

An Experimental Study on the Improvement of Attention by Badminton Training in Secondary School Students

Tong Guan, Ke Zhou*

School of Sports Science, Henan University, 475000, Kaifeng, Henan, China

**Corresponding author*

Keywords: Badminton Training; Attention; Secondary School Students; Intervention

Abstract: This study investigates the impact of an 8-week badminton training intervention on attention levels among secondary school students. Sixty seventh-grade students from a secondary school in China were randomly selected and divided into an experimental group and a control group. The experimental group participated in 8 weeks of after-school badminton practice sessions, while the control group followed their routine. The results indicated no significant difference in attention transfer between the two groups ($p > 0.05$). However, significant improvements were observed in attention span ($p < 0.05$), with highly significant improvements in attention stability ($p < 0.01$) and attention allocation ($p < 0.01$). These findings suggest that badminton training can effectively enhance attention levels in secondary school students. Future research should explore the long-term effects and underlying mechanisms of badminton training in this population.

1. Introduction

Attention is a complex interwoven mental activity mode, which encourages people to accept new knowledge and new things. To a certain extent, they promote each other and spiralize with individual cognition and emotional development [15] (Posner & Petersen, 1990). The field of cognitive psychology generally accepts and recognizes the view that “attention is the beginning of all learning” [2] (Casey et al., 2005). Attention plays an important role in the memorization of knowledge symbols and the internalization of life experience [4] (Deroche, 2021). It runs through the whole stage of individual cognition from low to high order [22] (Yang, 1981). Previous studies have shown that good attention can significantly improve people's learning efficiency, such as the acquisition of a second language [16] (Raz & Buhle, 2006). At the same time, good attention can also significantly inhibit people's anomalies, such as anxiety, depression, and other bad emotions and aggressive behavior [12] (Muris et al., 2007). It can also effectively promote the formation of an individual's social network [21] (Vitale et al., 2005).

Attention can be divided into two types: intentional attention and unintentional attention [18] (Seli et al., 2019). Attention of individuals in the early childhood stage has few preset attention objects and also lack the will and persistence to participate in psychological activities [1] (Barkley et al., 2002). Attention in the early childhood stage is often limited by individual interests and belongs to the category of unintentional attention [3] (Chan et al., 2012). In the other category, intentional attention is gradually reflected in childhood of individual development and plays a dominant role in the

development of adolescents in secondary school [6] (Gestsdottir & Lerner, 2008); With the process of individual physiological development, the attention level of adolescents also increases and tends to remain stable in a certain state [5] (Diamond & Lee, 2011). One of the notable features is that adolescents' attention to the object gradually changes from passive to active, that is, from unintentional attention to intentional attention, and this stage is a sensitive period for the development of intentional attention [8] (Johnson & Proctor, 2004). In this stage, the stability of intentional attention is enhanced, the breadth is expanded, and the ability of attention control makes students better adapt to the subject learning [7] (Hale, 2012). On the contrary, if students' attention is not effectively developed, they will not be able to interact efficiently and stably with the external environment, which is not only not conducive to their experience acquisition, but also affects the cognition and understanding of knowledge in the learning field, and over time, it will affect the comprehensive development of students [10] (Lodge & Harrison, 2019).

It is worth noting that, the attention level of Chinese adolescents is not optimistic [23] (Yuan et al., 2015). According to the National Adolescent Attention Survey (2016), 40% of primary and secondary school students in China do not pay attention in class, and 60% of primary and secondary school students do not pay attention continuously in class, which leads to low learning efficiency, poor learning effect, and even reduce students' interest in learning or tired of learning and other serious problems (see Ma, 2016). In addition, the World Health Organization has surveyed children's attention development problems, and the results show that more than half of the children's attention problems will be alleviated with physiological development, but there are still a considerable number of children with attention problems (about 40%) slow recovery, and even this part of children's attention problems may even be lifelong (WHO, 2017). As mentioned above, attention problems are important facilitators of an individual's overall development, and attention can (positively or negatively) affect a child's future ability to work and interact socially [9] (Langevin et al., 2023). Because secondary school students are in the golden period of attention development, at the same time, with the increase of their grades, the curriculum knowledge is also more and more, whether they can concentrate well will directly affect the process and effect of classroom learning, more intuitively reflects that is, their grasp and digestion of knowledge, information efficiency and speed will ultimately affect their academic performance [17] (Roberts et al., 2015). In addition, human development is inseparable from the interaction between the individual and the external environment, and attention will also affect students' social learning efficiency outside the campus. It can be seen that good attention has a profound impact on the study and life of individuals.

Through literature review, it was found that although the current intervention measures for adolescent attention development have become increasingly mature, such as instrument training and box and court training, these interventions are not easy to be widely implemented due to expensive equipment, or time-consuming and labor-consuming, and have intervention effects but no intervention efficiency [19] (Tang et al., 2007). Since perceptual integration training using sports have been getting more and more attention by practitioners and researchers, it could be an effective strategy for helping the adolescents to enhance their attention development. Some studies have shown that sports such as Wushu, basketball, Rumba dance, and other sports can promote the development of adolescents' attention. However, there are few studies on sport-related exercise [14,20] (Tomprowski et al., 2011, Pontifex et al., 2013). This study is based on the discussion of the intervention effect of sport-related exercise on adolescent attention, to provide a practical basis for the intervention of badminton-related exercise on attention.

Badminton is a kind of net confrontation sport. Its offensive and defensive characteristics and the application of movement technology are in line with the law of adolescents' physical and psychological development, and it is one of the excellent sports to promote their physical and mental health. In the hitting round of badminton, the technical movements are diverse and the combination

of techniques is ever-changing, which increases the fun of badminton [11] (Manrique & González-Badillo, 2003). In the badminton batting round, students must pay high attention, track the arc, falling point, rotation, and other trajectories of the badminton ball, use their footsteps to move, adjust the hitting position and the Angle of the racket face, and make reasonable judgments and decisions [13] (Phomsoupha & Laffaye, 2015). In addition, the open nature of badminton itself helps students explore the application and change of techniques and tactics in the process of learning and practicing, which is conducive to maintaining students sustained and stable attention in the process of learning and practicing.

2. Method

In this study, the seventh-grade students of a secondary school were selected as the experimental subjects, and 60 students were randomly divided into the experimental group and the control group using the computer-generated randomization method (www.randomization.org). The experimental group was given badminton practice intervention after class for 8 weeks, while the control group resumed their normal routine and was not given any intervention. Before the experiment, the “attention test table” was used as the students' self-investigation report tool, and the data were collected and processed accordingly. After the experiment, the two groups completed the “attention test table” again as a post-test under the same condition, and the data were analyzed accordingly.

2.1 Participants

In this study, the 60 seventh-grade students of a secondary school in China participated. They were randomly divided into two research conditions: experimental group and control group. Among them, 30 students were assigned as the experimental group and the other 30 students were assigned as the control group. There were 12 male students in the intervention group, accounting for 42.5%, and 18 female students, accounting for 57.5%. Aged between 12 and 14 years.

2.2 Measures

The attention test was selected from the Attention Test prepared by Yin Hengchan et al [24]. (Yin et al., 2004).

The test content and schedule are shown in Table 1, and the time interval between tests is determined to avoid the influence of fatigue.

Table 1 Test content and time

Name of the Scale	Objective of measurement	Time of operation
Test 1 Concept Formation Test (Pattern Discrimination Test)	Allocation of attention	3 minutes
Test 2 Attention Span Test (choose four circles)	Span of attention	3 minutes
Test 3 Attention Stability Test (Visual tracking)	Stability of Attention	2 minutes
Test 4 Attention Shift Test (Addition and subtraction test)	Shift of Attention	3 minutes

During the test, all participants were explained the requirements of the test, and they were led by the researchers to perform the testing. After all the participants understood the meaning of the questions, then, the formal test was carried out. The time should be strictly controlled according to the requirements, using the computer system, and the time was also controlled by the computer

program to ensure accuracy and consistency.

2.3 Procedure

Before the experiment, the attention of students in the experimental class and the control class was tested (pre-test), and the data were sorted out. After communicating with the school leaders and educational administrators, the after-school teaching plan for the experimental class and the control group was implemented. The intervention lasted for a period of eight weeks, three times a week (Monday, Wednesday, and Thursday) for badminton practice after school. The duration of the intervention was 60 minutes. Following the after-school badminton practice intervention of the experimental class, the attention of the experimental class and the control class were again evaluated, and the measurements were the same as those before the experiment.

2.4 Data Analysis

Statistical software IBM SPSS 27.0 was used to analyze the collected data. The data were checked for normality and were analyzed by ANCOVA, and the differences between the experimental group and the control group before and after the experiment were tested by comparison means and independent sample *t*-test.

3. Result

3.1 Analysis of pretest results

Before the experimental intervention, the attention test form was distributed to both the experimental and control groups, and the collected data were statistically analyzed to determine whether there was a difference in attention level between the two groups prior to the experiment.

An Independent sample *t*-test was used to test and analyze whether there were differences in the four attention indicators between the experimental group and the control group before the experiment. The results of the data analysis are shown in Table 2.

Table 2 Comparative analysis of attention level measurement results before the experiment

	Grouping	N	M	t-test	p-value
Diversion of attention	Experimental group	30	44.83 \pm 19.805	- 316.	0.753
	Control group	30	46.03 \pm 13.522		
Span of attention	Experimental group	30	56.13 \pm 8.259	812.	0.419
	Control group	30	54.60 \pm 8.545		
Stability of attention	Experimental group	30	9.13 \pm 1.539	726.	0.470
	Control group	30	8.88 \pm 1.539		
Distribution of attention	Experimental group	30	14.03 \pm 4.111	- 584.	0.561
	Control group	30	14.60 \pm 4.673		

As shown in Table 2, the attention measurement results of the experimental group and the control group before the experiment showed that although the attention index scores of the experimental group and the control group were different, For example, the score of attention transfer (44.83 \pm 19.805) in the experimental group was lower than that in the control group (46.03 \pm 13.522), attention span (56.13 \pm 8.259) was higher than that in the control group (54.60 \pm 8.545), attention stability (9.13 \pm 1.539) was higher than that in the control group (8.88 \pm 1.539), the score of attention distribution was 14.03 \pm 4.111 was lower than that of the control group (14.60 \pm 4.673), after difference analysis, Before the experiment, there were no significant differences in attention transfer,

attention span, attention stability, and attention distribution between the two research conditions (all $p > 0.05$). Therefore, it can be shown that the grouping of the experimental group and the control group in this experiment is reasonable and comparable.

3.2 Analysis of post-test results

After eight weeks of experimental intervention, the experimental group and the control group were given the same attention test again, and the collected data were statistically processed to test whether there was any difference in the attention level of the experimental group and the control group after the experimental intervention, and the attention level of the experimental group and the control group before and after the experiment. The specific results were analyzed as follows.

Comparative analysis of attention level measurement.

By testing and analyzing whether there are differences in the four indicators of attention of students in the experimental group and the control group after the experiment, the results of data analysis are shown in Table 3.

Table 3 Comparative analysis of the measurement results of attention level between the experimental group and the control group after the experiment

	Grouping	N	M	<i>t</i> -test	<i>p</i> -value
Diversion of attention	Experimental group	30	51.30 ± 13.086	1.783	0.079
	Control group	30	46.45 ± 11.170		
Attention span	Experimental group	30	63.78 ± 9.986	3.107**	0.003
	Control group	30	57.13 ± 9.140		
Stability of attention	Experimental group	30	13.95 ± 3.250	6.413***	0.0001
	Control group	30	10.00 ± 2.148		
Distribution of attention	Experimental group	30	20.60 ± 4.181	6.326***	0.0001
	Control group	30	15.10 ± 3.572		

As shown in Table 3, the measurement results of attention of the experimental group and the control group after the experiment showed that there was a significant difference in the scores of attention indicators between the experimental group and the control group for attention span, stability of attention and distribution of attention ($p < 0.05$). The attention span score was 63.78 ± 9.986 in the experimental group and 57.13 ± 9.140 in the control group. The score of attention stability was 13.95 ± 3.250 in the experimental group and 10.00 ± 2.148 in the control group. The score of attention allocation was 20.60 ± 4.181 in the experimental group and 15.10 ± 3.572 in the control group. Therefore, except for diversion of attention, the other factors of attention levels of the experimental group was significantly improved after the experimental intervention.

Comparison and analysis of the measurement results of the attention level of the experimental group before and after the experiment

Through testing and analyzing whether there are differences in the four indicators of attention of the experimental group students before and after the experiment, the results of data analysis are shown in Table 4.

As shown in Table 4, the measurement results of attention in the experimental group before and after the experiment showed that the score of attention index of the students before the experiment was significantly lower than that after the experiment. The score of attention transfer was 44.83 ± 19.805 before the experiment and 51.30 ± 13.086 after the experiment. The attention span score was 56.13 ± 8.259 before the experiment and 63.78 ± 9.986 after the experiment. The score of attention stability was 9.13 ± 1.539 before the experiment and 13.95 ± 3.250 after the experiment. The score of attention distribution was 14.03 ± 4.111 before the experiment and 20.60 ± 4.181 after the

experiment. The difference analysis showed that there were significant differences in attention transfer ($P<0.05$), attention span ($P<0.01$), attention stability ($P<0.001$), and attention distribution ($P<0.001$) before and after the experiment in the experimental group. According to the data, the attention level of the experimental group was significantly improved after the intervention.

Table 4 Comparison and analysis of the measurement results of the attention level of the experimental group before and after the experiment

	Grouping	N	M	<i>t</i> -test	<i>p</i> -value
Diversion of attention	Before the experiment	30	44.83 \pm 19.805	2.113	041.
	After the experiment	30	51.30 \pm 13.086		
Attention span	Before the experiment	30	56.13 \pm 8.259	3.925	000.
	After the experiment	30	63.78 \pm 9.986		
Stability of attention	Before the experiment	30	9.13 \pm 1.539	9.236	000.
	After the experiment	30	13.95 \pm 3.250		
Distribution of attention	Before the experiment	30	14.03 \pm 4.111	7.925	000.
	After the experiment	30	20.60 \pm 4.181		

3.3 Comparative analysis of the measurement results of the attention level of the control group before and after the experiment

By analyzing whether there are differences in the four indicators of attention of students in the control group before and after the experiment, the results of data analysis are shown in Table 5.

Table 5 Comparative analysis of measurements of attention level in the control group before and after the experiment

	Grouping	N	M	<i>t</i> -test	<i>p</i> -value
Diversion of attention	Before the experiment	30	46.03 \pm 13.522	- 376.	784.
	After the experiment	30	46.45 \pm 11.170		
Attention span	Before the experiment	30	54.60 \pm 8.545	673.	674.
	After the experiment	30	57.13 \pm 9.140		
Stability of attention	Before the experiment	30	8.88 \pm 1.539	1.676	083.
	After the experiment	30	10.00 \pm 2.148		
Distribution of attention	Before the experiment	30	14.60 \pm 4.673	1.487	433.
	After the experiment	30	15.10 \pm 3.572		

It can be seen from Table 5 that the scores of the attention index of the control group before and after the experiment were different. The score of attention shift was 46.45 \pm 11.170, and that before the experiment was 46.03 \pm 13.522. The scores of attention span (57.13 \pm 9.140), attention stability (10.00 \pm 2.148), and attention distribution (15.10 \pm 3.572) were not significantly different from those before the experiment (54.60 \pm 8.545, 8.88 \pm 1.539 and 14.60 \pm 4.673, respectively). The difference analysis showed that there was no significant difference in attention transfer ($P>0.05$), attention span ($P>0.05$), attention stability ($P>0.05$), and attention distribution ($P>0.05$) before and after the experiment in the control group. Therefore, the attention level of the control group without intervention was not improved in this experiment.

4. Discussion

After 8 weeks of after-school badminton practice three times a week, the attention level was measured before and after the course intervention to compare the difference in attention level between

the experimental group who increased badminton practice after class and the control group who did not. The results showed that the attention level of the experimental group was improved to a certain extent after a period of after-class badminton practice. The inter-group significance test showed that the attention gap between the two groups of secondary school students changed from no significant difference before the experiment to a significant difference, and the intra-group significance test showed that the overall attention level of the experimental group before and after the experiment was significantly different. There was no significant difference in the control group, indicating that the improvement in attention level in the experimental group was significantly higher than that in the control group.

4.1 Analysis of the influence of badminton practice on attention allocation of secondary school students

Attention allocation is essentially different from attention distraction. Attention allocation is the ability of people to successfully allocate their attention to more than two kinds of objects or activities at the same time. Individuals can adjust their attention direction according to their needs in a specific spatiotemporal environment. The proficiency of attention allocation determines the success of attention allocation. That is to say, when an individual carries out two or more activities at the same time, there must be only one activity that is unfamiliar and needs to be focused on, and other activities can be completed if they are extremely skilled and need to pay attention to the edge. The long-term increase of badminton practice can effectively stimulate the activation and control of the central nervous system of secondary school students, the neural pathway is more unimpeded, and the overall function of the brain is mentioned. In this experiment, some exercises related to attention distribution were designed to improve the level of attention distribution of secondary school students, such as: (1) bouncing the ball around the marker pole: Based on the student's familiarity with bouncing the ball, four or five marker buckets were placed vertically on the badminton court, and each student walked around the marker buckets around the word "eight" while bouncing the ball; (2) Badminton service techniques include forehand serving and forehand serving in front of the net. There is a strong consistency between the two in action. The former is mostly used for the opponent standing in the back, while the latter is mostly used for the opponent standing in the front. After mastering THE forehand serving and forehand serving, students should observe the opponent's position and center of gravity on the court while doing the serving action, to choose a reasonable service way before hitting the ball.

Of course, the test before and after the experiment showed that the improvement of attention allocation in the two groups of students after the experiment was not particularly significant, suggesting that the improvement of attention allocation may need a long time of intervention to get good results.

4.2 Analysis of the influence of Badminton practice on the attention span of secondary school students

Attention span refers to the range of attention. In short, it is the number of things that individuals can observe in a moment when they pay attention to something. Of course, there must be individual differences in attention span, for example, children's attention span is generally smaller than that of adults. It should be pointed out that with the increase in children's age and the scientific and reasonable exercise of their consciousness, children's attention span will be further improved. In badminton teaching, students' nervous mood is relaxed, and their attention span should be improved when they face the technical movements to be learned again after a temporary rest. In this experimental intervention, the exercises for improving students' attention span are designed as

follows:

(1) The "attacking the middle" strategy in badminton doubles strategy means that when the other side is standing on the left and right sides in the defensive state, we should try our best to attack the ball into the middle space between the two sides. When teachers guide students to learn the tactics of "attacking the middle", they need to emphasize that when they get the opportunity to attack, they should not only pay attention to the flight trajectory of the ball but also take into account the standing space of the opposing player.

(2) When learning the service-receiving technique in doubles, the receiving side should not only pay attention to the service movement of the opponent's front-court player but also observe the position of the opponent's back court player. If the opponent's back court player's position is close to the forehand area, it can use the push technique to hit the ball to the backhand area.

4.3 Analysis of the influence of badminton practice on the attention stability of secondary school students

Attention stability refers to the ability of individuals to stably devote their attention to an activity or object within a specific time. At present, attention stability has gradually attracted the attention of domestic experts and scholars, and the research related to attention stability is gradually enriched. Many research results show that attention stability is an important factor affecting individual learning effect and directly determines the quality of learning. This study conducted an 8-week campus badminton experiment on secondary school students. After the experiment, the experimental group had a significant improvement in attention stability compared with the control group. The main reason may be that increasing badminton practice can actively activate the central nervous system of secondary school students participating in work (badminton and learning). And rapidly, deeply, and extensively inhibit the central nervous system that does not participate in work. For example, in the practice of hitting the high ball or picking the ball in place, the teacher needs to throw the ball to the students' batting position at the same Angle and speed, and the students need to focus on the ball so that the ball is hit at a fixed position; In the practice of high ball, pick the ball and other movements that need to use the front racket face to hit the ball, students will generally occur the phenomenon of "cut racket", that is, using the oblique racket face to hit the ball, affecting the batting effect. Therefore, teachers need to repeatedly emphasize the Angle between the racket and the incoming ball in the teaching process, and remind students to focus on the racket's face at the moment of hitting the ball. The experimental results show that increasing badminton practice can effectively promote the development of attention stability of secondary school students, and can effectively improve the attention stability time of secondary school students, to create a good condition for improving the quality of campus badminton teaching.

4.4 Analysis of the influence of badminton practice on attention transfer of secondary school students

Attention transfer refers to the ability of individuals to purposefully and actively transfer their attention from one activity or object to other activities or objects. Attention shifting and attention focusing are two important states in daily life. Students need to rely on these two states to live and study. They pay attention to listening to lectures in class and transfer their attention to the next course after class, relying on attention and focusing on learning. Improving the ability of attention transfer and concentration can improve the learning effect of students with half the effort. The results of this experiment show that the improvement degree of attention shifting ability of the experimental group with increased badminton practice is higher than that of the control group, but there is no significant difference. The comparison between the experimental group and the control group shows that the

improved degree of attention shifting ability of secondary school students with increased badminton practice is effective. Due to the close connection between the hitting technique and the footwork in badminton, fast and reasonable movement is the important foundation to ensure the stability of the hitting action, so in this badminton intervention practice, students should first master the hitting high and long ball, then learn the backward step method, and finally combine the backward step method with hitting the high and long ball to form a complete technical combination. The quick connection of these two movements can effectively promote the transfer of students' attention; In the transition of attack and defense in badminton doubles, if one side starts a high ball, it should use a parallel standing position and lower the body's center of gravity to defend, and the other side should use front and rear standing position to "kill after before blocking" attack. In a doubles match, both players are always in the transition of attack and defense, this practice can also improve the efficiency of attention transfer.

In conclusion, in this badminton intervention experiment, many exercises are designed pertinently, which can effectively improve students' attention level based on meeting students' practice needs and improving students' interest in learning and practicing. Through analysis and discussion, it is shown that badminton related exercises or sports intervention can effectively improve students' attention levels.

5. Conclusion

Increasing badminton practice after class is conducive to improving students' physical fitness and attention level. Therefore, schools should attach importance to the development of badminton and various sports activities, and integrate sports with other disciplines. Based on acknowledging the differences between disciplines, schools should constantly break the boundaries of disciplines, promote mutual penetration and cross activities between disciplines, help students learn better, and finally achieve the purpose of comprehensive training of students. Parents should actively cooperate with schools to promote the family-school-community linkage mechanism, integrate all resources, and build a broader platform for the growth of students. Teachers should try to get rid of the traditional boring method of learning and practicing. The cognition of secondary school students is not yet mature, and they often show a strong desire for things they are interested in and reject things they don't like. Because of this situation, teachers should design situational teaching or students' favorite games when teaching badminton, follow the teaching principle of "game + competition", and integrate practice into games and competitions. In addition, when choosing teaching content, teachers need to take into account the content of the course and the status of students in class, mobilize the enthusiasm of students in the form of games and mobilize the competitiveness of students in the form of competitions. For example, multi-ball practice, bouncing the ball around the sign pole, etc.

References

- [1] Barkley, R. A., Fischer, M., Smallish, L., & Fletcher, K. (2002). The persistence of attention-deficit/hyperactivity disorder into young adulthood as a function of reporting source and definition of disorder. *Journal of Abnormal Psychology*, 111(2), 279–289. <https://doi.org/10.1037/0021-843X.111.2.279>
- [2] Casey, B., Tottenham, N., Liston, C., & Durston, S. (2005). Imaging the developing brain: What have we learned about cognitive development? *Trends in Cognitive Sciences*, 9(3), 104–110. <https://doi.org/10.1016/j.tics.2005.01.011>
- [3] Chan, W. M., Chin, K. N., Bhatt, S., & Walker, I. (2012). *Perspectives on Individual Characteristics and Foreign Language Education*. Walter de Gruyter.
- [4] Deroche, M.-H. (2021). Mindful wisdom: The path integrating memory, judgment, and attention. *Asian Philosophy*, 31(1), 19–32. <https://doi.org/10.1080/09552367.2021.1875610>
- [5] Diamond, A., & Lee, K. (2011). Interventions Shown to Aid Executive Function Development in Children 4 to 12 Years Old. *Science*, 333(6045), 959–964. <https://doi.org/10.1126/science.1204529>
- [6] Gestsdottir, S., & Lerner, R. M. (2008). *Positive Development in Adolescence: The Development and Role of*

- Intentional Self-Regulation. *Human Development*, 51(3), 202–224. <https://doi.org/10.1159/000135757>
- [7] Hale, G. (2012). *Attention and Cognitive Development*. Springer Science & Business Media.
- [8] Johnson, A., & Proctor, R. W. (2004). *Attention: Theory and Practice*. SAGE.
- [9] Langevin, R., Marshall, C., Wallace, A., Gagné M.-E., Kingsland, E., & Temcheff, C. (2023). Disentangling the Associations Between Attention Deficit Hyperactivity Disorder and Child Sexual Abuse: A Systematic Review. *Trauma, Violence, & Abuse*, 24(2), 369–389. <https://doi.org/10.1177/15248380211030234>
- [10] Lodge, J. M., & Harrison, W. J. (2019). The Role of Attention in Learning in the Digital Age. *The Yale Journal of Biology and Medicine*, 92(1), 21–28.
- [11] Manrique, D. C., & González-Badillo, J. J. (2003). Analysis of the characteristics of competitive badminton. *British Journal of Sports Medicine*, 37(1), 62–66. <https://doi.org/10.1136/bjsm.37.1.62>
- [12] Muris, P., Meesters, C., & Rompelberg, L. (2007). Attention control in middle childhood: Relations to psychopathological symptoms and threat perception distortions. *Behaviour Research and Therapy*, 45(5), 997–1010. <https://doi.org/10.1016/j.brat.2006.07.010>
- [13] Phomsoupha, M., & Laffaye, G. (2015). The Science of Badminton: Game Characteristics, Anthropometry, Physiology, Visual Fitness and Biomechanics. *Sports Medicine*, 45(4), 473–495. <https://doi.org/10.1007/s40279-014-0287-2>
- [14] Pontifex, M. B., Saliba, B. J., Raine, L. B., Picchietti, D. L., & Hillman, C. H. (2013). Exercise Improves Behavioral, Neurocognitive, and Scholastic Performance in Children with Attention-Deficit/Hyperactivity Disorder. *The Journal of Pediatrics*, 162(3), 543–551. <https://doi.org/10.1016/j.jpeds.2012.08.036>
- [15] Posner, M. I., & Petersen, S. E. (1990). The Attention System of the Human Brain. *Annual Review of Neuroscience*, 13(1), 25–42. <https://doi.org/10.1146/annurev.ne.13.030190.000325>
- [16] Raz, A., & Buhle, J. (2006). Typologies of attentional networks. *Nature Reviews Neuroscience*, 7(5), Article 5. <https://doi.org/10.1038/nrn1903>
- [17] Roberts, G., Rane, S., Fall, A.-M., Denton, C. A., Fletcher, J. M., & Vaughn, S. (2015). The Impact of Intensive Reading Intervention on Level of Attention in Middle School Students. *Journal of Clinical Child & Adolescent Psychology*, 44(6), 942–953. <https://doi.org/10.1080/15374416.2014.913251>
- [18] Seli, P., Schacter, D. L., Risko, E. F., & Smilek, D. (2019). Increasing participant motivation reduces rates of intentional and unintentional mind wandering. *Psychological Research*, 83(5), 1057–1069. <https://doi.org/10.1007/s00426-017-0914-2>
- [19] Tang, Y.-Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., Yu, Q., Sui, D., Rothbart, M. K., Fan, M., & Posner, M. I. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences*, 104(43), 17152–17156. <https://doi.org/10.1073/pnas.0707678104>
- [20] Tomporowski, P. D., Lambourne, K., & Okumura, M. S. (2011). Physical activity interventions and children's mental function: An introduction and overview. *Preventive Medicine*, 52, S3–S9. <https://doi.org/10.1016/j.ypmed.2011.01.028>
- [21] Vitale, J. E., Newman, J. P., Bates, J. E., Goodnight, J., Dodge, K. A., & Pettit, G. S. (2005). Deficient Behavioral Inhibition and Anomalous Selective Attention in a Community Sample of Adolescents with Psychopathic Traits and Low-Anxiety Traits. *Journal of Abnormal Child Psychology*, 33(4), 461–470.
- [22] Yang Qing.(1981). psychology [M]. Jilin: Jilin People's Press, 12-16.
- [23] Yin Hengchan. (2003). Study of attention test and evaluation indicators in adolescents [J]. *China Sports Science and Technology*, 39 (3): 51-53.
- [24] Zhenguo Yuan, Zhongjing Huang, Jingjuan Li, Jing Zhang. (2021) Report on Chinese Adolescence's Development of Social and Emotional Skills[J]. *Journal of East China Normal University (Educational Sciences)*, 39(9): 1-32.