

Effectiveness of Sports Games in Reducing Stereotypic Behaviors in Children with Autism

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Abstract: Under the context of China's increasing emphasis on children with autism and the continuous enrichment of therapeutic approaches, there remains limited research on the application of sports games to intervene in stereotypic behaviors. This study aims to explore the effectiveness of sports games in intervening stereotypic behaviors among children with autism. An A-B-A single-subject research design was implemented to intervene with three stereotypic behaviors (hand-biting, nose-picking, and self-talk) in an 11-year-old child with autism. Multi-dimensional sports games based on sensory integration theory were designed and administered over a 30-day intervention period. The results showed that the frequency of hand-biting decreased to an average of 5.20 times/day during the maintenance phase, and nose-picking decreased to 2.40 times/day, with stable intervention effects. However, self-talk showed no significant improvement ($p>0.05$). Additionally, improvements were observed in the participant's tactile perception, proprioception, and vestibular sensation functions. The conclusion indicates that sports games can effectively reduce stereotypic behaviors driven by sensory stimulation, but demonstrate limited effectiveness on behaviors motivated by multiple factors.

Keywords: Children with Autism; Sports Games; Stereotypic Behaviors; Sensory Integration; Behavior Intervention; Rehabilitation Training

1. Introduction

With the continuous progress of Chinese society and the robust development of special education, greater attention has been devoted to the education and rehabilitation of individuals with Autism Spectrum Disorder (ASD). In recent

years, the Chinese government has enacted a series of comprehensive policies and regulations aimed at protecting the legal rights and welfare of people with physical and mental disabilities. Notably, in 2024, seven governmental departments, including the China Disabled Persons' Federation, collaboratively issued the *Implementation Plan for the Care and Promotion of Children with Autism (2024–2028)*. This plan outlines a strategic, five-year framework to systematically enhance the mechanisms and services supporting the care of children with autism, thereby offering unprecedented policy support and fostering new opportunities for both practical interventions and academic research in this vital field^[1].

Autism, classified as a neurodevelopmental disorder, is characterized primarily by persistent deficits in social communication and social interaction, alongside restricted, repetitive patterns of behavior, interests, or activities^[2]. Among these symptoms, stereotypic behaviors stand out as one of the most prominent features, severely impeding the learning efficiency, social adaptability, and overall quality of life of children with autism. These behaviors not only disrupt daily learning and living but also potentially lead to secondary complications such as self-injury and social exclusion, imposing long-term burdens on families and society.

Currently, intervention strategies for children with autism are increasingly diverse, encompassing applied behavior analysis, sensory integration therapy, music therapy, educational rehabilitation, and more. However, no single approach has yet achieved a definitive cure; existing interventions predominantly aim to alleviate symptoms and enhance functional abilities^[3]. Within this context, sports games have emerged as a promising non-pharmacological intervention, integrating physical activity, sensory stimulation, social interaction, and enjoyment. Owing to their low

cost, ease of implementation, and high acceptance among children, sports games have gradually revealed unique potential in this field. Grounded in children's physical and psychological developmental principles, these carefully designed exercises and playful activities systematically promote holistic development^[4]. Beyond enhancing physical fitness and motor coordination, sports games provide appropriate sensory input and pleasurable interactive experiences, fulfilling intrinsic perceptual needs and thereby reducing the frequency of stereotypic behaviors^[5].

Despite the evident advantages of sports games, existing research predominantly focuses on their effects in improving social skills, emotional regulation, or overall behavior in children with autism. Investigations specifically targeting stereotypic behaviors—one of the disorder's core symptoms—and thoroughly examining the underlying intervention mechanisms and differential efficacy remain scarce. In particular, the motivational functions driving various stereotypic behaviors, such as sensory seeking, task avoidance, or attention elicitation, differ markedly; yet current studies rarely explore tailored sports game interventions designed to address these distinct behavioral motivations. Therefore, this study intends to employ a single-subject experimental design to rigorously examine the effectiveness and sustainability of multidimensional sports games, grounded in sensory integration theory, in mitigating functionally diverse stereotypic behaviors in a child with autism. The ultimate goal is to provide empirical evidence and practical insights to inform the development of personalized and precisely targeted rehabilitation interventions.

2. Literature Review

2.1 The Concept, Advantages, and Impact of Sports Games on Children with Autism

2.1.1 The concept and characteristics of sports games

In his work *Sports Games*, Liu Fulin defines sports games as a form of planned and systematic educational activity that integrates physical exercise and entertainment, tailored to align with children's physical and psychological developmental attributes and organized through diverse formats^[6]. Compared to sensory integration therapy, sports games, while similarly incorporating physical activity, diverge

in implementation strategies and objectives. Sensory integration therapy primarily focuses on delivering specific sensory stimuli—such as vestibular and proprioceptive input—to facilitate their neural integration, typically conducted in specialized sensory integration rooms, characterized by high individualization but limited social interaction. Conversely, sports games exhibit greater flexibility and integrative qualities; they can be administered across various venues, including playgrounds and classrooms, emphasize social engagement and rule comprehension, and concurrently foster children's motor skills, cognitive abilities, and emotional regulation, thereby achieving a more holistic developmental objective.

2.1.2 The positive impacts of sports games on children with autism

Extensive research both domestically and internationally has demonstrated the multifaceted benefits of sports games for children with autism. Abroad, Lu Kin A observed that solitary sports games significantly enhance hand-eye coordination, reaction speed, and spatial body awareness in children with autism^[7]. A randomized controlled trial by Ferreira et al. confirmed that structured physical activities markedly reduce stereotypic behaviors and elevate physical activity levels among autistic children^[8]. Within China, Zeng Xiaobin highlighted the effectiveness of sports game interventions as adjunctive rehabilitation methods in early intervention programs for children with autism^[9]. Li Hailian's research revealed that sports games positively influence language development, emotional regulation, and behavioral issues in special-needs children^[10]. Jing Guoliang underscored the role of team-based sports games in cultivating communicative skills and augmenting concentration in individuals with autism^[11]. Zhang Lan provided a comprehensive summary of how sports games promote motor skills, attention, emotional control, social interaction, and cooperative as well as competitive abilities among children on the spectrum^[12].

2.2 Causes, Functions, and Current Interventions of Stereotypic Behaviors in Children with Autism

2.2.1 Causes and functions of stereotypic behaviors

The origins of stereotypic behaviors are multifaceted, arising from the intricate interplay

of physiological, psychological, and environmental factors. From a physiological perspective, such behaviors may be linked to atypical neural mechanisms or sensory processing anomalies, causing children with autism to exhibit hypersensitivity or hyposensitivity to sensory input, thereby engaging in stereotypic actions as a form of self-regulation^[13]. Functionally, these repetitive behaviors are not devoid of purpose. Baker et al. contend that such behaviors serve to obtain or avoid sensory stimuli, helping the individual achieve a state of equilibrium^[14]. Cui Shuang further elucidates that the principal functions encompass positive reinforcement, negative reinforcement, sensory regulation, and sensory stimulation, with the latter two playing especially pivotal roles^[15]. This suggests that a single stereotypic behavior might fulfill distinct functions across different contexts; for instance, hand-biting may simultaneously act as a strategy for seeking deep pressure input (sensory stimulation) and escaping challenging tasks (negative reinforcement).

2.2.2 Review of interventions targeting stereotypic behaviors

Intervention strategies targeting stereotypic behaviors are diverse, spanning behavioral approaches such as differential reinforcement and self-management, sensory-based therapies including sensory integration training and physical activity interventions, to creative therapies like music therapy. Long Yanlin systematically reviewed ten efficacious international interventions for stereotypic behaviors^[16]. In China, Xiao Junfeng utilized positive behavior support plans to successfully mitigate stereotypes in varying contexts among children with autism^[17]. Ding Fangyu demonstrated the effectiveness of sensory integration therapy in reducing stereotypic behaviors in two autistic children^[18]. Furthermore, research by Ge Junnan directly substantiated the beneficial impact of physical education classes — comprising rhythmic gymnastics and basketball — in diminishing repetitive stereotypic behaviors among children with autism^[19].

2.2.3 Advances in sports games intervention for stereotypic behaviors and innovations of this study

In recent years, the application of sports games to address stereotypic behaviors has gained momentum. Researchers worldwide have

employed a variety of sports game modalities—including ball games, balance activities, and mimicry exercises—across diverse methodological designs such as A-B-A single-subject experiments and randomized controlled trials, with most studies reporting reductions in stereotypic behaviors.

However, existing literature reveals several limitations: (1) the majority of studies fail to conduct detailed functional analyses of stereotypic behaviors, resulting in interventions that lack specificity; (2) game designs tend to emphasize traditional sports, lacking sufficient contextualization, engagement, and personalization; (3) investigations into the durability of intervention effects and the mediating role of sensory integration capacity remain insufficient.

This study's innovation lies in: (1) employing an integrative pre-intervention assessment combining ABC observations, motivation scales, and sensory integration evaluations to thoroughly analyze the functions and perceptual foundations of each targeted behavior; (2) creatively incorporating narrative-driven scenarios—such as “The Little Magician Protecting the Energy Crystal”—and role-playing elements to enhance emotional involvement and intrinsic motivation; (3) implementing a dynamic adjustment mechanism that tailors game difficulty and stimulus intensity in real time according to the participant's responses, achieving personalized intervention; (4) systematically examining the intervention's impact on sensory integration abilities and exploring its intrinsic relationship with the amelioration of stereotypic behaviors.

3. Research Design

3.1 Participants

The study selected an 11-year-old boy with autism (pseudonym: Panpan) from a special education school in Foshan City as the research subject. Inclusion criteria were as follows: (1) a formal diagnosis of Autism Spectrum Disorder confirmed by a professional institution; (2) presence of frequent and disruptive stereotypic behaviors; (3) informed consent obtained from the parents. Through a preliminary three-week observation period combined with interviews with both teachers and parents, the three most disruptive stereotypic behaviors were identified: hand-biting, nose-picking, and self-talk. Sensory

integration assessment revealed moderate to mild dysregulation in Panpan's vestibular, tactile, and proprioceptive functions.

3.2 Methodology and Experimental Design

3.2.1 Research design

An A-B-A single-subject experimental design was employed, consisting of a baseline phase (A1, 5 days), an intervention phase (B, 20 days), and a maintenance phase (A2, 5 days).

3.2.2 Variables

Independent Variable: A personalized sports game program designed based on sensory integration theory.

Dependent Variables: Frequency of the three targeted stereotypic behaviors within a specified time frame.

Control Variables: Observation time (during a specific morning class), observation setting (naturalistic classroom environment), and the interventionist.

3.3 Research Instruments

1) *ABC Behavioral Observation Record Sheet*: Utilized for analyzing antecedents, behaviors, and consequences to infer behavior functions.

2) *Behavioral Motivation Scale* (adapted from Niu Wenying's revised edition): Employed to quantitatively assess motivation underlying behaviors.

3) *Children's Sensory Integration Development Assessment Scale*: Used to evaluate sensory integration capabilities.

4) *Stereotypic Behavior Observation Record Sheet* (self-developed): Adopted for systematic documentation of behavior frequency.

5) Teacher interview guidelines and parental informed consent forms.

3.4 Data Collection and Analysis

During the baseline, intervention, and maintenance phases, the researcher, together with a trained head teacher, conducted observations in a fixed setting, recording occurrences of the target behaviors. Partial interval recording was employed, with 1-minute intervals documenting behavior occurrence over a 45-minute session. Upon study completion, interobserver agreement (IOA) was calculated, with all three phases exceeding 80%, meeting research reliability standards.

Data analysis combined visual inspection with statistical testing. Behavioral data trends were graphed using Excel for visual analysis, while

SPSS 26.0 was utilized to perform C-statistics (or equivalent methods) on the three-phase data to evaluate the significance of phase-to-phase changes, with $p < 0.05$ regarded as statistically significant.

4. Research Findings

4.1 Changes in Stereotypic Behaviors

4.1.1 Quantitative data and visual analysis results

Table 1. Comparison of Mean Frequency and Standard Deviation of Stereotypic Behaviors

	Baseline Phase		Intervention Phase		Maintenance Phase	
	Mean	SD	Mean	SD	Mean	SD
Hand-biting	17.60	3.050	6.45	4.136	5.20	2.280
Nose-picking	10.40	1.114	5.05	3.395	2.40	1.140
Self-talk	17.40	1.140	13.75	4.411	12.60	2.702

Table 2. Autocorrelation and Significance Tests of Stereotypic Behavior Frequencies

	Autocorrelation Test	Significance Test		
	Br(A1)	A1-B	B-A2	A1-A2
Hand-biting	-0.827	0.000	0.512	0.000
Nose-picking	0.268	0.001	0.080	0.000
Self-talk	-0.671	0.070	0.557	0.060

Note: $P < 0.05$ indicates statistical significance; $P < 0.01$ denotes high significance; $P < 0.001$ reflects extreme significance; $P > 0.05$ signifies no significant difference.

Hand-biting: A substantial immediate decline in frequency was observed following intervention onset, with a consistently downward trend throughout the intervention phase. The maintenance phase preserved behavior at a low frequency, accompanied by minimal data overlap, demonstrating a significant and stable intervention effect.

Nose-picking: An initial "extinction burst" was noted early in the intervention phase; nonetheless, the overall trend indicated a progressive decrease. Frequencies further diminished during maintenance, reflecting sustained therapeutic impact.

Self-talk: Data exhibited considerable fluctuation during intervention, lacking a clear directional trend and showing high overlap with baseline and maintenance phases. The intervention yielded limited improvement in this behavior, as is shown in Table 1-2.

4.2 Changes in Sensory Integration Abilities

The results indicate that the sports game

intervention produced a marked enhancement in the participant's tactile and proprioceptive functions, as is shown in Table 3.

Table 3. Pre- and Post-Intervention Assessment of Sensory Integration Functions

	Vestibular		Tactile		Proprioceptive	
	Pre-Test Score	Post-Test Score	Pre-Test Score	Post-Test Score	Pre-Test Score	Post-Test Score
Raw	44	46	62	68	37	39
Standard	30	32	24	30	25	29

4.3 Social Validity

Interviews with the classroom teacher revealed the following insights:

- 1) Recognition of Intervention Effectiveness: The educator acknowledged a marked reduction in hand-biting and nose-picking behaviors, alongside notable improvements in classroom attentiveness, lunchtime hygiene habits, and motor coordination.
- 2) Feasibility Appraisal: The gaming protocol was deemed “practical and effective”, although the teacher highlighted the burden posed by the preparation of equipment and venues. Furthermore, a more sophisticated design was recommended to address the self-talk behavior.
- 3) Family Feedback: Parents expressed satisfaction with the intervention outcomes, voiced a desire for additional home-based game programs, and reported observable enhancements in their child's sleep quality.

5. Discussion

5.1 Differential Efficacy of Sports Games on Stereotypic Behaviors with Distinct Functions

The findings of this study unequivocally demonstrate that the efficacy of sports game interventions is intricately linked to the underlying functions of the stereotypic behaviors.

For behaviors predominantly driven by sensory stimulation, such as nose-picking, and those exhibiting a dual function of sensory-seeking and task avoidance, like hand-biting, the intervention proved particularly efficacious. This corroborates our hypothesis that sports games, meticulously designed based on sensory integration theory, can effectively fulfill the sensory needs of the participant through tailored and adaptive sensory inputs—such as tactile stimulation from textured mats, deep pressure from large ball activities, and vestibular input via spinning chairs. These targeted sensory provisions effectively substitute the sensory regulation originally achieved through the stereotypic behaviors. The observed

enhancement in sensory integration abilities, especially tactile and proprioceptive functions, further consolidates this effect by normalizing the individual's responses to external stimuli and diminishing reliance on stereotypic behaviors. Conversely, for behaviors with multifaceted motivations, such as self-talk—motivated by auditory self-stimulation, task avoidance, and social communicative intent—a unidimensional intervention centered primarily on vestibular and tactile stimuli failed to comprehensively address all driving factors. Although rhythmic activities within the games, such as clapping, may partially substitute auditory stimuli, they did not adequately mitigate avoidance driven by task demands nor integrate sufficient linguistic interaction to guide social expression. This limitation resulted in no statistically significant improvement compared to baseline measures. These outcomes parallel findings by Tse et al., who observed that while dribbling games reduced hand-flapping, they were ineffective in addressing body rocking, underscoring the heterogeneous responsiveness of different stereotypic behaviors to identical motor interventions^[20].

5.2 Innovation and Dynamic Adaptation of the Intervention Protocol

The incorporation of contextualized storytelling and role-playing within this study profoundly enhanced the participant's intrinsic motivation and mitigated resistance toward the intervention—a significant advancement over conventional, monotonous, and repetitive sensory trainings. The dynamic adjustment strategies employed—such as permitting the use of a “pause card” contingent on Panpan's emotional state and real-time modulation of rotational speed—ensured the intervention consistently operated within the participant's “zone of proximal development”. This approach maintained an optimal balance between challenge and comfort, preventing avoidance behaviors induced by excessive discomfort, thus serving as a pivotal factor for the smooth execution and efficacy of the intervention.

5.3 Limitations and Future Directions

5.3.1 Limitations

(1) The limited generalizability inherent in a single-subject design warrants cautious extrapolation of findings. (2) The relatively brief duration of both intervention and maintenance phases constrains insights into long-term effects. (3) The assessment of self-talk behaviors lacked granular analysis of linguistic content and situational context. (4) The emergence of “clothing biting” as a substitute behavior post-intervention underscores the need for comprehensive attention to behavioral replacements.

5.3.2 Future directions

(1) Expand sample size to facilitate group-based studies. (2) Prolong intervention duration with extended longitudinal follow-ups. (3) Develop layered, integrative intervention frameworks combining sports games, language behavior therapies, and social stories to address behaviors driven by complex motivations. (4) Strengthen family-school collaboration by designing systematic home-generalization programs to consolidate and extend intervention outcomes.

6. Conclusions and Recommendations

6.1 Research Conclusions

1) Personalized sports game interventions grounded in sensory integration theory can effectively diminish stereotypic behaviors in children with autism that are primarily driven by sensory stimulation, with effects demonstrating commendable durability.

2) Sports game interventions significantly enhance sensory integration capabilities in children with autism, particularly tactile and proprioceptive functions, which likely constitute a key mechanism underlying the reduction of sensory-driven stereotypies.

3) The efficacy of sports games in addressing complex stereotypic behaviors motivated by multiple factors—including sensory needs, task avoidance, and social communication—is limited, necessitating more targeted and multifaceted intervention strategies.

6.2 Educational Recommendations

1) Suggestions for Practitioners: Prior to intervention, conduct comprehensive functional assessments of stereotypic behaviors. When designing sports games, emphasize engagement,

contextual relevance, and individualized adaptation, while establishing mechanisms for dynamic adjustment.

2) Suggestions for Parents: Actively collaborate with educational institutions to extend sports game interventions into the home environment, particularly by guiding children to generalize alternative behaviors learned during gameplay to daily life situations.

3) Suggestions for Educational Administrators: Advocate for the integration of sports game interventions into special education curricula, develop dedicated teaching resource repositories, and organize interdisciplinary professional development programs encompassing special education, physical education, and rehabilitation fields.

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