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A Review on Gender Differences in Minors with Autism Spectrum Disorder and the Application of Music Therapy

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Abstract. Nowadays, Autism Spectrum Disorder (ASD) is not far from us, it exists in different people with different ages or jobs. ASD is congenital and currently incurable, yet several systematic interventions exist. Besides conventional approaches, music and other creative therapies are widely used as adjuncts to primary treatment, and they have shown effectiveness. While patients with ASD may appear similar, symptom presentation varies due to multiple factors—among which gender is the focus of this essay. In this essay, I will focus on the correlation between gender difference and its effect of cognition and sensation, the manifestation of gender difference towards ASD's symptoms, the application mechanism and diversity of music therapy, the correlation between music therapy and the therapeutic result of ASD, the effect of gender bias towards ASD's treatment. Based on data from 303 minors with ASD, we found significant gender-related differences in social and emotional interaction, but no correlation between gender and the efficacy of music therapy.

Keywords: Autism, Gender difference, music therapy, gender bias, behavioral disorders

1. Introduction

WHO data for 2025 put the global ASD population at 62 million, roughly 1 in 127 people [1]. In China, that figure is even higher: a 2025 CCTV science report (Five Signs for Early Identification of Autism) notes over 13 million patients, or about 1 in 100 [2]. Besides, social gender bias and stereotypes have a serious negative impact on ASD diagnosis. ASD's main symptoms are repetitive behaviors, restricted interests, and social deficits. There are also various comorbidities, such as depression, anxiety disorders, obsessive-compulsive disorder, and attention deficit hyperactivity disorder. In addition, ASD can be divided into high-functioning and low-functioning subtypes. Symptoms in high-functioning individuals are not very obvious in social settings, but they tend to experience sensory overload; on the other hand, low-functioning patients show much more severe impairments in both social and sensory areas. Recently, the increasing number of individuals with ASD in China has driven rapid progress in ASD intervention research.

ASD intervention is undergoing a significant shift from traditional behavioral interventions to innovative multimodal accurate therapies. Plus, emerging therapeutic technologies for ASD cover key fields including innovative behavioral interventions, novel drug development, neuromodulation techniques, gut microbiota regulation, cell therapy and digital therapeutics. These technologies offer a new way to improve quality of life and social participation. This essay asks two main questions:

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whether gender difference influences ASD symptom presentation, and whether music therapy produces different effects on ASD patients of different genders. The study draws on existing domestic data through bibliometric analysis and multicenter retrospective statistical methods, and also looks at the application and efficacy of music therapy along with gender-related symptom differences. This study finally directly indicates the effects of gender difference of ASD, proving the effectiveness of music therapy. At the same time, it highlights the negative impact of social gender bias, particularly against women, in ASD care. Eventually, I hope that in the future, there will no longer be a significant gender gap in the missed diagnosis rate between women and men individuals with ASD, which will also facilitate the development of more comprehensive standard and intervention techniques.

2. Analysis of gender differences in symptoms among minors with ASD

2.1. The theoretical basis of gender differences in ASD: the Extreme Male Brain Theory

According to Baron-Cohen's Extreme Male Brain Theory, permanent physiological differences between genders are observable through behaviors, and therefore he suggests that gender is central to ASD. Baron-Cohen's theory says that men innately have good ability in comprehension and organization; women innately have good ability in sympathy and understanding. Both capabilities can help people to predict others' behaviors. Therefore, the Extreme Male Brain Theory proposes that for ASD patients, males usually show higher systemizing levels (technical systems, natural systems, abstract systems, social systems, organizational systems, and motor systems), while females tend to have superior empathic abilities (realizing and predicting others' behaviors, and giving a response) [3, 4]. Specifically, because of the better empathic abilities, females can easily notice others' expression, so they are more likely to camouflage the symptoms. Thus, one reason why females' missed diagnosis rate is much higher than males' lies in the difficulty of detection. For males, their missed diagnosis rate is lower because they are not as sensitive as females, so their symptoms can be detected more easily.

2.2. Gender comparison of symptom severity in ASD based on clinical sample data

Based on the analysis of data from 621 children diagnosed with ASD at the Child Development and Behavior Center of the Third Affiliated Hospital of Sun Yat-sen University between June 2013 and June 2015 (503 boys and 118 girls), among children within the same classification level, the proportion of girls with severe impairments in communication, physical performance and behavioral functioning was much higher than that of boys [5]. For communication, the proportion of girls with severe impairments is 45.76%, and the proportion of boys with severe impairments is 19.28%; for physical performance, the figures are 49.16% for girls and 24.65% for boys; for behaviors, the rate is 43.23% in girls with severe impairments and 21.07% in boys with severe impairments. These differences are statistically significant. These findings show that ASD patients' symptoms are intensely affected by gender difference.

2.3. Specific manifestations of gender differences in core symptoms among male and female minors with ASD

Based on the data above, female ASD patients scored lower than males in development areas including cognition, verbal expression, language comprehension, fine motor skills, gross motor

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skills, imitation, as well as emotional expression, social interaction, and both verbal and nonverbal behavioral characteristics within behavioral domains [5]. These differences indicate that females with ASD exhibit more prominent behavioral developmental deficits compared with males. Specifically, in terms of cognition and language, female individuals with ASD are harder to understand the potential meaning of others' words, communicate with others, and mimic others' reaction and facial expression; in terms of social sentiment, they are more likely to hide their emotions and symptoms, whereas males with ASD show these much more obviously as for repetitive behavior, male patients exhibit prominent, easily noticeable repetitive behaviors like intense body rocking, loud hand clapping, and constant spinning, which appear abnormal to most people. By contrast, restricted and repetitive behaviors in females with ASD tend to be more subtle and hidden, such as twirling hair, biting lips, or continuously rubbing fingers.

3. The mechanism and clinical application of Music Therapy in ASD's intervention

3.1. Three basic functional mechanisms of Music Therapy in ASD's intervention

Music therapy is a method that uses music, and its important functions include reducing social stress, enhancing speaking ability, and providing new sensory experiences. There are three fundamental mechanisms of music therapy. At the neurophysiological level, music playback activates the auditory cortex, the limbic system which is responsible for emotion regulation, the prefrontal cortex that controls impulses, and the motor cortex, stimulating the brain to form new neural connections. Meanwhile, listening to peaceful music promotes the brain to secrete mood-boosting substances such as dopamine, oxytocin and endorphins, which reduce cortisol, the stress hormone. For females with ASD, because they often suppress or hide their feelings, music therapy can help reduce emotional blunting; for males with ASD, since exaggerated reactions are their usual way of expressing emotions, music therapy can lessen their outbursts. For most minors with ASD, the biggest obstacle is language, but music works as a nonverbal emotional carrier that doesn't require physical expression, so it is quite safe and friendly for children who struggle with expression and communication. At the emotion recognition level, music helps doctors to identify the real sentiment instead of the sentiment after camouflaging. Different timbres and rhythms can convey completely different emotions, which is a good way to practice quickly recognizing various emotions; at the cognitive level, the stable beat in music helps ASD patients focus and improves the problem of weak short-term memory. During the music playback, therapists can guide individuals with ASD to sing along to practice their pronunciation and imitation skills. Collectively, this intervention enhances minors' verbal expression and social skill. Music therapy is inclusive, with various types of therapeutic systems that suit a wide range of patients.

3.2. Mainstream global Music Therapy schools and their adapted intervention models for minors with ASD

American music therapist Wilgram summarizes and clearly defines five models of music therapy: 1) Guided Imagery and Music Therapy, practiced in the American region, targeting adults and the elderly. 2) Analytical Music Therapy, practiced mainly in Europe, suitable for most children and teenagers. 3) Free Improvisational Music Therapy—this is a globally prevalent approach first developed for mental disorders, and was later expanded to pediatric populations, including children with ASD, intellectual disabilities, and physical disabilities. 4) Behavioral Music Therapy, which is really popular in America, has a wide range of applicable populations. 5) Creative Music Therapy,

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prevalent in Europe, primarily targets pediatric populations but was later extended to the elderly. Therefore, music therapy enjoys great prestige worldwide and has become a diversified therapeutic approach.

3.3. Evidence-based clinical effect verification of Music Therapy interventions for individuals with ASD

In the report Evidence-Based Practices for Children, Youth, and Young Adults with ASD published by the National ASD Evidence-Based Practice Review Panel in the United States, music therapy advanced from having limited supporting evidence in 2014 to meeting formal evidence-based criteria in 2020, and it was listed as one of the 28 effective intervention strategies [6]. Music therapy yields remarkable outcomes for minors with ASD. A study conducted by Gansu Provincial Rehabilitation Center Hospital in China included 108 children with ASD aged 2 to 6 years, who were randomly divided into two groups; the control group received rehabilitation intervention based on analytical therapy and structured teaching, whereas the observation group received music therapy in addition to the same rehabilitation intervention; standardized clinical scales were used to assess and compare outcomes after six months; and statistical analysis showed a significant difference between the two groups [7] Specifically, the pre-post score improvement margin of the control group was smaller than that of the observation group receiving combined rehabilitation intervention plus music therapy. The observation group achieved lower scores across five typical behaviors: sensation, social interaction, physical movement, verbal communication, and daily living skills. In conclusion, music therapy does effectively improve symptoms of minors with ASD, and it produces significantly stronger effects when combined with basic interventions.

4. Verification of gender differences in therapeutic effects of Music therapy and the impact of gender diagnostic bias

4.1. The experimental analysis of verification of Music Therapy's gender differences in therapeutic effects

From the evidence above, we know that ASD symptoms are affected by gender differences, so whether they also affect the therapeutic outcomes of music therapy becomes a key question. According to nearly 20 years of clinical music therapy data in China, 303 children with ASD were enrolled as research subjects, whose ages mainly ranged from 3 to 8 years old. Among them, there were 190 males and 81 females [8]. Researchers found that whether male or female, symptoms like social, sensory, emotional detection, expression skills were truly improved a lot after a long-term music therapy. Statistical results indicate no notable gender gap in overall treatment efficacy, yet boys and girls hold distinct musical tastes. Autistic boys mostly gravitate toward high-rhythm music, whereas girls lean toward melodic pieces. Therefore, gender itself exerts no significant impact on therapeutic outcomes, yet personal musical preferences partially mediate treatment effects.

4.2. The negative impact of gender diagnostic effects towards females

Nowadays, due to a lack of scientific outreach, many people hold serious stereotypes about ASD in general and about female patients in particular. For ASD, most people define ASD as simple introversion without any prior knowledge, so they don't even know the basic symptoms and living difficulties of ASD. Thus, this puts individuals with ASD that already belong to a vulnerable group

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at an additional disadvantage. In terms of clinical diagnosis, according to 2025 global data including 826 psychiatrists across 12 countries, 71.3% of doctors hold the implicit assumption that ASD predominantly affects males and tend to classify female patients' symptoms as personality or other emotional issues by priority [9]. Such ingrained bias directly demonstrates how gender prejudice harms accurate diagnosis for autistic females.

4.3. Hazards of long-term lack of intervention caused by high missed diagnosis rates

In terms of gender, epidemiological surveys indicate that male-to-female prevalence rate is about 5:1 which suggests that gender differences exist in ASD. This type of difference is not only caused by physiological factors, but also social gender bias. Society holds strong stereotypes and prejudices against females. People generally think that women should be introverted, gentle, and incommunicative. As a result, relatives of patients often easily overlook abnormal clinical symptoms when they appear in their female children. Instead, some families consider these symptoms perfectly normal for girls, which leads their children to miss the optimal period for diagnosis and intervention. Once they miss the best chance to get diagnosis, their disorders of social interaction, speaking skills, physical movement will be solidified, affecting the whole lifetime. Between 2014 and 2020, 80% of female minors with ASD globally failed to receive a formal diagnosis before age 18. After 2022, as global awareness of autistic females grew, the underdiagnosis rate dropped from 80% to 73%, but it remains high. Accordingly, professionals in psychiatry and psychology should pay more attention to female patients with ASD, who often have difficulty getting a diagnosis, and work to improve clinical practice going forward.

5. Optimization strategies for ASD diagnosis and gender-based interventions

5.1. Eliminate gender bias and improve the clinical diagnosis system for autistic females

In order to mitigate the large difference in male-to-female missed diagnosis rates, we can start with eliminating the gender bias. In psychology, personality is seen as a combination of both innate and environmental factors, rather than either one alone. Thus, we cannot judge others' personalities through gender. In fact, females can possess tough personalities, and males can also be gentle. Both two traits are not mutually exclusive. In the clinical diagnostic system for females with ASD, medical staff should pay attention to the common symptom of "social camouflaging" among women with ASD. Hospitals should provide regular specialized training on how gender plays a role in ASD, and work to reduce the fixed mindset that ASD is mainly a male condition. Hospitals can also set up quality control system for diagnostic bias, reviewing female patient cases monthly to prevent doctors give the clinical conclusions without thorough scrutiny. For society, more ASD-themed lectures and science talks should be held to remove public stereotypes and bias against ASD. The public ought to avoid sensationalized staring, condescending pity, or excessive attention around people with ASD. Patience and equal communication are the best ways to support the ASD community.

5.2. Optimizing individualized Music Therapy intervention programs based on gender traits

As social media has developed rapidly, public views on music have become more diverse. This indirectly improves the acceptiveness of individuals with ASD to music. One Indian study recruited 120 ASD children aged around 2 to 14 and analyzed their musical preferences. The final results

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showed that music therapy had positive effects on all participants, regardless of gender. Specifically, 74% of male participants favored rhythmic music and percussion, but only 28% of female participants preferred percussion, while 72% of females preferred melodic music [10]. Therefore, when designing individualized music therapy plans for patients, doctors should first choose between rhythmic and melodic music based on gender, after assessing core symptoms.

6. Conclusion

The essay mainly introduces about the basic definition, symptoms, and social status of ASD. Using both international and domestic professional evidence and analyzing the data, we find that gender differences clearly exist in ASD symptoms. Besides, the essay demonstrates the effectiveness of music therapy and musical preferences in minors with ASD, regardless of gender, and provides evidence that there is no clear gender difference in therapeutic outcomes, although gender differences do appear in musical preferences. In addition, the author investigates social influences such as gender bias in ASD, particularly affecting females. The essay explores gender disparities among ASD and the application of music therapy. However, most experimental data are sourced from a limited number of individual countries and regions, which differ widely in cultural and family backgrounds. Therefore, the findings may not be generalizable to all autistic minors, either nationwide or globally.

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