

A practical study regarding the effect of adaptive roller-skating on emotion regulation ability of autistic children

W. GUAN¹, B. TANG², Q.-F. WANG³

¹Hunan International Business Vocational College, ²Hunan Modern Logistics College, ³Changsha Normal University, Changsha, Hunan, China

Abstract. – OBJECTIVE: Our aim is to analyze the effect of adaptive roller-skating on emotional regulation of autistic children.

MATERIALS AND METHODS: Adaptive roller-skating course was designed for autistic children based on adaptive sports and A-B-A experiments.

RESULTS: The adaptive roller-skating intervention focuses on improving emotional regulation ability, and directs the children to reasonably vent, recognize and stabilize their emotions. Adaptive roller-skating has a significant effect in intervening sadness, anger, anxiety and fear in autistic children; the intervention content setting and difficulty setting of the course have a certain impact on the intervention effect. Highly difficult and risky content can stimulate children.

CONCLUSIONS: Adaptive roller-skating intervention course should obey the concept of adaptive movement in view of the differences between autistic children and the fun of roller-skating and guide the autistic children in emotion regulation with positive emotions.

Key Words:

Adaptive sports, Autistic children, Health promotion, Emotion regulation, Roller-skating intervention, Sports methods, Case study.

Introduction

Emotion regulation is a process of regulating the intensity or duration of intrinsic emotional or motivational states to achieve social adaptation or personal goals¹, which is an important developmental task in early childhood². Difficult emotion regulation is a serious problem for autistic children. Because of insufficient emotion regulation³, autistic children exhibit aggressive and self-harming behaviors, as well as disruptive behaviors and hyperactivity when experiencing negative or hyperactive emotions⁴. These emotional and behav-

ioral problems bring great challenges to the daily life of autistic children⁵, such as poor social development, poor interpersonal communication and academic failure⁶, depression and anxiety, high parenting pressure and family distress for autistic children. On March 27, 2020, the Centers for Disease Control and Prevention (CDC)⁷ released the latest report on the prevalence of autism among children in the United States. The report indicated that the prevalence of autism increased from 1/68 in 2014 to the current 1/54⁸, presenting continuous rise, which has attracted increasing attention from all walks of life⁹. Therefore, it is urgent to intervene on the emotion recognition ability of autistic children.

There are two main types of emotion regulation interventions for autistic children at home and abroad: cognitive-behavioral therapy and sports behavioral intervention analysis¹⁰. Research shows that physical exercise positively affects emotional health and behavioral problems in autistic children. For example, Yang¹¹ believes that both yoga and jogging can enhance physical strength, concentration and self-esteem in autistic children, found that regular participation in exercise was closely associated with increased self-efficacy and reduced emotional and behavioral problems, especially improved emotional regulation in autistic children. Bremer's study¹² suggests that physical exercise may be one effective intervention to improve the social and behavioral function of autistic children¹².

However, none of the previous study¹³ have directly examined the effect of physical exercise on emotional function in autistic children.

The purpose of this pilot study is to examine the effect of physical exercise intervention (adaptive roller-skating) on emotional regulation in autistic children. Adaptive roller-skating is used for intervention because it is a controllable sport that helps improve sensory integration in autistic children¹⁴.

Table I. List of research objects.

Name	Age	Emotion Regulation Characteristics
Little A	6 years and 5 months	Distracted attention, erratic eyes; with spontaneous speech, illogical, when stimulated or forced to a certain extent, there will be screaming and anger, and cannot be calmed down by others.
Little B	6 years and 4 months	Typical hyperactivity, poor concentration, easy to lose control of emotions, cry and attack others when losing control, unable to calm down despite others' comfort, accompanied with self-injury behavior, thin, with inferior lower limbs strength and body balance compared to children of the same age.
Little C	6 years and 8 months	Emotionally unstable, easily affected by the outside world and himself, loses his temper, shouts; emotional out of control is often accompanied by high-fives (strong), chest beating, head-beating and other self-mutilation behaviors and other behaviors that attack others, can't calm down despite others' comfort. The appeasement of external factors is not very evident.
Little D	6 years and 1 month	Does not like sports, resists new objects; timid, afraid of all kinds of dangerous things, when stimulated or forced, will scream, get angry, conduct self-mutilation, can't calm down despite others' comfort. In order to ensure the safety of the children, sports injury insurance was purchased for the children during the experiment.

The available evidence proves that physical activity is beneficial to the mood and behavior of autistic children, so it is hypothesized that adaptive roller-skating intervention would positively affect emotional regulation in autistic children¹⁵. To this end, the first group of goals of this study is to deeply study adaptive roller-skating curriculum design by observing the emotional performance of autistic children in the classroom¹⁶, such as sadness, anger, anxiety, fear, etc. The second group of goals is to examine the correlation between course effect and emotion regulation in autistic children, observe the autistic children's ability to regulate sadness¹⁷, anger, anxiety, fear, etc. in the adaptive roller-skating course.

Materials and Methods

Materials

After obtaining the consent from parents of the Hunan Special Children's Sports Intervention Center, patients aged 6-7 years old with autism (moderate) diagnosed by Grade A Class 3 hospitals, sensory integration disorder (severe), no other physical complications, basic motor ability were selected. According to the requirements of the emotional regulation field test in the "Guidelines for Educational Evaluation of School-aged Children with Autism", the children shall basically meet two requirements, and the following 4 children were finally determined after screening (Table I).

Methods

Single-Subject Experimental Method

This experiment adopted the single-subject experimental method, the experimental design of

A-B-A. The experimental stage was divided into three stages: baseline stage, intervention stage and maintenance stage. During the baseline period, the experimental children were investigated, and a specific implementation plan conforming to the adaptive roller-skating intervention of the research object was designed. The Delphi method was used to further verify and finally determine the experimental plan.

Intervention Method

The mixed teaching mode of group and individual case was adopted to highlight the advantages of group teaching intervention for autistic children and the particularity of individual cases of autistic children. Situational teaching method was adopted to let children better integrate into group activities. According to the comprehensive ability of the children, unified teaching content was designed and implemented by the chief coach, and then the assistant coach conducted one-to-one teaching based on individual case differences to improve the comprehensive ability of the children, so that different teaching methods were designed for the children under unified teaching goal. The applied behavior analysis method (A-B-A) was adopted to let the children adjust their emotions when the chief coach explained the teaching content, so that the children can adapt to the group teaching. The assistant coach conducted one-to-one regulation to strengthen the children's emotional regulation. Then, the chief coach explained the teaching content to the children, the assistant coach decomposed the teaching content in view of the children's status, so that the children could regulate their emotions while learning the teaching content, thus improving emotional regulation ability through adaptive roller-skating.

Evaluation Rules

According to the test items in the field of emotion regulation in the “Guidelines for Educational Assessment of School-Aged Children with Autism”, we selected four negative emotions including fear, anxiety, anger, and sadness in terms of emotional performance. In emotion regulation level, 5 levels were selected for assessment, including “whether the subject with negative emotion can calm down after being comforted by others; whether the subject can realize and control his excessive emotions and maintain emotional stability; whether the subject can accept and properly deal with setbacks; whether the subject can remain stable emotions when disturbed; whether the subject can handle emotional expressions to conform to social norms and human habits”.

Experiment Content

Stages of Adaptive Roller-Skating Course

Based on the adaptive roller-skating characteristics and the emotion regulation ability of the four experimental subjects, the teaching of adaptive roller-skating is divided into six stages from perception to liking, to learning and then to the final consolidation. The details are as follows: in the first stage, let the children watch roller-skating videos, touch the roller-skating shoes, adapt to the teacher, familiarize with the teaching environment, and mainly observe the children’s anxiety and fear. In the second stage, let children familiarize with protective gears, put on shoes, overcome fears, and basically stand on the floor mat. Mainly observe the children’s anxiety. In the third stage, let the children adapt to standing on the floor mat, move and then return to the ground. Partial coercion was implemented. Observe the symptoms of anxiety and anger in children at this stage. In the fourth stage, conduct comprehensive teaching and training of children, and comprehensively observe emotional regulation ability of the children in the course. In the fifth stage, add wrestling, turning, and braking on the original basis. Partial coercion was implemented. Comprehensively observe the children’s emotional regulation ability in the course. In the sixth stage, integrate all the previous teaching contents, design situational teaching, obstacle teaching, and comprehensively observe the children’s emotional regulation ability in the course. The course contents are shown in Table II.

Data Acquisition

Pre-test

Before implementing this intervention, communicate with parents to observe the children’s emotional regulation ability in natural course. At this stage, no intervention is performed at this stage and only the emotional performance and emotional regulation ability of the children are recorded in the course. The specific method lasted for 4 weeks, 3 times a week, and each time, the children’s emotional performance in the natural course was recorded by the researcher.

Intervention

In this study, blended teaching was adopted for intervention, and a natural collective classroom was set with four children as a group. With situational teaching as the main method, a head teacher was set during the teaching period. Using one-to-one intervention, the other four children were intervened 3 times a week for 8 weeks, a total of 24 times. Emotional regulation changes of children were observed in the course: fear, anxiety, anger, sadness, and course contents were designed in turn. During the whole process, one-to-one coaches guided the children’s performance throughout the course. When emotions have appeared, regulate and sort out the children’s emotions in time, so as to improve the children’s emotional regulation ability. After the children’s emotions have stabilized, take the children into the classroom for intervention exercises; so this intervention course was 90 minutes per time (45 minutes with a 10-minute break).

Maintenance Period Test

After the 8-week intervention course, observation was conducted in the same way as the pre-test, and communication with parents and teachers was conducted to understand the children’s performance after the intervention course. This period lasted for 4 weeks, which is mainly to observe the children’s emotional regulation performance in the natural classroom after the intervention. For the specific method, the researcher recorded the number of children’s emotional performance in the natural course each time with the frequency of 3 times a week.

Results

Analysis of Changes in Little A’s Emotional Regulation Ability Before and After the Experiment

Figure 1 and Table III show that little A has serious emotional regulation problems in the

Table II. Content design for adaptive roller-skating course.

Stage	Content	Emotional expression	Emotional regulation goals
Stage 1	Watch the roller-skating video Familiarize with the teaching environment Watch teachers slide Students experience the feeling of sliding	Pay attention to the children's fear and anxiety after being comforted by others.	Children can be attracted by the video and the teacher's actions and provide reinforcement points. Emotions change with the changes of the "plot", and children can adjust emotions and calm down with the help of the teacher
Stage 2	Put on and take off roller skates Put on and take off roller skating protective gear	Pay attention to the fear, anxiety, and anger of the children after being comforted by others.	The emotional response is migrated from the video to the actual operation. After the forced intervention in the operation, the children have aggressive emotions, who can adjust emotion and calm down with the teacher's assistance.
Stage 3	stand still on (floor mat) march forward (on floor mat) stand in parallel Stand in parallel	Pay attention to the sadness, anxiety, and anger of the children after being comforted by others	Gradually adapt to the danger of the exercise during the floor mat exercise, gradually reduce the number of emotional reactions with the teacher's assistance and enter minor stability
Stage 4	left and right lateral step high knee lift single foot support Sliding back and forth in situ parallel walking Stand up	Pay attention to the sadness, fear, anxiety and anger of the children after being comforted by others.	In stage transitions, let the children change their mood through stimulation and fun of sliding. With the teacher's assistance, reduce the number of emotional reactions in each lesson by 5-6 times in overall.
Stage 5	Forward Wrestling double sliding sideways wrestling brake stop Low-profile inertial turning	Pay attention to the sadness, fear, anxiety, and anger of the children after being comforted by others	Increase the content difficulty to stimulate the children's emotions, so that emotions will fluctuate to a certain extent. Children should gradually adjust themselves during exercise under teacher's comfort
Stage 6	Straight sliding Train sliding Obstacle sliding Comprehensive sliding	Pay attention to the sadness, fear, anxiety, and anger of the children after being comforted by others.	Increase adaptive means and entertainment. Otherwise, strengthen the children's emotional stability with the teacher's comfort.

baseline period, mainly reflected in sadness (14.50±0.926), anger (18.63±1.506), anxiety (18.13±0.641) and fear (14.63±2.220). The absolute value of Br in each group is smaller than 1 in the baseline period and the baseline maintenance period. That is, the data in each group are not self-correlated and therefore valid. In the intervention period, the absolute value of Br is greater than 1 in each group, showing self-correlation without random distribution and a certain trend of change. The *t*-test showed that sadness emotion regulation ability of little A had no significant difference between the intervention period and the baseline period. The sadness fluctuated greatly during the intervention process but tended to stabilize in baseline maintenance period. Other emotions also exhibited continuous fluctuations during the intervention period, but the value was significantly lower in the intervention period than in the baseline period (*p*<0.01), indicating that adaptive roller-skating intervention had an immediate effect on little A's other emotional reg-

ulation. The number of little A's emotional fluctuations was significantly different between the intervention period and baseline maintenance period (*p*<0.01), which was related to the fluctuation of the intervention period, indicating that the experimental treatment still had a delayed effect. To sum up, adaptive roller-skating was positively correlated with little A's emotional stability (*p*<0.01), which had positive effects on little A's emotions to varying degrees.

Analysis of Changes in Little B's Emotional Regulation Ability Before and After the Experiment

Figure 2 and Table IV show that Little B has serious emotional regulation problems at the baseline period, mainly reflected in sadness (15.00±0.746), anger (15.38±0.744), anxiety (16.13±0.835) and fear (16.50±0.926). The absolute value of Br in each group is smaller than 1 in the baseline period and baseline maintenance period, showing non-self-correlation, indicating that the data are valid. In the intervention period, the absolute value of Br is

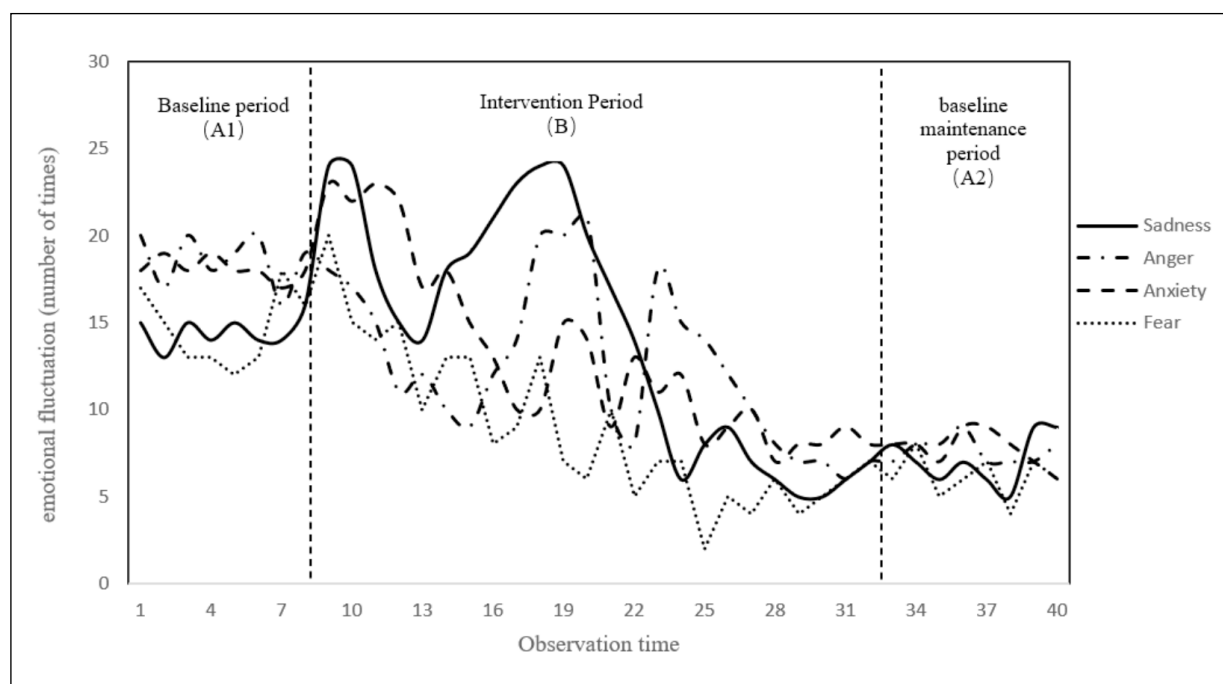


Figure 1. Record table of changes in the number of little A's emotional fluctuations.

greater than 1 in each group, showing self-correlation without random distribution and a certain trend of change. The *t*-test showed that sadness emotion regulation ability of little B was not significantly different during the intervention period and baseline period. During the intervention process, little B's sadness fluctuated greatly, but eased and tended to stabilize during the baseline maintenance period, indicating that emotional regulation effect of adaptive skating on little B's sadness exhibited an unstable-stable trend. Regulation of other emotions also exhibited continuous fluctuations during the intervention period, but the value was significantly

lower in the intervention period than in the baseline period ($p < 0.01$), indicating that adaptive roller-skating intervention had immediate effect on little B's other emotional regulation. The number of little B's emotional fluctuations was significantly different between the intervention period and the baseline maintenance period ($p < 0.01$), which was related to the fluctuation in the intervention period, indicating that the experimental treatment still had a delayed effect. To sum up, adaptive roller-skating was positively correlated with little B's emotional stability ($p < 0.01$), which had positive effects on little B's emotions to varying degrees.

Table III. Little A's emotion before and after intervention.

	Sadness			Anger			Anxiety			Fear		
	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2
Comparison before and after intervention												
Changes and effects of trend direction	Positive-negative			Positive-negative			Positive-negative			Positive-negative		
Trend stability change	Unstable-stable			Unstable-stable			Unstable-stable			Unstable-stable		
M	14.50	14.33	7.13	18.63	12.54	7.63	18.13	13.08	7.75	14.63	8.79	6.13
SD	0.926	7.110	1.458	1.506	4.615	0.744	0.641	5.225	1.035	2.220	4.462	1.246
Br	-0.65	2.13	0.21	-0.86	1.48	0.04	-0.07	1.91	0.37	0.44	1.49	-0.80
Linear regression slope	0.12	-0.83	0.15	-0.13	-0.33	-0.04	-0.13	-0.65	-0.19	0.08	-0.53	-0.08
<i>p</i> A1-B	0.912 (>0.05)			0.000 (<0.01)			0.000 (<0.01)			0.001 (<0.01)		
<i>p</i> A1-A2	0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)		
<i>p</i> B-A2	0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)			0.013 (<0.05)		

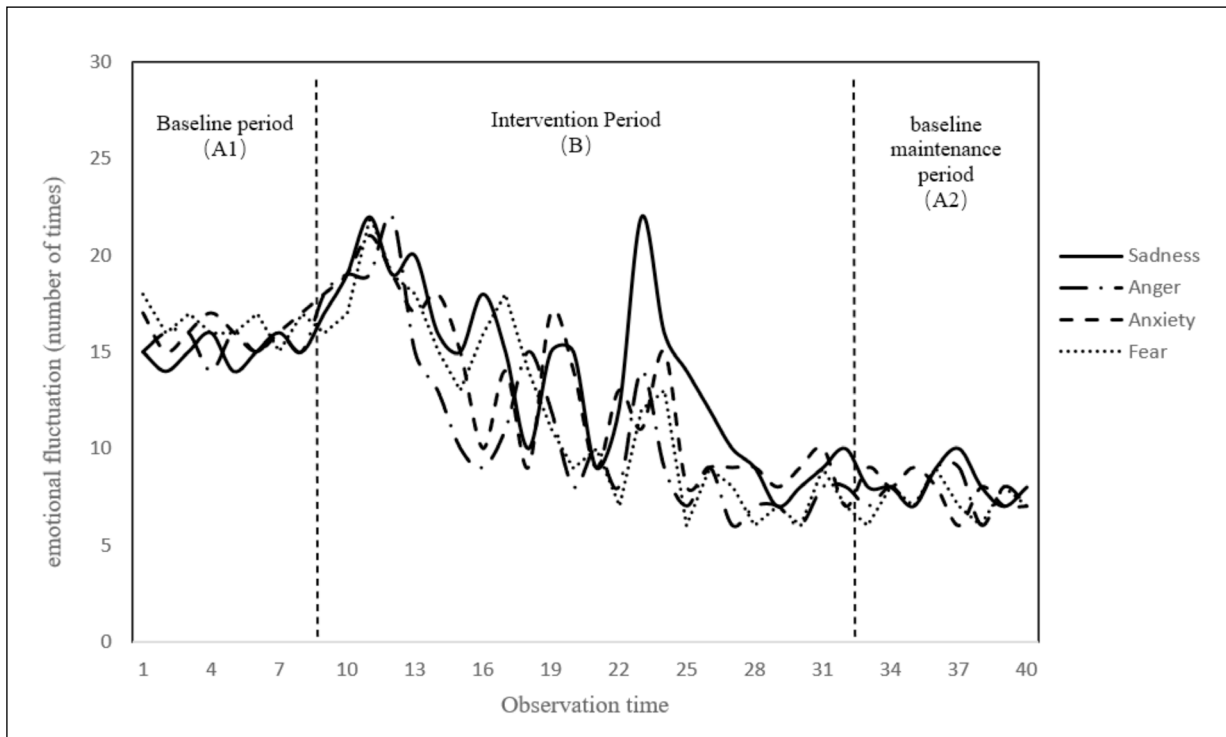


Figure 2. Record table of changes in the number of little B's emotional fluctuations.

Analysis of Changes in Little C's Emotional Regulation Ability Before and After the Experiment

Figure 3 and Table V show that Little B has serious emotional regulation problems at the baseline period, mainly reflected in sadness (14.75 ± 0.886), anger (15.75 ± 0.707), anxiety (15.38 ± 0.744) and fear (13.25 ± 0.707). The absolute value of Br in each group is smaller than 1 in the baseline period and baseline maintenance period, showing non-self-correlation, indicating that the data are valid. In the intervention period, the absolute val-

ue of Br is greater than 1 in each group, showing self-correlation without random distribution and a certain trend of change. The *t*-test showed that sadness emotion regulation ability of little C was not significantly different during the intervention period and baseline period. During the intervention process, little C's sadness fluctuated greatly, but eased and tended to stabilize at a value smaller than the baseline period during the baseline maintenance period, indicating that emotional regulation effect of adaptive skating on little C's sadness exhibited an unstable-stable trend. Other

Table IV. Little B's emotion before and after intervention.

Comparison before and after intervention	Sadness			Anger			Anxiety			Fear		
	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2
Changes and effects of trend direction	Positive-negative			Positive-negative			Positive-negative			Positive-negative		
Trend stability change	Unstable-stable			Unstable-stable			Unstable-stable			Unstable-stable		
M	15.00	14.13	8.13	15.38	11.25	7.63	16.13	12.83	7.75	16.50	12.00	7.25
SD	0.756	4.504	0.991	0.744	4.618	1.061	0.835	4.331	1.035	0.926	4.773	1.035
Br	-0.35	1.57	0.18	-0.83	1.79	-0.45	-0.26	1.47	0.08	-0.65	1.87	-0.53
Linear regression slope	0.10	-0.48	-0.01	-0.01	-0.54	-0.04	0.01	-0.51	-0.29	-0.14	-0.58	0.02
pA1-B	0.369 (>0.05)			0.000 (<0.01)			0.001 (<0.01)			0.000 (<0.01)		
pA1-A2	0.000 (<0.01)			0.001 (<0.01)			0.000 (<0.01)			0.000 (<0.01)		
pB-A2	0.000 (<0.01)			0.001 (<0.01)			0.000 (<0.01)			0.000 (<0.01)		

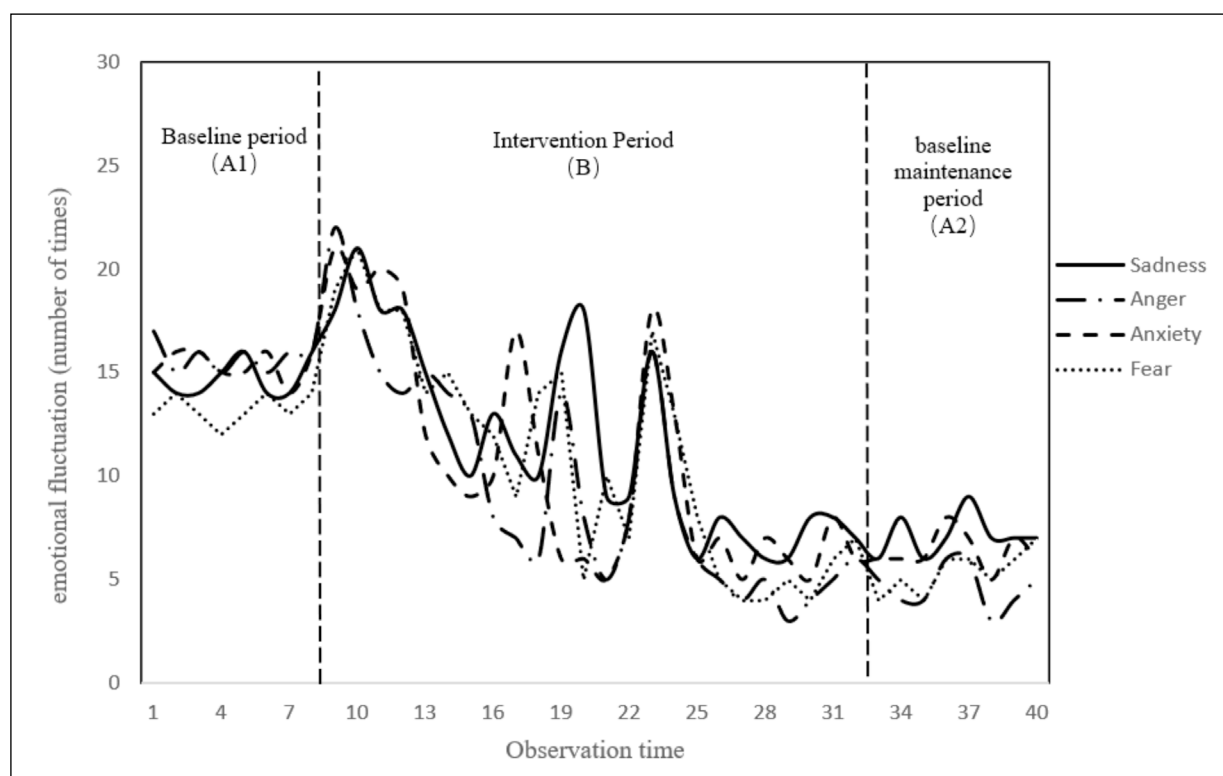


Figure 3. Record table of changes in the number of little C’s emotional fluctuations.

emotions also exhibited continuous fluctuations during the intervention period, but the value was significantly lower in the intervention period than in the baseline period ($p < 0.01$), indicating that adaptive roller-skating intervention had immediate effect on little B’s other emotional regulation. The number of little C’s emotional fluctuations was significantly different between the intervention period and the baseline maintenance period ($p < 0.01$), which was related to the fluctuation in the intervention period, indicating that the experi-

mental treatment still had a delayed effect. To sum up, adaptive roller-skating was positively correlated with little C’s emotional stability ($p < 0.01$), which had positive effects on little C’s emotions to varying degrees.

Analysis of Changes in Little D’s Emotional Regulation Ability Before and After the Experiment

Figure 4 and Table VI show that Little D has serious emotional regulation problems at

Table V. Little C’s emotion before and after intervention.

Comparison before and after intervention	Sadness			Anger			Anxiety			Fear		
	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2
Changes and effects of trend direction	Positive-negative			Positive-negative			Positive-negative			Positive-negative		
Trend stability change	Unstable-stable			Unstable-stable			Unstable-stable			Unstable-stable		
M	14.75	11.63	7.13	15.75	9.58	4.63	15.38	10.58	6.38	13.25	10.96	10.96
SD	0.886	4.689	0.991	0.707	0.266	1.061	0.744	5.453	0.916	0.707	5.449	1.061
Br	-0.21	1.59	-0.47	-0.73	1.54	-0.05	-0.69	1.54	-0.30	-0.13	1.66	0.20
Linear regression slope	0.10	-0.53	0.08	-0.05	-0.60	-0.04	-0.04	-0.55	0.01	0.07	-0.64	0.35
p_{A1-B}	0.004 (<0.01)			0.000 (<0.01)			0.000 (<0.01)			0.055 (>0.05)		
p_{A1-A2}	0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)		
p_{B-A2}	0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)		

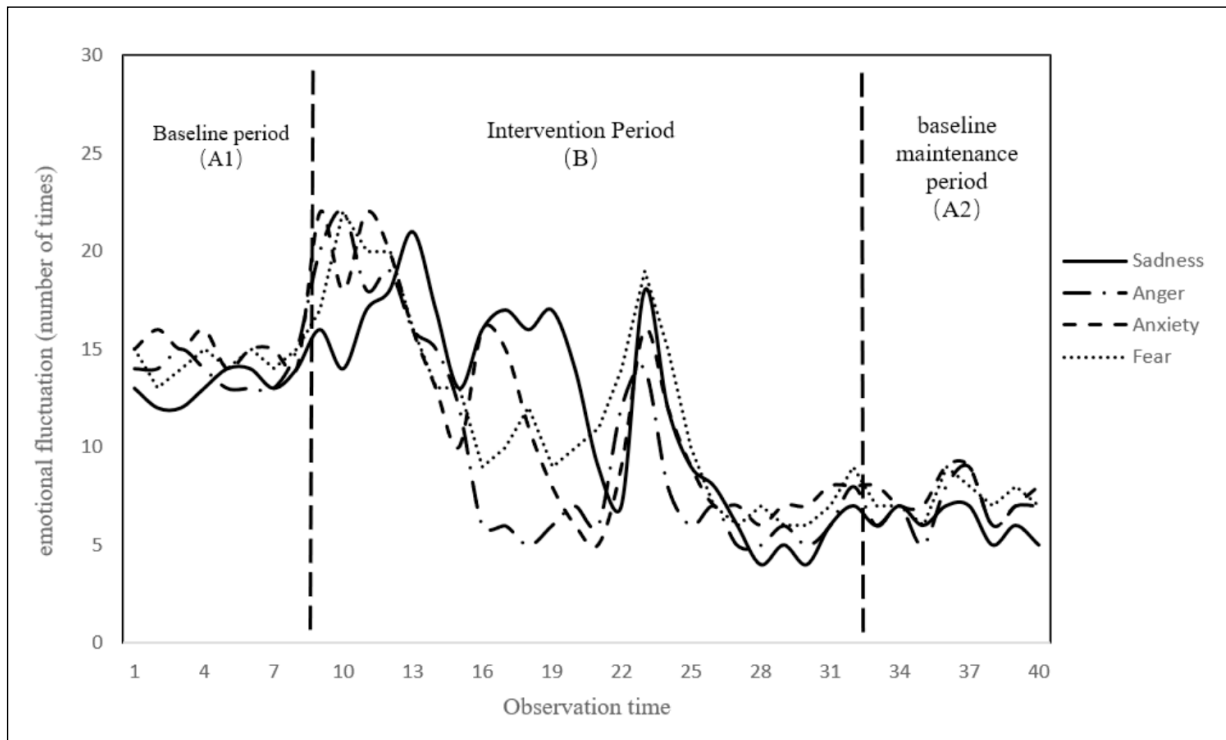


Figure 4. Record table of changes in the number of little D’s emotional fluctuations.

the baseline period, mainly reflected in sadness (13.13 ± 0.835), anger (13.88 ± 0.835), anxiety (15.00 ± 0.756) and fear (14.38 ± 0.744). The absolute value of Br in each group is smaller than 1 in the baseline period and baseline maintenance period, showing non-self-correlation, indicating that the data is valid. In the intervention period, the absolute value of Br is greater than 1 in each group, showing self-correlation without random distribution and a certain trend of change. The *t*-test showed that sadness emotion of little D was not significantly different during the intervention

period and baseline period. During the intervention process, little D’s sadness fluctuated greatly, but eased during the baseline maintenance period, indicating that emotional regulation effect of adaptive skating on little D’s sadness exhibited an unstable-stable trend. Other emotions also exhibited continuous fluctuations during the intervention period, but the value was significantly lower in the intervention period than in the baseline period ($p < 0.01$), indicating that adaptive roller-skating intervention had immediate effect on little D’s other emotional regulation. The number of

Table IV. Little B’s emotion before and after intervention.

Comparison before and after intervention	Sadness			Anger			Anxiety			Fear		
	A1	B	A2	A1	B	A2	A1	B	A2	A1	B	A2
Changes and effects of trend direction	Positive-negative			Positive-negative			Positive-negative			Positive-negative		
Trend stability change	Unstable-stable			Unstable-stable			Unstable-stable			Unstable-stable		
M	13.13	12.13	6.13	13.88	10.00	6.88	15.00	11.58	7.63	14.38	12.00	7.50
SD	0.835	5.286	0.835	0.835	5.564	1.246	0.756	5.299	1.061	0.744	4.917	0.926
Br	0.58	1.82	-0.08	0.21	1.97	-0.26	-0.35	1.78	-0.03	-0.55	1.98	-0.30
Linear regression slope	0.23	-0.62	-0.18	-0.06	-0.59	0.13	-0.17	-0.59	-0.04	0.08	-0.52	0.12
<i>p</i> A1-B	0.380 (>0.05)			0.003 (<0.01)			0.005 (<0.01)			0.030 (<0.05)		
<i>p</i> A1-A2	0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)			0.000 (<0.01)		
<i>p</i> B-A2	0.000 (<0.01)			0.016 (<0.05)			0.002 (<0.01)			0.000 (<0.01)		

little D's emotional fluctuations was significantly different between the intervention period and the baseline maintenance period ($p < 0.01$), which was related to the fluctuation in the intervention period, indicating that the experimental treatment still had a delay effect. To sum up, adaptive roller-skating was positively correlated with little D's emotional stability ($p < 0.01$), which had positive effects on little D's emotions to varying degrees.

Conclusions

This study mainly investigates the effect of adaptive roller-skating on the emotional regulation ability of autistic children by assuming that intervention helps to improve emotional regulation ability of autistic children. Experiments have proved that adaptive roller-skating can effectively regulate autistic children's emotion. In the future, when providing exercise prescription for autistic children, doctors and educators can use it as one factor to comprehensively observe autistic children's emotional regulation. Consistent with the results of a study¹¹ on emotional regulation of autistic children, interventions such as 12-week jogging significantly improved emotional regulation and behavioral problems in autistic children. In this study, referring to the characteristics of roller-skating, the four emotions of autistic children, including fear, anxiety, sadness, and anger, were analyzed. After intervention, all the four autistic children improved their emotion regulation ability to varying degrees, especially in fear. However, this experiment mainly observed autistic children's ability to regulate their emotions after being comforted by others after emotions appear and fails to observe autistic children's ability to self-regulate emotions. Future researchers should take this factor into account.

During the experiment, the main observation point was autistic children's emotion regulation ability, and at the same time, less observation was made on the stereotyped behavior and social communication ability of autistic children. After the experiment, it was found that stereotyped behavior was less frequent in the four children. For instance, little A's involuntary clapping, little C's screaming, little B's stomping, and little D's head shaking, all eased to a great extent after the experiment (based on communication with parents and observations in baseline maintenance period). This is consistent with the research results of other scholars. For example, 12-week small basketball exercise can reduce the repetitive stereotyped behavior of pre-

school children with ASD. However, because this observation point was not used as an experimental point at the beginning of this experiment, it was not discussed further. Future studies could provide in-depth observations of this behavior.

This is the first attempt to use adaptive roller-skating as an experimental medium for improving emotional regulation in autistic children, which has yielded promising results. Experiments have shown that adaptive roller-skating intervention can improve the emotional regulation ability of autistic children, which means a great change from the original emotional regulation. Taking these factors into consideration, it is necessary to further study the positive effects of adaptive roller-skating on emotion regulation and behavior in autistic children and its mechanisms.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Ethical Approval

Not applicable.

Informed Consent

Informed consent was obtained from the parents of the patients involved in the study.

Authors' Contribution

All authors were involved in specific aspects of the study. Wei Guan contributed to the data sorting and the first draft of the paper. Biao Tang contributed to the data analysis, Qifu Wang contributed to the sorting out charts.

ORCID ID

Wei Guan, <https://orcid.org/0000-0002-4680-4704>
Biao Tang, <https://orcid.org/0000-0001-5323-2145>
Qifu Wang, <https://orcid.org/0000-0001-6747-4428>

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