is UE-16B machine manufactured by Symtop, and the electrodes are placed in line with the international 10-20 standard system (Redish, 2004). Since the purpose of this experiment is to verify the hemispheric characteristics of limb movements, the focus lies in monitoring the EEG at both C3 and C4 electrodes related to left and right limb movements.

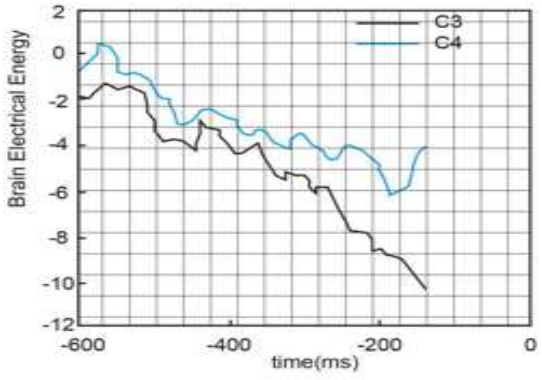

Figure 4. The Brain Electrical Energy when left foot rope skipping

(1) Single left/right foot rope skipping

The first group of students are asked to skip the rope with only the left foot, while the second group of students with only the right foot. During the experiment, the interference of other limb movements should be minimized except for the movements necessary for rope skipping. The experimental results as shown in figure 4 and figure 5.

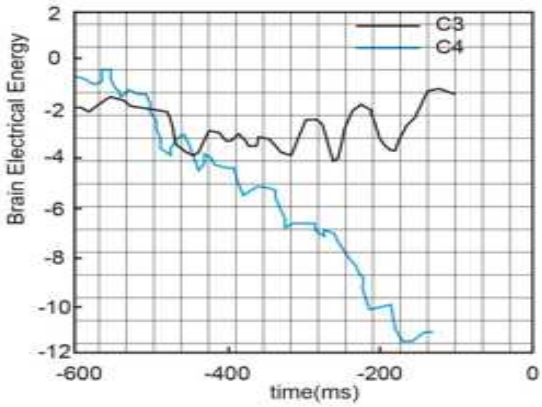

Figure 5. The Brain Electrical Energy when right foot rope skipping

From the above EEG energy diagram, it can be seen that the fluctuations of the left hemisphere EEG energy monitored by C3 electrode and the right hemisphere EEG energy monitored by C4 electrode decrease after the jumping action whether it with the left single foot or with the right one. In particular, when that left foot skips the rope, the energy of the brain detected by the C3 electrode decreases more rapidly, indicating that the left brain area near it is not active enough, which indirectly confirmed that the left foot skipping can keep the right cerebral hemisphere in a more active state. In contrast, the energy of the left brain is higher and decreases more slowly when the right foot skips the rope. The unilateral foot skipping test can verify the theory of the brain's influence on limb movement.

(2) Two-feet rope skipping simultaneously/ successively

With a view to further verifying the different effects of left and right hemispheres on limb motion, and to explore the coordination between left and right hemispheres during exercise with high body coordination requirements, the first group of students are asked to skip the rope with both feet jumping at the same time, while the second group of students to skip the rope with one foot switching to another to observe the frequency and trend of the

EEG changes monitored at the C3 and C4 electrodes. The experimental results as shown in figure 6 and figure 7.

For the students with both feet skipping at the same time, both the energy of left hemisphere EEG monitored by C3 or that of right hemisphere EEG monitored by C4 electrode are at a higher level, and the fluctuations are consistent. For the students who jump ropes with one foot switching to another, the left and right cerebral EEG energy fluctuations have obvious periodicity, and the peak troughs of EEG energy of the left and right cerebral hemispheres are interlaced. Despite that, the lowest value of EEG energy of left and right cerebral hemispheres of the students skipping with one foot switching to another is higher than that of the students skipping with one single foot, suggesting that coordinated movement of the left and right limbs helps to maintain the brain in a more active state.

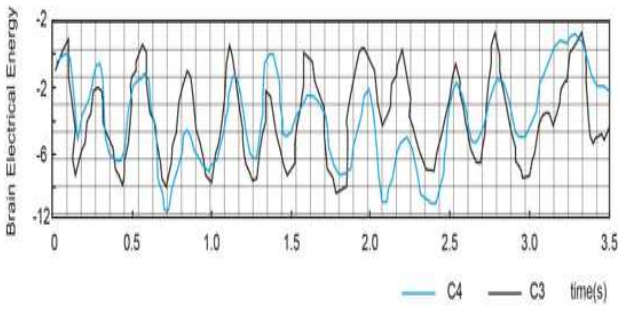

Figure 6. The Brain Electrical Energy when both foot together rope skipping

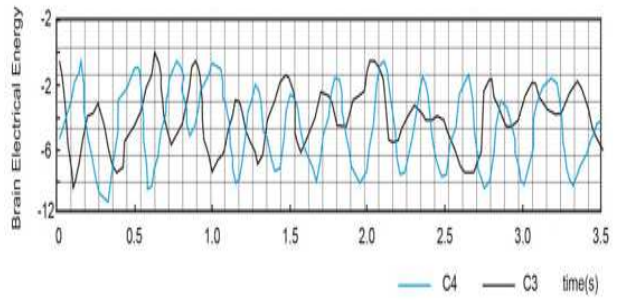

Figure 7. The Brain Electrical Energy when both foot cross rope skipping

Both Side Body Training to Balance the Development Between Left/Right Side Brain

Despite the obvious contralateral characteristics of the brain's control of limb movement, adding that under the influence of the traditional educational model, the activity of the left hemisphere is much higher than that of the right hemisphere, the left limb training aiming to reduce the unbalanced development of the left and right hemispheres shall not be encouraged. Compared with making up for the inflexibility of left limbs, the simultaneous movement of bilateral limbs is more helpful to promote the harmonious development of students (Leonard *et al.,* 1999). According to the above experimental results, the simultaneous training of bilateral limbs can not only stimulate the left and right brain equally, but also can help to keep both sides of brain in a more active state compared to the movement of unilateral limbs.

In the practice of physical education, the training of bilateral limbs should be performed in accordance with the students' actual physical conditions, mental state and the facilities and sites that can be provided by the school. Bi-lateral limb training can be based on two ways, one is to use sports equipment as teaching aids, and the other is to enhance interactivity. According to the relevant policies and regulations, schools at all levels should be equipped with at least one standard track and field and related sports equipment such as football, basketball, badminton and volleyball (Stein, 2001).

The proper application of sports equipment on class can raise the fun in training and help students to coordinate the right and left sides equally. In addition, game settings involving many people can enhance the interactivity of sports, and the fun that playmates bring in the game can keep students in a good level of emotional cognition, which is essential to maintain the activity of the brain. The following table 1 is a list of bi-lateral limb training programs developed in accordance with the approaches mentioned above.

Table 1. Name List of Both Side Body Training Activity

Project Name	Sport Equipment	Interactivity
Both Hand Cross Bunch The Ball (in situ)	Yes	No
Both Hand Cross Bunch The Ball (relay)	Yes	Yes
Both Foot Cross Rope Skipping	Yes	No
Both Foot Together Rope Skipping	Yes	No
Both Foot Cross Kick The Ball (in pair)	Yes	Yes
Both Foot Cross Kick The Ball (relay)	Yes	Yes
Setting-up Exercise	No	No
Relay Running	No	Yes

The curriculum of physical education has the characteristics of a close connection between physical training and thinking activity training, thus scientific teaching methods are needed in the hope of achieving the multi-dimensional goal of coordinated development students' physical and mental health through physical education. Therefore, physical education should change the traditional training mode of simple imitation and mechanical repetition, but to carry out more scientific bilateral limb training by applying sports equipment and setting interactive games, so as to promote the harmonious development of students through the training of the left and right brain.

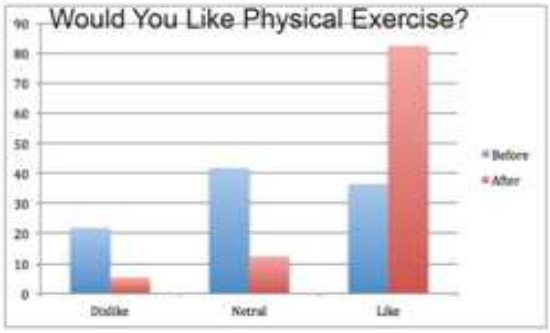

Figure 8. The Survey Outcome of Attitude Towards Physical Exercise Before And After Training

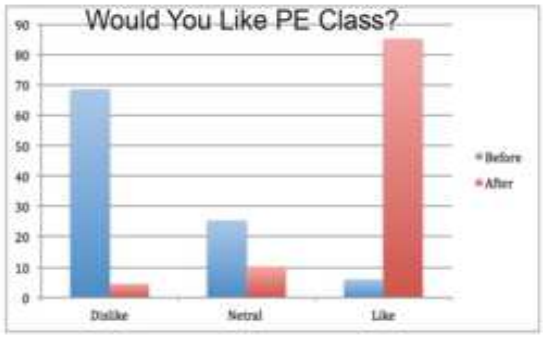

Figure 9. The Survey Outcome of Attitude Towards PE Class Before And After Training

With the scientific arrangement of sports training in PE teaching class and the introduction of auxiliary equipment and setting of the interactive games, the fun of the PE class have significantly raised, the students' enthusiasm for sports class is enhanced, and their attitude towards sports training has gradually changed. The following bar chart shows the surveys of the same group of students' preference for sports and PE class before and after regular bi-lateral limb training. The results show that the students are fond of the physical education class, and their positive attitude has also extended to the daily physical training, which can help the students to develop good sports habits and enable them to grow up in a healthy and harmonious way. (Dufresne *et al.,* 2002). The change of students' attitude towards physical education class and physical exercise is not only due to the scientificity of the simultaneous training of both limbs, but also due to the intervention of sports equipment and the increasing interactivity, which enables the students to exercise healthily in a pleasant atmosphere. The Survey Outcome of Attitude Towards Physical Exercise Before And After Training as shown in figure 8, The Survey Outcome of Attitude Towards PE Class Before And After Training as shown in figure 9.

Conclusions

According to the present research results of brain science, there is a bidirectional relationship and benign interaction between brain and limb movement. The improvement of brain structure and function can enhance the reactivity and coordination of the body, and proper aerobic training can promote the healthy development of the brain in return. The above rope skipping experiment has verified the ability of the left and right cerebral hemispheres to control the contralateral body, that is, the left side of the brain controls the movement of the right side limb, while the left side of the body movement is determined by the right side of the brain. Since the traditional discipline education emphasizes the training of logic thinking and memory ability, the left side brain is more active, and there still exists imbalanced development between left and right cerebral hemispheres. However, limb movement is not entirely controlled by the half-side brain. Strengthening the left side exercise to activate the right side of the brain will split the left and right brain cooperation, thus has a negative impact on the coordination of the student's body. PE teaching shall put emphasis on the simultaneous training of both limbs and better mobilize the enthusiasm of students in participating teaching activities through the appropriate application of sports equipment and design of interactive games. Thus it is very important to involve the left and right brain simultaneously in bilateral limb training so as to improve the students'' PE teaching achievement and promote their coordinated development.

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