Effect of functional motor training on sensory integration ability of children

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Abstract: This paper aims to explore the effect of functional motor training on children's sensory integration ability. From March to June 2023, 27 children aged 3-6 with SID were selected from a kindergarten and randomly divided into control group (n = 14) and experimental group (n = 13). The experimental group received functional motor training for 30 min each time, 3 times a week for 16 weeks. The control group continued with the usual activity schedule. Before and after the experiment, vestibular dysfunction, tactile defense and proprioceptive dysregulation in the children's sensory integration development rating scale were used to evaluate. After intervention, the improvement of SID in the experimental group was better than that in the control group ($P < 0.05$). There were no significant differences in vestibular dysfunction, tactile defense and proprioceptive dysregulation scores before and after intervention in control group ($P > 0.05$). After intervention, the scores of the experimental group were significantly improved ($P < 0.01$), and significantly higher than that of the control group ($P < 0.01$). The above results show that functional motor training can effectively improve children's vestibular dysfunction, tactile defense and proprioceptive dysfunction.

1. Introduction

Sensory integration theory is a set of theories first put forward systematically in 1972 by Ayres, an American psychologist, based on his research on brain function [1]. Sensory integration disorder (SID) mainly refers to vestibular balance, tactile defense, proprioception, and visual, auditory, and language disorders [2]. After children's sensory integration disorder, the external sensory stimulation signals cannot be effectively combined in the child's brain and nervous system, and the body cannot coordinate the operation [3]. Over time, various diseases form and eventually affect the physical and mental health of young children. Children's sensory integration disorder means that children's brains lose the ability to control and combine various organs of the body, which will weaken their cognitive ability and adaptability to varying degrees, thus delaying their socialization process [4].

Functional training originated in the field of medical rehabilitation in the United States, which is for the injured athletes to restore their health and athletic level, competitive ability and return to the game. In recent years, the theory has achieved remarkable results in sports rehabilitation, competitive sports, public fitness, physical training, school sports and other fields. Functional training has a more significant effect on teenagers. Song Shiling pointed out that functional training can significantly improve the high and low shoulder problems of grade students[5]. Liang Tian found that functional training can improve the physical fitness of 8-9 year old students, promote physical health, improve body quality, improve body function, and improve the overall physical state [6]. Liu Tao et al. found that functional training has a significant promoting effect on the attention level of 3 to 4 years old children [7]. Gu Ying et al. concluded that functional training can significantly improve the motor index scores of children aged 3 to 6, and can significantly improve the motor development level of children [8]. Zhang Diluo pointed out that the functional training program designed according to the law of physical and mental development of children and the characteristics of physiological structure conforms to the law of children's development and development, and the functional training program designed from the perspective of gross movement can effectively improve children's basic movement ability, improve physique and promote healthy development [9]. He Jianlong et al. concluded that

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functional training can significantly improve the development of children's gross motor ability, and its effect is higher than that of the original kindergarten activity curriculum [10]. The above is part of the literature on the application of functional training in children. Through these previous studies, it can be seen that children's functional training has a strong promoting effect on the improvement of posture, concentration of attention, movement development and other aspects, which shows the feasibility and practicability of functional training theory applied to children.

This study intends to analyze the changes of children's sensory integration ability by means of functional motor training and rehabilitation physical activity intervention for children with sensory integration disorder, using horizontal and vertical comparison methods.

2. Data and methods

2.1 General information

From March to June 2023, parents of children aged 3 to 6 years old in a kindergarten were investigated with the Children's Sensory Integration Development Scale. A total of 43 scales were distributed in this survey. 38 valid questionnaires were collected, with an effective recovery rate of 88.4%. Inclusion criteria: ①3~6 years old; ② Fill in through physical examination and children's sensory integration development assessment scale; (3) In line with the sensory integration disorder behavior, that is, vestibular balance dysfunction, excessive sensitivity or dullness of touch, proprioceptive disorder, visual and auditory sense of poor, poor motor coordination and so on [11]; (4) Children's sensory integration ability development rating scale standard score <40 points; ⑤ Patients and their families are informed and sign informed consent forms [12]. Exclusion criteria [11]: ① Accompanied by organ dysfunction; ② Epilepsy, severe mental disorder, bipolar disorder, conduct disorder, extensive developmental disorder, autism, Asperger's syndrome; ③ Significant limb injury or movement disorder; ④ The child had a history of severe trauma and surgery in the past six months; ⑤ Parents refuse to participate; ⑥ Impulsive behavior and damage injury behavior; ⑦ Being treated with drugs; ⑧ IQ <80.

According to the original score of the Sensory Integration Development Rating Scale and the standard score conversion scale, the conversion and statistical analysis of the original score and standard score were carried out. According to the comprehensive research needs, 27 children with SID were finally included, including 11 males and 16 females. There were 6 cases aged 3 to 4 years, 8 cases aged 4 to 5 years and 13 cases aged 5 to 6 years. The prevalence rate was 71.1%. Among them, there were 21 cases with mild vestibular dysfunction (55.3%) and 6 cases with severe dysfunction (15.8%). There were 20 cases with tactile defense (52.6%) and hyperdefense in 7 cases (18.4%). There were 17 cases with mild proprioceptive disorder (44.7%) and 10 cases with severe proprioceptive disorder (26.3%). The children were divided into control group (n = 14) and experimental group (n = 13) according to random number table method. During the whole experiment, no children quit. There were no significant differences in gender, age, height, body mass and body mass index between the two groups ($P > 0.05$). This study was approved by the Ethics Committee of a city sports College.

2.2 Methods

The children in the control group kept the same activity arrangement as before, while the children in the experimental group used the designed functional movement training game three times a week for 30 minutes each time for a total of 16 weeks. Among them, the functional motor training games are designed according to the physical motor function training mode applicable to children in the Physical Motor Function Training for Children and the development needs of children's sensory integration ability, as shown in Table 1.

Table 1 Functional movement training table

Training essential factor	Training action	Training games
Displacement motor skills	Walk: Walk around the obstacle curve, walk on the balance beam, etc	Transporting food, leeches moving, crossing the river and so on
	Running: rewinding, fast running, walking and running alternately	Through the forest, maze, fancy running, etc
	Jump: two-foot longitudinal jump, one-foot longitudinal jump, standing long jump, etc	Rabbit into town, jump rope, kangaroo home and so on
	Others: tumbling, climbing, drilling, sliding, etc	Roller wars, wheel plates, hot dog buns, mouse burrows, sushi rolls, etc
Manipulative motor skills	Stretch, bend, push, pull, toss, throw, kick, pat, catch, roll, swing, rock, etc	Ribbon dance, whack-a-mole, paper airplane, pass relay, shake and shake, spiral kick, etc

2.3 Evaluation methods

In order to scientifically and objectively measure the development of Children's Sensory Integration ability before and after the intervention practice, the Children Sensory Integration Rating Scale (CSIRS) was used as an assessment tool to assess the children participating in the practice. The scale was compiled by Zheng Xinxiong, a Taiwan scholar, based on the research results of Dr. Ayres, a foreign scholar. Later, it was introduced into the mainland and further revised by the Institute of Mental Health of Beijing Medical University. The application of the revised CSIRS in many places in China has proved that it has high reliability and validity, and can objectively reflect the development level of children's sensory integration ability. There are a total of 58 questions in this scale applicable to children in small classes, which are divided into three dimensions: vestibular function, proprioceptive function and tactile defense function. All questions are scored by likert five-level scoring method. The higher the score of children in each dimension, the better the development of children's sensory integration ability. When using this scale to assess the development of children's sensory integration ability, it should be noted that: (1) Due to the limited cognitive level of children in small classes, all questions should be filled by parents according to their children's recent performance; (2) When calculating the scores of children's sensory integration ability in each dimension, pay attention to converting the original scores of children in each dimension into standard scores according to the conversion standard provided by Beijing Medical University.

2.4 Statistical methods

SPSS 26.0 was used for statistical analysis. The measurement data were represented by ($\bar{x} \pm s$), and T-test was performed on the data before and after intervention; Chi-square test was performed for the data. Significance level $\alpha = 0.05$.

3. Results

There were no significant differences in vestibular dysfunction, tactile defense and proprioceptive dysregulation between the two groups before intervention ($P > 0.05$). After intervention, vestibular function, proprioceptive function and tactile defense function of the experimental group were greatly improved ($P < 0.05$), as shown in Table 2.

Table 2 Evaluation table of sensory integration ability of two groups of children before and after intervention

Groups	Vestibular function		Proprioceptive function		Tactile defense function	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Experimental group(n=13)	42.61±10.08	53.39±9.18	41.26±10.34	49.43±7.74	43.51±7.82	49.90±10.00
Control group(n=14)	43.20±10.47	46.75±10.10	41.45±11.10	44.46±10.27	43.16±9.45	45.81±9.86
t	-0.240	4.154	0.135	3.400	0.190	3.116
p	0.770	0.003	0.894	0.020	0.815	0.024

4. Discussion

Exercise is an effective means to prevent and improve sensory integration disorders in children, but there are few reports on the effects of different exercise prescriptions on sensory integration [13-14]. The role of functional motor training in children's sensory integration disorder is also very limited.

During the 16-week practice period, the sensory integration ability of children in both the experimental group and the control group was developed, but the results of the comparison between groups showed that the development of sensory integration ability of children in the experimental group receiving functional motor training was significantly better than that of the control group continuing the normal activity arrangement. According to the analysis, the reasons are as follows:

(1) The scores of children in the control group in the assessment of sensory integration ability after 16 weeks were higher than those before the practice, indicating that their sensory integration ability had been developed. According to the analysis, on the one hand, the individual's sensory integration ability would improve with the natural growth of age. Although this improvement was limited, it was also reflected to some extent during the 16-week practice period. On the other hand, for the control group of children who continued the normal activity arrangement, the physical activities carried out normally in accordance with the requirements of the kindergarten during the 16-week practice period could also bring certain external stimulation to children and promote the development of children's sensory integration ability. However, because these activities are relatively routine and lack targeted stimulation of children's sensory system, although they can promote the development of children's sensory integration ability, the effect of such stimulation is generally limited within 16 weeks, and correspondingly, the improvement of children's sensory integration ability within 16 weeks is also limited.

(2) After 16 weeks, the scores of sensory integration ability of children in the experimental group were higher than before the practice, and also significantly higher than that of the control group, and the improvement of sensory integration ability scores before and after the practice was also significantly greater than that of the control group. According to the analysis, this is mainly because in addition to the development of sensory integration ability brought by the natural growth of age and normal activities in kindergarten, the development of functional motor training games makes the sensory system of children get more targeted stimulation, and correspondingly the development of sensory integration ability is more ideal. For example: Aiming at the tumbling movements of the "displacement motor skills" in the functional motor training elements, the functional motor training game "Drum War" is designed. By allowing two children to drill into the drum at the same time and roll towards the center of the field from both ends, and roll back to the same place after hitting the center of the field, the children's vestibular system and tactile system can be effectively stimulated. Thus, the development of children's vestibular function and tactile defense function can promote the development of children's sensory integration ability. Therefore, the experimental group of children who were superposed with aging, normal activity stimulation and functional motor training game stimulation showed more significant and ideal development of sensory integration ability in 16-week practice, which also verified the positive role of functional motor training game in promoting the development of children's sensory integration ability.

To sum up, functional movement training games designed based on children's functional movement training elements have a positive and positive impact on the development of children's sensory integration ability. Therefore, in preschool preschool education, in order to seize the "golden period" of the development of children's sensory integration ability, conduct scientific and effective intervention in the development of children's sensory integration ability, and promote the comprehensive development of children's physical and mental health, preschool teachers can actively try to introduce the concept of functional motor training into educational activities, and combine the characteristics of children like games. Design a series of functional action training games suitable for preschool children and can stimulate children's interest in participation.

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