

The reasons for girls diagnosed with autism spectrum disorders (ASD) less commonly than boys

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Abstract: This study used qualitative research methods to explore autism and gender differences, and found that due to the influence of behavioural abnormalities, language disorders, gene mutation differences, cognitive neurological dysfunction, chromosome abnormalities, heredity and gender bias, which further explain some of the reasons why there is more autism in males than in females, also provide valuable ideas for further research.

Keywords: ASD, Gender influence, Autism prevention

1. Introduction

The terms “autism” and “autism spectrum disorder” (ASD) were first proposed by Kanner (1943)^[32]. A year later, Asperger (1943)^[2] further described the phenomenon: according to him, autism mainly manifested itself in children's stereotyped behaviors before the age of 3 and their social and communication deficits. Subsequently, autism began to receive widespread attention. In various countries, children were diagnosed with this symptom, which led to the conclusion that autism is a globalized childhood physical and mental development disorder. In both Kanner's and Asperger's descriptions of autism cases, men have always been the main research object, which resulted in a consensus that autism is a male disease.

In recent years, fields such as genetics, neurobiology, cognitive neuroscience, as well as developmental and experimental psychology have progressed rapidly; a tremendous breakthrough in explaining the mysteries of nature has been made, including causes of autism (Happe, Briskman & Frith, 2001)^[25]. Since Kanner discovered autism in 1943^[32], the phenomenon has been investigated for more than 60 years. Therefore, the perception of autism has significantly evolved throughout this period: from the theory that autism is a failure of parental rearing, which was proposed in the 1960s, to the view of autism as a developmental abnormality of brain biology, which became prevalent in the 1990s. Currently, autism is defined as a disorder of children's cognitive, neurological mechanisms caused by the interaction between genetics and environment (Dawson et al., 2002)^[12], and the mysteries of autism are being revealed step by step. This essay will further explore the issue of gender differences in autism.

2. Autism and gender differences

2.1 Gender differences

Does sex matter? mentions a number of interesting findings. When exploring biological health of males and females, it was found that state diseases only occur in men, while ovarian diseases only occur in females (Pardue & Wizemann, 2001)^[44]. Therefore, it seems that many differences in physiological function or pathology are indeed related to gender (Pardue & Wizemann, 2001)^[44]. However, Thompson, Caruso, & Ellerbeck (2003)^[51] point out that gender differences are worth paying attention to, because, according to them, such differences can be significant in the context of many diseases. The same conclusion can be extended to people with special needs; nevertheless, in the field of special needs, gender differences have not been fully studied or practiced, which creates the need for more researcher.

2.2 Gender differences in the incidence of autism

In 2007, the Centers for Disease Control and Prevention published an estimate of the ratio of males to females with autism spectrum disorders, which ranged from 5.5:1.4 to 16.8:4.0. However, it should be pointed out that statistics from countries around the world presented in the survey of gender differences

in the incidence of autism are inconsistent. For example, the ratio of men to females in the survey data of researchers in London and other places is 4.25:1 (Rutter & Lockyer, 1967)^[47]; while the ratio of males to females in the survey data in the United States is 3.6:1 (Lord & Schopler, 1985)^[35]; therefore, it can be seen that ASD is also present in females. The number of people diagnosed in China is far lower than that of males. Compared with the number of males, the diagnosed rate is much lower, almost 4:1, this is consistent with findings of the study by Fombonne. He showed that in most disease studies, the ratio of reported males to females is also about 4:1.

Although the survey results from different countries are somewhat different, these data can still give clear clues: there are gender differences in the incidence of autism, and it is evident that males are more affected than females. As a result of this noticeable gender difference, most research on autism focuses on men. This high proportion of male morbidity may also lead to differences in cognitive and behavioral problems (Hartley & Sikora 2009)^[26]. It was not until the emergence of the new research results by Loomes et al. (2017)^[34] that the previously reported large difference in the ratio of males to females in ASD was not true. The meta-analysis of epidemiological studies confirmed that, in fact, the number of girls with ASD had been seriously underestimated, and that specific characteristics of girls made the diagnosis of autism in females less effective; as a result, some girls suffering from the condition were not correctly diagnosed. According to Hendrickx's research (2015)^[28], the actual male-to-female ratio was even higher: small 3:1 or 2:1. This difference was due to the differences in brain functions of different sexes and the uniqueness of cognitive characteristics (Hendrickx, 2015)^[28].

2.3 The reason why less girls are frequently diagnosed with autism spectrum disorders

According to the data, the main reason why there are more boys with autism than girls is that the characteristics of autism are mainly derived from case studies of boys. Research shows that there are indeed differences between the innate neurological composition and acquired dominant behaviours of boys and girls. In other words, there is a difference in performance, as most males are inherently more aggressive and dominant (Zahn-Waxler, Shirtcliff & Marceau, 2008)^[56]. Although boys and girls are often diagnosed with the same severity of ASD, the abnormal performance of boys is more noticeable in its manifestation, while the symptoms of girls are often less evident. This is because they are better at hiding autism and, as a result, show no apparent autistic behavior in the interpersonal environment (Lai, Lombardo, Auyeung, Chakrabarti & Baron-Cohen, 2015)^[33]. For example, socially, girls are generally quieter and less self-confident than boys. A shy girl often feels normal, while a boy with the same behavior will attract attention. In addition, there are also girls whose average diagnosis time is longer than that of boys (Ernsperger & Wendel, 2007; Miller, 2003)^[20,40]. The case study sample of female autism is small, a small sample is not enough to provide more characteristics of autism in girls, which may cause girls with autism to be missed or misdiagnosed.

As this issue has received widespread attention (Corsaro & Eder, 1990; Dhuey & Lipscomb, 2010)^[10,17], it has been found that the physical differences between boys and girls affect the diagnosis of autism. Physiology promotes psychological characteristics: different physiological characteristics affect behaviour, language, and cognition (Thompson, Caruso, & Ellerbeck, 2003)^[51]. In general, the more research on the genetics and neurobiology of male-female differences there is, the easier it will be to discover the characteristics of autistic patients, and it will also be more effective for girls with autism, which need more data support and verification (Werling, 2016)^[55].

2.3.1 Behavioural abnormalities

Numerous studies show that boys and girls behave differently in social activities. While most boys seem to prefer stimulating, strenuous and competitive activities (Corsaro & Eder, 1990; Maccoby, 1988; Pellegrini et al., 2004)^[10,57,45], girls tend to build friendships by sharing secrets and spending more time communicating (Maccoby, 2004)^[38]. These gender-specific behaviours are strengthened and affirmed to a certain extent in children with autism (Maccoby, 2004; Tierney et al., 2016)^[38,52]; boys with autistic behaviours have a more comprehensive range of behavioural disorders than girls, which are mainly manifested in aggression, self-injury, and destructive behaviours (Dhuey & Lipscomb, 2010)^[17]. In addition, boys with ASD often manifest learning problems: attention deficit and hyperactivity disorder (Gould and Ashton-Smith, 2011; Hiller, Young & Weber, 2014)^[23,29]. On the other hand, girls with ASD tend to be quieter, usually behave, and have the same hobbies as normal girls (Gould & Ashton-Smith, 2011; Hiller, Young & Weber, 2014)^[23,29]. For example, children with autism rarely keep their eyes on their interlocutor's eyes. It is a common characteristic of autism; however, girls' performance is likely to be considered quiet and shy. In contrast, boys with ASD are more likely to behave abnormally to their parents or teachers (Dworzynski, Ronald, Bolton & Happé, 2012; Hiller, Young & Weber, 2014; Mandy

et al., 2011)^[19,29,39]. According to Johnson (1995)^[31] this could be due to the fact that teachers and parents subconsciously tend to give more attention to boys, especially in areas involving patriarchal thinking, this kind of thinking believes that men's activities are always regarded as absolutely important. The cultural system has given absolute authority and value to men's roles and activities. Most of the society is dominated by men and is centered on men, although this phenomenon is slowly being changed, some traditional consciousness still exists. Thus giving boys more opportunities to receive the correct medical diagnosis and intervention (Dean, Harwood & Kasari, 2016)^[13]. On the other hand. Since the behavior of girls affected by ASD tends to be closer to that of ordinary people, and they are good at disguising their traits, their Autism is often unnoticed (Asher et al., 2001; Dean et al., 2014)^[1]. Therefore, it could be argued that behavioral differences are one of the reasons for the low diagnosis rate of girls with autism.

2.3.2 Language disorders and autism

According to neurobiological evidence, the differences in language processing between males and females are due to differences in brain structure and physiology, and these differences lead to females' superiority in particular language abilities (Burman, Bitan & Booth, 2008)^[7]. Female style of verbal communication makes them more seem more "normal", thus frequently resulting in their autism remaining unnoticed.

Language belongs to the high-level cognitive activities in the nerve center and is also an essential indicator for detecting the functioning of the cognitive nervous system. Language nerves in the brains of children with autism dominate the presentation of language functions (Whitehouse & Bishop, 2008)^[53]. Compared with females, males are significantly delayed in their language cognition and have a broader range of obstacles, such as stuttering or dyslexia (D'Mello & Stoodley, 2015)^[18]. Therefore, the ratio and severity of problems in males are higher than in females (Wray, Knott & Silove, 2005)^[54]. In addition, pathological manifestations such as speech abnormalities, mechanical reply, and sudden loss of speech are mainly concentrated in males (Baron-Cohen, 2002)^[58]. In contrast, existing data show that female advantages include faster language function development and a lower chance of suffering from speech disorders, as well as higher effectiveness at recognition of emotions, compassion and cooperation, higher fluency in verbal expression, better coordination of fine motor movement, higher mathematical calculation skills and greater ease in interactions with children (Baron-Cohen & Hammer, 1997)^[59].

2.3.3 Gene mutation differences

Mutations in the gene system also affect the diagnosis of autism. Studies have shown that de novo copy number variations (CNVs) and de novo loss of function point mutations have lower mutation rates in females than males (Sanders et al., 2011; Jacquemont et al., 2014)^[49,30]. At the same time, due to clinical medicine cases and a higher number of existing cases, there are more studies on copy number variations of male genes. Therefore, it is difficult to diagnose and detect female gene mutations during disease examinations because there is relatively little research to support the process. In subsequent studies, more studies focusing on females' CNVs found that the detection of female autistic patients is beneficial, the more discoveries, the more medical evidence to support the diagnosis of female autism (Iossifov, 2014; De Rubeis et al., 2014)^[36,15].

In order to study the pathogenic genes affecting autism, scientists have adopted a new type of research method starting in 2011, that is, by collecting three or four families (with normal parents and one or two children sick) for exposure according to recessive inheritance patterns, subgroup sequencing, or new mutation ideas and methods. At present, this type of method is used in the research of most neurological diseases, and significant progress has been made. Regardless of whether disease-related mutations are found, copy number variations (CNV) are caused by the rearrangement of the genome. Generally, the copy number of large genome fragments increases or decreases with a length of more than 1 kb, which is mainly manifested as deletions and duplications at the sub- microscopic level, which is one of the important pathogenic factors of human diseases. Abnormal DNA copy number variations (CNV) are an important molecular mechanism of many human diseases (such as cancer, genetic diseases, and cardiovascular diseases)(de Sousa Lima, Barros & Aragão, 2020)^[16]. As a biomarker of diseases, chromosome deletion, amplification, and other changes have become a hotspot in many diseases (Buxbaum et al., 2001)^[8]. Therefore, the more research on female gene mutation there is, the more female autism cases will be diagnosed.

2.3.4 Cognitive neurological dysfunction and chromosome abnormalities

Explaining the problem of autism from the perspective of neurobiology is mainly possible due to the current research results of neuroscience (Saitoh, 2001; Sparks et al., 2002)^[48,50]. This neurobiological model of autism mainly considers the impact or obstacles of specific brain structure damage on people's

cognitive and behavioural functions (National Research Council, 2001) ^[60]. For example, cerebellar damage has effects on cognitive memory, and movement regulation has an impact on neurocognition. Hippocampal damage will make it difficult to imitate delayed actions, and damage to the amygdala will make it difficult for children with autism to respond appropriately to social stimuli, this theory must describe the specific damage to the brain structure and its relationship with cognitive-behavioral disorders. However, there are subtle differences in the structure of males' and females' left and right hemispheres. The differences in brain structure caused by gender differences also determine the incidence of male and female autism, the manifestation of symptoms, and the differences in brain dysfunction (Bailey, Phillips & Rutter, 1996) ^[3]. Therefore the perspective of neurobiology will be considered first, followed by a discussion of the factors of gender differences.

If it is determined that a particular brain part or circuit of autistic people is damaged, and this damage is a sufficient and necessary condition for causing autism symptoms, it could be assumed that the mechanism of autism has been successfully revealed. The brains of autistic patients show gene expression patterns more like typical males than typical females. Some of these genes are unique to microglia, which are immune cells in the brain that can remove debris and shape neuronal connections. It is also possible that girls are blocked to some extent (Morgan et al., 2010) ^[41]. Girls with autism tend to have more mutations than boys with the disease, and boys with autism seem to be more likely to inherit genetic mutations from unaffected mothers, and the genetic influence from their fathers (Halladay et al., 2015) ^[24]. In short, these results indicate that girls need more significant genetic mutations than boys to develop autism.

2.3.5 Autism and heredity

Studies have found that autism is related to a small number of genetic mutations on the X chromosome. Female sex chromosomes are composed of XX, while males are XY (Buxbaum et al., 2001) ^[8]. For females, when one gene is wrong, the other can be repaired, and only if two genes are wrong at the same time can they be affected by the condition. Nevertheless, men have only one gene related to autism, and as long as there is a genetic error, they will be affected. Therefore, the probability of men to have autism is much greater than that of females. From a genetic point of view, males are more genetically inherited. This is also why there are more and more male autistic patients, while female autistic patients are fewer (Belek, 2020) ^[4].

Since autism has a strong genetic background, the heritability of the disease is of great concern to researchers and the general public. The probability of having a second child with autistic parents is higher than that of the average population. The incidence of the normal population is about 1%, but for families with autism, this probability is reported to be 8%-25% (Centers for Disease Control and Prevention, 2007) ^[9]. The share of male and female patients is contrary to 1:1. There are more male patients, and the share of male and female patients may be as high as 4:1, which means that autism may be related to gender or sex chromosomes (Hebert & Koulouglioti, 2010) ^[27]. Since males have only one X chromosome, it is assumed to follow a recessive inheritance model. The genes on the X chromosome of male babies require only one copy of the gene to undergo genetic mutations, or new mutations will cause disease.

Female babies have two alleles at the same time, it will cause illness, and the probability should be twice as small. The probability of identical twins who have autism is 50%-90%, which is higher than that of fraternal twins. Twins experience the same environment from conception to birth. Whether there is a difference between twins, how big the difference is, and how much the heritability of a disease is based on this (Buxbaum et al., 2001) ^[8]. In addition, the older the parents are, the greater the risk of children suffering from autism. This is because the older people are, the greater is the probability of mutations in germ cell DNA. Most of the evaluations now only focus on the children with autism themselves, perhaps without careful evaluation of their parents. Multiple genes may manipulate quantitative traits, and each gene's contribution is relatively small. Such traits are also affected by the environment. Autism is a neurological disorder caused by multiple factors. It is not like bleeding that can be traced back to a wound. It may be possible to prevented and cured autism, but this requires a great deal of of research and discussion. In summary, from a chromosomal and genetic point of view, there are more males with autism and fewer females.

2.3.6 Gender bias

Stereotypes about typical male and female behaviour may cause some people to miss specific symptoms. Autism is more commonly seen among boys, partly because parents, caregivers, and doctors may not be effective at finding symptoms of autism in girls (Fine, 2010) ^[21]. Men are considered vital from birth (Burnham & Harris, 1992) ^[6], and females are weak from birth (Rubin, Provenzano, & Luria, 1974) ^[46]. Moreover, many people think that girls are quieter or prefer to be alone more often than boys

(Hendrickx, 2015)^[28]. However, research shows that the symptoms of autism (less talking, like being alone) are more common in boys, with more cases (Hendrickx, 2015)^[28]. For example, boys with autism have more frequent repetitive behaviors and difficulty with impulse control than girls with autism. These symptoms are easier to detect than issues with communication or social difficulties (Fine, 2010)^[21].

Doctors may not be effective at finding the symptoms in girls. Girls and boys diagnosed with autism at the same time show different symptoms. Girls may hide their symptoms or devote more time and energy to learning social norms (Nichols, Moravcik & Tetenbaum, 2009)^[42]; as a result, girls with autism are also more likely to build the friendly relationship with others than boys with autism. This can mask autism because social difficulties are considered one of the acute symptoms of autism. A common misdiagnosis of autism is also due to mental health problems (Ghaziuddin, 2005)^[22]. Anxiety, depression, and personality disorders may all have some common symptoms with autism, which may lead doctors to misdiagnose. A general lack of understanding of autism may mean that doctors, teachers or parents miss the symptoms in girls. It is worth noting that doctors have mainly used male case studies to develop screening tests for autism. This may mean that these tests do not include the symptoms which are more common in girls (Nichols, Moravcik & Tetenbaum, 2009)^[42].

3. Autism prevention

At present, the pathogenesis of autism is still a question of clinical discussion. Nonetheless, in order to allow children to develop better, attempts at early prevention of autism are necessary and can play a crucial role (Dawson, 2008)^[11]. The prevention of autism is complex and as such may involve multiple, complex actions. Most children with autism have problems which originated at the early stages of brain development; therefore, it is the parents who play an essential role in preventing their children from developing autistic symptoms. During pregnancy, regular birth check-ups are required, and appropriate health care during pregnancy is required to provide a typical developmental environment for the fetus. Paying attention to diet and lifestyle in order to ensure that the fetus's brain can develop and be healthy is also crucial. After the child is born, parents should regularly take the baby to the hospital for routine developmental physical examinations. If there are behavioral or psychological deviations during the child's development, parents need to be vigilant and arrange for psychological and physical development checks as early as possible. Such intervention and treatment can effectively reduce the incidence of autism.

Behavioural intervention is also significant. The core content of intervention training for children with autism is "one high and one low". "High" refers to improving social communication, while "low" to reducing stereotyped and repetitive behaviour patterns. Intervention training emphasizes the early stages, i.e. trying to carry out rescue intervention training in the critical period when the child's brain development has not been fully finalized to reduce the degree of obstacles. Intervention training should follow the principle of "social first" (Lovaas & Smith, 2003)^[37]. Last but not least, autism drug treatment also plays a positive role in the prevention of autism. Psychoactive drugs can play a particularly important role (Oswald & Sonenklar, 2007)^[43]. Drugs aimed at adults have also been shown to be effective in the treatment of autism and specific neurological mutations (Buck et al., 2014)^[5]. Nevertheless, drug therapy cannot achieve a radical effect and takes a long time. In addition to paying attention to the effect of the drug itself, it is necessary to understand the complications induced by the drug and closely monitor its side effects.

4. Conclusion

This essay has investigated gender differences in autism and found that due to the influence of behavioural abnormalities, language disorders, gene mutation differences, cognitive neurological dysfunction, chromosome abnormalities, heredity and gender bias, there are indeed fewer girls with autism than boys. Many researchers have studied gender differences and have concluded that the differences which exist between males and females also affect people with special needs. As can be seen from the above, the incidence of autism spectrum disorder in males is generally higher than that of females, and they affect their physical and mental development, language, intelligence, and behavior. However, there is still no conclusion regarding gender differences in the autism spectrum barriers, and much research is needed to investigate this issue further.

Understanding gender differences in autism spectrum disorder has a beneficial impact on its early intervention. Once the characteristics of males and females have been defined, and an intervention

method is set, this allows for growth and development of people with an autism spectrum disorder. Such targeted intervention can be effective. Autism is a kind of mental illness. Therefore, understanding the cause of autism and its mechanism is very helpful from early stages. Diagnosis and targeted, comprehensive correction, intervention, education, and training are significant. Gender differences in the occurrence mechanism of autism will have further practical clinical significance for health care and monitoring of pregnant females and newborns, especially for exploring the etiology of autism, screening and identifying. The development of diagnostic tools has high value. In addition, children with autism should also receive more attention, respect and understanding. It is expected that researchers will bring more light to children with autism, so that they will no longer be lonely angels.

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