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EFFECTS OF MUSICOTHERAPY COMBINED WITH COGNITIVE BEHAVIORAL INTERVENTION ON THE COGNITIVE ABILITY OF CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

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SUMMARY

Background: *Attention deficit hyperactivity disorder (ADHD) mainly manifests as learning difficulties, emotional impulsiveness, excessive activities, and attention deficit disorder. Given that it can influence social communication abilities, as well as physical and psychological health and viability, ADHD rehabilitation has attracted close attention. This study aims to discuss the influences of musicotherapy combined with cognitive behavioral intervention on the cognitive ability of children with ADHD and provide some references for ADHD rehabilitation.*

Subjects and methods: *A total of 120 children with ADHD in the Cooperative Hospital of Guangzhou University from June 2018 to May 2021 were chosen as the research objects. They were divided randomly into the control and observation groups with 60 cases in each group via the observing random digital method. The control group was the blank control and did not receive any intervention. The observation group received 16 weeks of musicotherapy combined with cognitive behavioral intervention. Symptoms and the results of the numerical cross-attention test, the Wisconsin card sorting test, the combined Raven's test (CRT), the Wechsler intelligence scale for children test, and Conner's child behavioral scale for parents of the two groups before and after the intervention were compared.*

Results*: The relevant indexes of the control group did not show any significant changes after the intervention (P>0.05). In the intervention group, the accurately crossed number and net scores increased significantly, whereas the wrongly crossed number and missed crossed number scores and error; attention deficit; hyperactivity-impulsiveness; and ADHD-RS-IV total scores declined dramatically after intervention relative to those before the intervention. Moreover, the above indexes of the observation group showed more significant improvements than those of the control group (P<0.05). In the observation group, the conceptual level percentage and the number of completed classes had significantly increased and the number of discontinuous errors and number of continuous errors after the intervention had dropped sharply compared with those before. The above indexes of the observation group had improved significantly compared with those of the control group (P<0.05). Moreover, in both groups, the concentration/attention factor and CRT scores increased dramatically and the scores of Conner's child behavior scale after the intervention had dropped significantly compared with those before. After intervention, the above indexes of the observation group showed greater improvements than those of the control group (P<0.05).*

Conclusions: *The musicotherapy combined with cognitive behavioral intervention can improve the cognitive functions of children with ADHD and has clinical application values.*

Key words: *musicotherapy - cognitive behavioral intervention – ADHD – children - cognitive functions*

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INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a common clinical behavioral disorder syndrome in children. The morbidity of ADHD in girls is lower than that in boys. This syndrome refers to the mismatches of the responses of children with normal intelligence in learning, cognition, emotion, attention, and mobility. In children, serious ADHD is accompanied by audiovisual impairment and memory deficits. Hence, ADHD is also called as minimal brain dysfunction (Schneidt et al. 2020). Relevant studies (Soriano et al. 2020) have shown that the incidence rate of ADHD is approximately 8%. Some child patients still have symptoms after growing up, and their social communication abilities, physical and psychological health, and living abilities are all affected to different extents.

Currently, the clinical pathogenetic mechanism of ADHD remains unknown. However, most scholars believe that the morbidity of ADHD is closely related to family, environmental, and biological factors. Family factors include the educational level and career of the patient's parents, parenting mode, and family environment. Environmental factors include the effects of neurotoxic substances. Biological factors include the nutrition condition, disease history, birth order, and parent age of the affected children, as well as family disease history, pregnancy anomalies, age, and gender (Ricketts et al. 2021). At present, no clinical cure for ADHD exists. Although drug therapy can ameliorate symptoms, the long-term administration of drugs may induce dependence and side effects. Hence, choosing an effective and reasonable therapy for ADHD is of particular importance.

Cognitive behavioral therapy is a nondrug therapy that is commonly used in the clinic. This therapeutic strategy combines behavioral and cognitive therapies. It emphasizes the process of behavior production and the importance of cognitive activities. It also uses behavioral and cognitive modifications to improve negative emotions and behaviors and also can improve the symptoms of children with ADHD. Musicotherapy (Wang & Agius 2018, Dukic & Jakovljevic 2021) is a therapy that can be an effective intervention for the mental diseases of teenagers. It can train the artistic aesthetics of children, lacks side effects, and is easily accepted by parents. Relevant studies (Liu et al. 2015) have reported that in children with ADHD, musicotherapy can decrease hyperactivity and improve academic performances and clinical symptoms significantly. Therefore, this study discussed the influences of musicotherapy combined with cognitive behavioral intervention on the cognitive ability of children with ADHD and provides some references for ADHD rehabilitation.

Katelijne et al. (2019) pointed out that psychological intervention for children with ADHD could improve the scores of child behavioral scales and the parenting pressure scores of parents, thus achieving a significant therapeutic effect. Hadar et al. (2021) revealed that compared with the blank control treatment without intervention, cognitive behavioral intervention could improve the combined Raven's test (CRT) test, Achenbach child behavioral scale scores, and the cognitive and behavioral abilities of child patients with ADHD. Tosto et al. (2021) concluded that in children with ADHD, cognitive behavioral therapy combined with spelling learning game intervention can well improve conduct problems, learning problems, impulsiveness and hyperactivity, and anxiety and hyperactivity indexes in PSQ and strengthen executive ability. Dursun et al. (2021) revealed that group musicotherapy can enhance the attention, control, and hyperactivity-impulsiveness symptoms of children with ADHD. Pfeifer (2021) demonstrated that compared with independent cognitive behavioral interventions, musicotherapy combined with cognitive behavioral therapy can better improve the SCARED and DSRSC scores of children with ADHD and thus improve therapeutic effects. Jacob et al. (2021) concluded that in children with ADHD, musicotherapy combined with cognitive behavioral intervention can improve conduct and learning problems, hyperactivity-impulsiveness, and the hyperactivity index of Conner's scale, thus improving the clinical symptoms and executive functions of patients.

Cognitive behavioral intervention is a new comprehensive treatment mode that was formed against the background of the transformation from the biological-medical mode into the comprehensive multifactor biological-psychological-social treatment mode. Throughout the whole intervention process, attention is paid to not only the adjustment of the social environment and the individual physical environment but also to the nonfunctional cognitive problems of patients. It attempts to change the attitudes and opinions of patients toward things or people and thereby eases their relevant psychological problems. Moreover, it is strongly interesting and can motivate the enthusiasm and initiative of child patients completely. Musicotherapy can provide children with strong self-organizational constraints and self-regulation and enable the perception, recognition, and regulation of stimuli. It has a positive intervention effect on children with ADHD. Huang et al. (2019) pointed out that after 1 month of intervention with biological feedback training combined with sensory integration training, the social communication, cognitive ability, and linguistic ability of children with ADHD were improved. These improvements were accompanied by the promotion of balance between the inhibition and the excitation of the central nervous system. Brd et al. (2020) found out that cognitive behavioral intervention could improve behavioral biases significantly in children with ADHD. Xiao (2018) showed that Orff music combined with ABA behavioral intervention could improve the cognitive functions and adaptation behaviors of children with ADHD.

Intervention for children with ADHD is extremely important. At present, although conventional clinical intervention methods are effective, they are slightly uninteresting. Children show low interest in these interventions. Thus, seeking an intervention that is appropriate for the characteristics of children is important. Musicotherapy and cognitive behavioral therapy are effective child-based psychological and behavioral therapies and have been proven to exert positive effects on the psychological health of children. A random control test was carried out to provide references for the rehabilitation of children with ADHD.

SUBJECTS AND METHODS

Study participants

A total of 120 children with ADHD in the Cooperative Hospital of Guangzhou University from June 2018 to May 2021 were chosen as the research objects. They were randomly divided into the control and observation groups with 60 cases in each group via the observing random digital method. The two groups had no statistically significant differences in terms of age, gender, disease course, and disease typing and were comparable (P>0.05). Their results are shown in Table 1.

Inclusion criteria

(a) met the diagnostic standards for child patients with ADHD in the fourth edition of *Diagnostic and Statistical Manual of Mental Disorders*; (b) did not take drugs, such as methylphenidate, for mental disorders 1 week before the diagnosis; (c) have intact families and good compliance; (d) the patients and their family members agreed and signed the informed consent; and (e) approved by the ethics committee of the hospital.

Table 1. Comparison of the basic data of the two groups of children (n = 60)

	Control group	Observation group	t/χ^2	P
Male/female (cases)	39/21	40/20	0.037	0.847
Age (cases)	2-7	2-7		
Average age (cases)	4.26±0.35	4.31±0.41	0.718	0.237
Course of disease (months)	11.96±3.08	12.05±3.01	0.162	0.436
Typing (n (%))			0.152	0.927
Attention deficit	21 (35.00)	19 (31.67)		
Hyperactivity-impulsiveness	16 (26.67)	17 (28.33)		
Mixed type	23 (38.33)	24 (40.00)		

Exclusion criteria

(a) with complications of delayed intelligence development, psychological illnesses, and other mental system disorders; (b) with complications of critical diseases, including cardiovascular and cerebrovascular diseases; (c) with behavioral disorders caused by nervous system lesions; (d) with complications of autism, epilepsy, emotional disorder, and conduct disorders; (e) with poor digestive system and nutrition; and (f) with poor compliance and quitting in the middle of the experiment.

Methods

Control group

The blank control group received no intervention throughout the experiment and the same musicotherapy intervention as the observation group after the experiment.

Observation group

The observation group received musicotherapy combined with cognitive behavioral intervention. The details of this intervention are as follows: (a) Cognitive behavioral intervention mainly provides basic attention training in the auditory and visual senses to child patients, thus increasing the attention levels of child patients with ADHD. The problem-solving ability training covers the following several questions: "other living problems of child patients," "how to face accusations and wrong treatment from others," "how to handle bullying by others," "mastering apology skills," "learning their own feelings and others' feelings," "learning to solve problems," and "learning self-control." It mainly guides child patients to solve encountered problems through five steps: ①recognizing problems; ②searching for solutions and predicting outcomes; ③choosing the optimal solution and predicting possible disorders; ④output behaviors; and ⑤self-reinforcing and evaluating output behaviors. In accordance with the leveled and individual training principle, the respondents were trained for five times every week. Each training session lasted for 60 min. The course of treatment was 16 weeks. (b) Musicotherapy: Musicotherapists adopted the active group music for intervention with five respondents per group and provided musicotherapy once every week. Musicotherapy lasted for 45 min per session and was provided for 16 weeks. Specific contents included attention training. The child patients focused on single music clues and ignored other relevant stimuli actively. Continuous attention training guides children with ADHD to focus on continuously changing music rhythms and make corresponding responses, such as changing rhythms and strength. Continuous attention training, such as echo playing and interaction among structuration, improvised playing, and free instrumental and music playing, is thus promoted. By establishing explicit and regular echo playing, music dialogue and cooperative playing, the respondents can develop their behaviors with a planned and directed relationship wherein their attention and behavior are connected.

Observation indexes

Improvement of symptoms

The ADHD rating scale for parents (ADHD-RS-IV) was used to evaluate symptoms before the intervention and their improvements after intervention (Ai et al. 2020). This scale mainly included hyperactivity-impulsiveness and attention deficit. Each part had 18 items with nine questions, which were scored as 0, 1, 2, or 3. The total score was 54. A high score is indicative of severe disease. ADHD-RS-IV has the coefficient of the internal consistency of 0.61-0.71 and the Cronbach's α of 0.90.

Numerical cross-attention test

The attention functions of child patients before and after the intervention were evaluated via the numerical cross-attention test (NCT). This scale is composed of four parts: First, the number 3 is deleted. Second, numbers before 3 are deleted. Third, numbers with 7 before 3 are deleted. Fourth, the previous three stages are implemented continuously. In different parts, the following calculations were carried out: (a) missed crossed number; (b) wrongly crossed number; (c) accurately crossed number; (d) error rate = (wrongly crossed number + missed crossed number/2) accurately crossed number × 100%; (e) net score of NCT = (accurately crossed number - wrongly crossed number - missed crossed number/2). The NCT can be used to evaluate the alertness, concentration, and attention of respondents and can well reflect the attention functions of child patients.

Wisconsin card sorting test

In the Wisconsin card sorting test (WCST), the cognitive flexibility of individuals was tested by presenting stimulus pictures with different dimensions. In accordance with feedback, the child patients determined how to classify the test pictures. The index contents included conceptual percentage, the number of discontinuous errors, the number of continuous errors, and the number of completed classes.

CRT

The CRT was used to test the comparison ability, homogenous comparison, inferential association, comparison reasoning, and perceptual discrimination of the respondents before and after the intervention. Each part has 72 items with 12 questions. The respondents obtained a score of 0 for wrong answers and a score of 1 for correct answers. The respondents were asked to finish the test in 40 min. The original scores were the sum of all items.

Wechsler intelligence scale for children

The Wechsler intelligence scale for children (C-WISC) that has been revised by Gong Yaoxian was used to evaluate the intelligence of the child patients before and after the intervention. The attention and memory factors of the child patients were evaluated on the basis of the records of the concentration/attention factor (C factor) (Canivez et al. 2021).

Conner's children behavior scale for parents

Connery's child behavior questionnaire for parents was used to evaluate the behavioral problems of the child patients before and after the intervention. The questionnaire covers six dimensions, including learning difficulties, anxiety, and conduct problems. All six dimensions have 48 items, which were scored as 0, 1, 2, or 3. High scores are indicative of severe symptoms. The questionnaire has high reliability and validity and a Cronbach's α of 0.75-0.86.

Statistical analysis

SPSS 20.00 was applied for statistical analysis. Measurement data were expressed as ($\bar{x} \pm s$) and subjected to the t-test. Enumeration data were expressed as (n (%)) and subjected to the x^2 test. P<0.05 indicates statistically significant differences.

RESULTS

Comparison of the symptoms of the two groups before and after the intervention

The relevant indexes of the control group have changed slightly before and after the intervention (P>0.05). In the observation group, the attention deficit, hyperactivity-impulsiveness, and ADHD-RS-IV total scores have declined significantly after the intervention relative to the same indexes before the intervention. Moreover, the symptoms of the observation group have improved more than those of the control group (P<0.05). The results are presented in Table 2.

Comparison of the NCT results of the two groups before and after the intervention

The relevant indexes of the control group have changed slightly before and after the intervention (P>0.05). In the observation group, the accurately crossed number and net scores have increased significantly and the wrongly crossed number, missed crossed number, and error rates have declined sharply after the intervention compared with those before the intervention. Moreover, the indexes of the observation group have improved more than those of the control group (P<0.05). The results are shown in Table 3.

Comparison of the WCST results of the two groups before and after the intervention

The relevant indexes of the control group have changed slightly before and after the intervention (P>0.05). Compared with the same indexes before the intervention, the conceptual level percentage and number of the completed classes of the observation group have increased significantly and the number of discontinuous errors and the number of continuous errors have declined significantly after the intervention. Furthermore, the indexes of the observation group have shown greater improvements than those of the control group (P<0.05). The results are given in Table 4.

Comparison of the CRT results of the two groups before and after the intervention

The relevant indexes of the control group have changed slightly before and after the intervention (P>0.05). The scores of perceptual discrimination, comparison reasoning, inferential association, homogeneous comparison, series comparison, and abstract reasoning of the observation group have increased significantly after the intervention compared with the same indexes before the intervention. Moreover, the indexes of the observation group have increased more than those of the control group (P<0.05). The results are provided in Table 5.

Comparison of the C-WISC results of the two groups before and after the intervention

The relevant indexes of the control group have changed slightly before and after the intervention (P>0.05). In the observation group, the C factor after the intervention has increased significantly compared with that before the intervention. Moreover, the increment in the C factor of the observation group is greater than that in the C-factor of the control group (P<0.05). The results are shown in Table 6.

Table 2. Comparison of the symptoms of the two groups before and after intervention (scores, $\bar{x} \pm s$)

Groups	Time	Attention deficit	Hyperactivity-impulsiveness	Total scores
Control group (n = 60)	Before	21.25±3.26	14.96±2.25	35.58±4.16
	After	21.18±2.65^{b}	14.28±2.06^{b}	35.49±3.28^{b}
Observation group (n = 60)	Before	21.19±3.18	14.87±2.31	35.63±4.05
	After	9.12±2.08^{a,c}	6.42±1.87^{a,c}	16.23±2.49^{a,c}

Notes: Compared with that before intervention, ^{a}P<0.05, ^{b}P>0.05; Compared with the control group after intervention, ^{c}P<0.05

Table 3. Comparison of the NCT results of the two groups before and after the intervention ($\bar{x} \pm s$)

		Accurately crossed number	Wrongly crossed number	Missed crossed number	Error rate (%)	Net score (Scores)
Control group (n = 60)	Before	63.25±3.46	2.54±0.25	10.96±2.16	10.36±2.05	56.92±4.68
	After	63.18±3.74^{b}	2.43±0.15^{b}	10.89±1.68^{b}	10.21±1.85^{b}	54.25±4.88^{b}
Observation group (n = 60)	Before	63.16±3.58	2.58±0.21	10.92±2.14	10.41±2.03	56.87±4.72
	After	69.87±3.85^{a,c}	1.10±0.17^{a,c}	6.25±1.52^{a,c}	5.64±1.59^{a,c}	69.85±5.02^{a,c}

Notes: Compared with that before intervention, ^{a}P<0.05, ^{b}P>0.05; Compared with the control group after intervention, ^{c}P<0.05

Table 4. Comparison of the C-WISC results of the two groups before and after the intervention($\bar{x} \pm s$)

		Conceptual level percentage (%)	Number of discontinuous errors	Number of continuous errors	Number of completed classes
Control group (n = 60)	Before	61.23±5.65	25.14±3.56	53.69±8.74	4.45±1.15
	After	61.52±5.87^{b}	25.16±3.74^{b}	53.62±6.59^{b}	4.34±1.22^{b}
Observation group (n = 60)	Before	61.31±5.59	25.21±3.43	53.75±8.69	4.52±1.17
	After	68.21±5.63^{a,c}	20.03±3.87^{a,c}	44.58±5.97^{a,c}	6.11±1.30^{a,c}

Notes: Compared with that before intervention, ^{a}P<0.05, ^{b}P>0.05; Compared with the control group after intervention, ^{c}P<0.05

Table 5. Comparison of the CRT results of the two groups before and after the intervention (scores, $\bar{x} \pm s$)

		Perceptual discrimination	Comparison reasoning	Inferential association	Homogeneous comparison	Series comparison	Abstract reasoning
Control group	Before	6.31±1.15	4.51±1.20	4.16±1.02	4.89±1.53	3.36±0.59	1.25±0.09
(n = 60)	After	6.62±1.28^{b}	4.52±1.36^{b}	4.29±1.15^{b}	4.12±1.65^{a,b}	3.35±0.87^{b}	1.24±0.12^{b}
Observation group	Before	6.28±1.13	4.46±1.28	4.13±1.06	4.92±1.45	3.41±0.65	1.21±0.07
(n = 60)	After	9.35±1.78^{a,c}	7.69±1.53^{a,c}	7.63±1.35^{a,c}	7.63±1.78^{a,c}	5.98±0.99^{a,c}	2.95±0.26^{a,c}

Notes: Compared with that before intervention, ^{a}P<0.05, ^{b}P>0.05; Compared with the control group after intervention, ^{c}P<0.05

Table 6. Comparison of the C-WISC results of the two groups before and after the intervention (scores, $\bar{x} \pm s$)

		C factors
Control group (n = 60)	Before	102.15±5.97
	After	103.59±6.26^{b}
Observation group (n = 60)	Before	101.26±5.48
	After	114.56±6.59^{a,c}

Compared with that before intervention, ^{a}P<0.05, ^{b}P>0.05; Compared with the control group after intervention, ^{c}P<0.05

Comparison of the ADHD-RS-IV results of the parents in the two groups before and after the intervention

The relevant indexes of the control group have changed slightly before and after the intervention (P>0.05). In the observation group, the anxiety, conduct problem, learning difficulty, physical, and psychological disorders, impulsiveness and hyperactivity, and hyperactivity index scores have decreased significantly after the intervention relative to those before the intervention. Moreover, the indexes of the observation group have decreased more than those of the control group (P<0.05). The results are exhibited in Table 7.

DISCUSSION

After the intervention, the attention deficit, hyperactivity-impulsiveness, and ADHD-RS-IV total scores of the observation group are far lower than those of the control group, indicating that musicotherapy combined with cognitive behavioral intervention can well improve the clinical symptoms of children with ADHD. This conclusion is similar to the conclusions reached by Shi et al. (2019). Machado et al. (2020) demonstrated that cognitive behavioral intervention can enhance the cognitive and execution functions of children with ADHD. In this study, cognitive behavioral therapy is found to promote the ability of the children with ADHD in the observation group to control and regulate their own behaviors in accordance with the feedback of external environmental information, thus alleviating mental symptoms.

Table 7. Comparison of the ADHD-RS-IV results of the parents in the two groups before and after the intervention (scores, $\bar{x} \pm s$)

		Anxiety	Conduct problem	Learning difficulty	Physical and psychological disorders	Impulsiveness and hyperactivity	Hyperactivity index
Control group (n = 60)	Before	2.29±0.36	7.32±1.15	7.98±1.95	1.89±0.26	6.58±1.56	9.41±1.74
	After	2.11±0.35^{b}	6.94±1.08^{b}	7.65±1.25^{b}	1.82±0.18^{b}	6.55±1.35^{b}	9.25±1.10^{b}
Observation group (n = 60)	Before	2.3±0.35	7.28±1.08	7.91±1.89	1.93±0.25	6.63±1.62	9.35±1.68
	After	1.01±0.10^{a,c}	3.74±1.11^{a,c}	3.41±1.05^{a,c}	0.95±0.08^{a,c}	2.61±0.62^{a,c}	3.89±0.65^{a,c}

Notes: Compared with that before intervention, $^{a}P<0.05$, $^{b}P>0.05$; Compared with the control group after intervention, $^{c}P<0.05$

In children, musicotherapy improves cognitive functions, strengthens attention, and stabilizes emotions because it can stimulate different regions of the brain, strengthen mutual coordination, and improve the functions of the prefrontal cortex-corpus striatum-norepinephrine pathway. As a result, the attention deficit, hyperactivity, and impulsiveness of children with ADHD are ameliorated. From this perspective, the principle of musicotherapy and behavioral therapy is similar to that of biological feedback therapy. Relevant studies (He et al. 2019) have stated that biological feedback therapy can ease the mental symptoms and enhance the cognitive functions of children with ADHD. This result proves indirectly that musicotherapy combined with cognitive intervention can improve the relevant symptoms of ADHD significantly.

Table 3 shows that after the intervention, the accurately crossed number and net scores are higher and the wrongly crossed number, missed crossed number, and error rates in the observation group are far lower than those in the control group. These results reveal that musicotherapy combined with cognitive behavioral intervention can improve the NCT results of children with ADHD well. This conclusion is similar to the conclusions of Oh et al. (2018). Given that the traditional memory and attention methods in the execution functions of NCT require children to find and mark numbers that meet the conditions of random numbers, it tests the attention levels of children. It is a behavioral mode that illustrates the short-term attention, easy distraction, and failure of children with ADHD to maintain their attention in boring activities with some difficulties. Li (2019) pointed out that cognitive behavioral intervention combined with methylphenidate can improve the cognitive, behavior, and balance functions of children with ADHD significantly. Wu (2019) demonstrated that musicotherapy can correct the misconduct of children with ADHD well and increase their attention and memory levels. Liao (2016) found that musicotherapy combined with cognitive intervention can enhance the execution function and memory of children with ADHD. All of these results support the research conclusions of this study. This situation proves that musicotherapy combined with cognitive intervention can improve the alertness and attention concentration of patients with ADHD and that this improvement is lasting, stable, and ideal. Cognitive behavioral therapy is highly interesting and lacks any toxic and side effects on bodies. In children with ADHD, cognitive behavioral therapy can motivate enthusiasm and initiative fully and reduce social functional deficits. Other researchers have pointed out that children are inborn with musical communication and can acquire experiences by listening to music. Therefore, musicotherapy combined with cognitive behavioral therapy can correct the execution functions of children with ADHD and is a feasible and effective means to promote the cognitive ability of children.

Tables 4 and 5 indicate that after the intervention, the scores of conceptual level percentage, the number of completed classes and perceptual discrimination, comparison reasoning, inferential association, homogeneous comparison, series comparison, and abstract reasoning of the observation group are far lower than those of the control group. The above situation proves that musicotherapy combined with cognitive behavioral intervention can improve the WCST and CRT results of children with ADHD. This conclusion is similar to the research conclusions of Lv (2020) likely because WCST is an index that is relatively sensitive to the cognitive function test and can reflect prefrontal executive function well. It mainly evaluates working memory, transfer ability, learning ability, concept formation, and abstract classification ability. WCST can reflect cognitive flexibility and distraction, poor error correction, and adherence to original standards in respondents effectively. A previous study (Rafeiy-Torghabeh et al. 2021) showed that children with ADHD have lower WCST indexes than normal children. Wang & Wu (2020) revealed that in children with ADHD, group musicotherapy can alleviate the clinical symptoms of emotional impulsiveness, hyperactivity, and distraction and increase cognitive abilities. These results all support the conclusions of this study, reflecting that in children with ADHD, musicotherapy combined with cognitive intervention can increase concept formation, abstract thinking ability, learning ability, cognitive transfer, and visual attention, as well as the coordination of various cognitive functions. The cognitive behavioral intervention applied in this work is a new comprehensive treatment mode that was formed against the background of the transformation of the biological-medical mode into the comprehensive multifactor biological-psychological-social treatment mode. The whole intervention process pays attention to the adjustment of the social environment and the individual physical environment, as well as nonfunctional

cognitive problems. It attempts to change the attitudes and opinions of the patients toward things or people and thereby eases their relevant psychological problems. The internal time structure of music tasks can provide children with strong self-organizational constraints and self-regulation in practicing reasoning, decision-making, real-time prompting, comprehensive processing, and problem solving, as well as perceiving, recognizing, and regulating stimuli. It has a positive intervention effect on children with ADHD. Therefore, musicotherapy combined with cognitive intervention is viewed as having some clinical importance for improving the cognitive ability of children.

Table 6 and Table 7 show that compared with those in the control group, the scores of anxiety, conduct problems, learning difficulties, physical and psychological disorders, impulsiveness-hyperactivity, and hyperactivity indexes are far lower in the observation group after the intervention. By contrast, the C factor of the observation group is significantly higher than that of the control after the intervention. These results imply that musicotherapy combined with cognitive behavioral intervention can improve the results of children with ADHD on the C-WISC and Conner's child behavioral scales. This conclusion is similar to the research conclusions of Young et al. (2021) likely because the C factor is an index that investigates the memory and attention of children. It is mainly used in coding tests and arithmetic and digit spans and can reflect the cognitive defect of children with ADHD. Niarchou et al. (2019) reported that parenting intervention combined with drug therapy can improve the C-WISC results of children with ADHD. Liu et al. (2020) demonstrated that compared with independent cognitive behavior therapy, cognitive behavior combined with musicotherapy can increase the intelligence level and cognitive ability of children with ADHD. All of these findings support the results of this study. In other words, musicotherapy combined with cognitive behavioral intervention can improve the reasoning, discrimination, and cognitive functions of children with ADHD. In this study, cognitive behavioral intervention can change poor cognition by changing behaviors or beliefs or thinking, thus eliminating poor behaviors and emotions. It is a psychological therapy that corrects and adapts to misconducts by changing the poor cognitions of patients through behavioral and cognitive technologies. In contrast to traditional behavioral therapy, cognitive behavioral intervention is characterized by periodicity, integrity, guidance, and enthusiasm. Moreover, cognitive behavioral intervention is highly interesting and lacks related toxic and side effects. In children with ADHD, it can motivate enthusiasm and initiative and improve social dysfunction. Music also can regulate the sensory stimuli level of children and provides strong stimuli for the neuroplasticity changes of the brains of adults and teenagers. It also integrates action and perception to connect relevant brain areas and promotes the development of the executive functions of children with ADHD. The effect of musicotherapy has been proven via neuropsychological tests and functional magnetic resonance imaging. Therefore, musicotherapy combined with cognitive behavioral intervention not only ameliorates the symptoms of children with ADHD, it also can improve their cognitive ability. Therefore, it has clinical importance.

CONCLUSIONS

Attention deficit hyperactivity disorder (ADHD) mainly manifests as learning difficulties, emotional impulsiveness, excessive activities, and attention deficit disorder. Given that it can influence social communication abilities, as well as physical and psychological health and viability, ADHD rehabilitation has attracted close attention. In the current study, musicotherapy combined with cognitive behavioral intervention can improve the cognitive functions of patients with ADHD and has clinical application values.

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