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Research Article

Intellectual Development Level of Autism Spectrum Disorders Children in Different Severity

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Keywords

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Abstract

This study investigated the intellectual development characteristics and core symptom of Autism spectrum disorders (ASD) children, and explored their relationship between the clinical manifestations with intellectual development level. 280 children (average age=5.09(4-5.67) years) with ASD were enrolled. The Gesell Developmental Scale (GDS) and Childhood Autism Rating Scale (CARS) were respectively used to assess children's intellectual development and core symptom. We found more female than male with profound intellectual developmental delay in ASD children ($P<0.05$); and we found that ASD children at 24 to 36 months of age were more likely to be in borderline intellectual ability than being at other months of age ($P<0.05$). The GDS severity was milder in younger ASD children compared to older ones ($P<0.05$). There was a positive correlation between ASD symptom severity and GDS total severity (Kendall's tau-b=2.227, P=0.000). These cores of all GDS functional areas of severe ASD children was significantly lower than that of mild-moderate ASD children, except for gross motor functional areas ($P<0.001$). And the score of every functional domain were generally at the level of moderate to severe defects. And compared with other functional areas, language functional domain scored lowest and was at severe developmental delays. The language function areas Development Age (DA) of children with mild to moderate ASD was mainly 12 to 24 months, while the language development level of children with severe ASD was lower, mainly at < = 18 months of age level, in which 40.1% is lower than 12 months. We should not only focus on ASD children core symptoms, but also pay attention to their clinical phenotype severity with intellectual development level, considering the impact between the two factors, especially their language ability in different symptom severity, and formulate an intervention plan that fits theirs.

ABBREVIATIONS

ASD: Autism Spectrum Disorders; CARS: Childhood Autism Rating Scale; GDS: Gesell Developmental Scale; IQ: Intelligence Quotient; DSM-V: Diagnostic Statistics of Mental Disorders, 5th edition; DQ: Developmental Quotient; DA Development Age; CA Chronological Age

INTRODUCTION

Autism spectrum disorders (ASD) is a group of neurodevelopmental disorders characterized by deficits in social communication and social interactions, and unusually restricted, repetitive patterns of behavior, interests, or activities. The incidence of ASD is getting higher and higher the worldwide population prevalence is about 1% [1], and the gender disparity has been consistently reported, with estimates of a male to female ratio of approximately 4.3:1[2]. Meanwhile, research has shown that more than 70% of individuals with autism have concurrent medical, developmental, or psychiatric conditions [3]. The common concurrent developmental problems of autistic children include intellectual disability, language disorders, attention-deficit hyperactivity disorder and so on [1], statistics vary tremendously, with 11–65% of school-age children with ASD reported as having intellectual disabilities [4,5]. The existing experience of rehabilitation intervention shows that the prognosis of autistic children with different intelligence development levels is significantly different [6]. It is important for clinicians and families to know about cognitive for children and to discuss these issues, as well as to recognize that the relationship between IQ and ASD differs in different populations and at different ages [7], for the assessment of cognitive development in children under 6 years old, the assessment is not only about cognitive function, but mainly about the comprehensive assessment of sports, cognition or problem solving, language and the four aspects or energy domain of individual-society [8], namely, Children's intellectual developmental level can be judged by their behavior developmental level. At the same time, obtaining information about language level, general behavioral diversity, and motor skills, including an estimate of cognitive functioning or IQ, is considered to be one of the standard practice of ASD early diagnosis [7], and GDS can fully assess the development level of the above aspects of ASD children. On the other hand, ASD individuals do not always manifest in the same way. Features are variable, with severity ranging from mild to severe, which are sometimes associated with poor clinical outcomes [9]. Therefore, it is important to understand the GDS scores in each functional domain of children with ASD in different clinical severity and to explore the relationship between the two. However, there are few studies on this subject. In our previous research, the percentage of ASD children with delayed behavior in the GDS assessment was 97%, 86%, 89%, 100% and 97%, respectively, in terms of adaptive behavior, large muscle, fine muscle, motor language

and personal social behavior, manifesting that intellectual disability was common in autistic children [10]. In the present study, we explored the cognition and behavioral development characteristics of ASD children, analyzed the cognition and behavioral development of ASD children with different clinical symptoms severity, and explored the relationship between them. Furthermore, it can provide scientific basis for developing more effective and individualized comprehensive and specific intervention programs.

METHODS

Participants and methods

Inclusion/exclusion criteria: A total of 280 ASD children, aged 2-6 years, were enrolled in the study from July 2017 to June 2018 at special training institutions in Chongqing, China. All of them were diagnosed by a child psychosocial specialist and two developmental pediatricians at the Children's Hospital Affiliated to Medical University of Chongqing according to the United States Handbook of Diagnostic Statistics of Mental Disorders, 5th edition (DSM-V). The exclusion criteria were as follows: children with other developmental behavioral disorders or who were reluctant to cooperate with investigators.

Intellectual developmental assessments: The Gesell Developmental Scale (GDS, version 1974), used to assess neuromotor integrity, pediatric functional maturity and intellectual potential of development in children with 0-6 years by a specially trained developmental appraiser. Which can objectively reflect the normal children of motor and mental development rule, and also can be used as a diagnostic tool of nerve injury and intellectual disability children [11,12]. Included adaptive behavior, gross motor, fine motor, language, personal-social behavior five functional domains. The evaluation criteria are that Developmental Quotient (DQ=DA/CA*100, DA: Development Age; CA: Chronological Age). DQ scores ≥ 85 were classified as normal cognitive function, 76 ~ 85 as marginal state, 55 ~ 75 as mild developmental delay (mild defects), 40 ~ 54 as moderate developmental delay (moderate defects), 25 ~ 39 as severe developmental delay (severe defects), and no more than 24 as profound developmental delay (profound defects), which has been revised and is widely used to evaluate children's neurodevelopment in China [13].

ASD severity assessments: The Childhood Autism Rating Scale. The Standard CARS is a 15-item behavioral rating scale developed to diagnose autism in combination with clinical judgment. Additionally, it commonly used as a diagnostic scale and for assessing for assessing the severity of ASD in children over 2 years of age [14,15], and it was completed by a specially trained developmental appraiser. The severity is classified according to the total scores as following: a total score of 15–29 is considered `non-autistic`, a score of 30–36.5 is considered `mild to moderate` autism and a score of 37–60 is considered `moderate to severe` autism [9]. CARS have a good inter-rater reliability (0.796) and good internal consistency (0.896) [16].

Statistical analysis: All analyses were conducted using SPSS Statistics software (version 22.0, SPSS Inc., Chicago, IL, USA).The measurement data (approximate) conform to normal distribution, which is represented by $\bar{x} \pm s$, and the comparison between groups was adopted in independent T test. Counting data were expressed as an example (%), and the comparison between groups was tested with the Chi-square, Fisher's exact test. Kendall's tau-b trend test was used for correlation analysis of ordered classification variables. *P* values of <0.05 were considered statistically significant.

RESULTS

Basic information

The study included 280 ASD children with an average age of 5.09 (4-5.67) years, including 233 male and 47 female (male: female =4.96:1). According to the severity of ASD symptoms assessed by CARS, children with ASD were divided into mild to moderate group and severe group. And the mild to moderate ASD group had 118 cases (42.1%), the severe ASD group had 162 cases (57.9%). On the basis of the GDS severity degree, 11(3.9%) ASD children were in borderline state, 55(19.6%) were in mild defects, 94(33.6%) were in moderate defects, 91(32.5%) were in severe defects, 29(10.4%) were in profound defects (Table 1).

The ASD symptoms and GDS severity among ASD children in different genders

We found that there are more female profound developmental delay (29.8%) than male (6.4%) in ASD children, and no differences in other severity types and ASD symptoms severity (P>0.05) (Table 2).

Note: If the markers were the same between the two groups, such as a and a, the difference between the two groups was not statistically significant. If not, such as a and b, the difference between the two groups was statistically significant.

The ASD symptoms and GDS severity among ASD children in different ages

There was no difference in ASD children symptoms severity of different ages (P>0.05). By comparing ASD children GDS severity in different ages, it was found that most of ASD children aged from 24 to 36 months were mainly in the marginal state or mildly defects; the majority of ASD children aged from 36 to 48 months were mainly in the mildly or moderate defects; and most ASD children aged from 48 to 60 months were mainly in the mildly to severe defects; when most of them aged from 60 to 72 months were mainly in the moderate or severe defects. We found that ASD children at 24 to 36 months of age were more likely to be in borderline state than being at other months of age (P<0.05). The GDS severity was milder in younger ASD children compared to older ones (P <0.05) (Table 3).

Note: If the markers were the same between the two groups, such as a and a, the difference between the two groups was not statistically significant. If not, such as a and b, the difference between the two groups was statistically significant.

ASD symptoms and total GDS severity

Kendall's tau-b correlation was used to study the relationship between ASD symptom severity and GDS total severity. It

Table 1: ASD Children Characteristics.

Item	ASD (n=280)
Age (median(1/4 quantile-3/4quantile), yr)	5.09 (4-5.67)
Gender (male: female)	4.96:1
ASD Severity Degree, n (%)	
Mild-moderate ASD	118 (42.1)
Severe ASD	162 (57.9)
GDS Severity Degree, n (%)	
Borderline state	11 (3.9)
Mild defects	55 (19.6)
Moderate defects	94 (33.6)
Severe defects	91 (32.5)
Profound defects	29 (10.4)

Table 2: GDS severity of ASD children in different genders.

	ASD male n=233	ASD female n=47	χ^2/Fisher test	*P*
ASD Severity Degree, n (%)				
Mild-moderate ASD	103 (44.2)	15 (31.9)	2.423	0.120
Severe ASD	130 (55.8)	32 (68.1)		
GDS Severity Degree, n (%)				
Marginal state	9 (3.9)[a]	2 (4.3)[a]	19.617	0.000
Mild defects	50 (21.5)[a]	5 (10.6)[a]		
Moderate defects	79 (33.9)[a]	15 (31.9)[a]		
Severe defects	80 (34.3)[a]	11 (23.4)[a]		
Profound defects	15 (6.4)[a]	14 (29.8)[b]		

Table 3: GDS severity of ASD children in different age groups.

	24m~	36m~	48m~	60m~72m	χ^2/Fisher test	*P*
ASD Severity Degree, n (%)						
Mild-moderate ASD	7 (53.8)	23 (41.8)	18 (32.7)	70 (44.6)	3.117	0.374
Severe ASD	6 (46.2)	32 (58.2)	37 (67.3)	87 (55.4)		
GDS Severity Degree, n (%)						
Borderline state	5a (38.5)	2b (3.6)	2b (3.6)	2b (1.3)	105.08	0.000
Mind defects	5a (38.5)	25a (45.5)	12a (21.8)	13b (8.3)		
Moderate defects	1a (7.7)	22a (40)	22a (40)	49a (31.2)		
Serious defects	1a,b (7.7)	6b (10.9)	15a,b (27.3)	69a (43.9)		
Severe defects	1a,b (7.7)	0b (0.0)	4a,b (7.3)	24a (15.3)		

was found that there was a positive correlation (Kendall's tau-b=0.227, P=0.000) (Table 4).

GDS functional domain and ASD symptom

Compared with the GDS scores of different severity ASD children, there was no difference between the two groups only in the large motor functional domain (P>0.05). In the other four functional domain, the scores of mild to moderate autistic children were higher than those of the severe autistic children (P<0.05). And the score of every functional domain were generally at the level of moderate to severe defects. The score trend of various functional domains of ASD children with the same severity was compared: gross motor score > fine motor score > adaptive behavior score or personal-social behavior score > language score (Table 5).

Language development and ASD symptom

According to the GDS measured the Development Age (DA) of ASD children's language functional domain, analysis of language development level of the ASD children in different severity. We found that mild to moderate autistic children's language functional domain's DA mainly in 12 ~ 24 months, while severe autism children's language development level mainly in < = 18 months of age level, in which of them 40.1% is lower than 12 months (Figure 1).

DISCUSSION

As far as we know, this study is the first to investigate the relationship of clinical phenotype severity and developmental level of ASD children during 2 to 6 years old in China. And our findings are as follows:

It is well known that ASD is associated with significantly higher rates of morbidity in male than in female, however, we found that there are more female than male with profound defects in ASD children, consistent with Banach et al., conclusions [2,17],

Table 4: Correlation analysis of ASD symptom severity and GDS total severity.

GDS Severity Degree, n (%)	Mild-moderate ASD (n=118)	Severe ASD (n=162)	Kendall's tau-b	*P*
Borderline state	8 (6.8)	3 (1.9)	2.227	0.000
Mild defects	26 (22)	29 (17.9)		
Moderate defects	50 (42.4)	44 (27.2)		
Severe defects	31 (26.3)	60 (37)		
Profound defects	3 (2.5)	26 (16)		

Table 5: Comparison of GDS every aspect score of ASD children with different severity.

GDS (scores, Means ± SD)	Mild-moderate ASD (n=118)	Severe ASD (n=162)	t	*P*
Total Score	48.36 ± 14.73	40.12 ± 15.34	4.509	0.000
Adaptive behavior	47.81 ± 16.79	37.90 ± 16.84	4.868	0.000
Gross motor	55.62 ± 16.17	51.57 ± 18.73	1.891	0.06
Fine motor	55.04 ± 17.77	44.71 ± 18.98	4.618	0.000
Language	35.63 ± 15.44	27.22 ± 14.52	4.656	0.000
Personal-social behavior	47.69 ± 16.75	39.21 ± 16.06	4.286	0.000

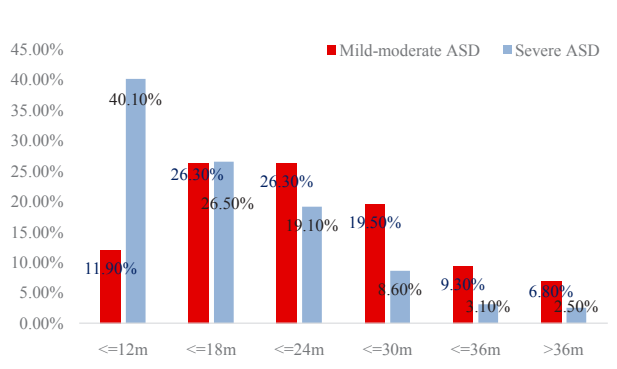

Figure 1 Comparison of language development level among children with autism in different severity.

also reached conclusion through a systematic review: Females with ASD have lower average intellectual ability than males. But Nicholas et al. [18], thought among those most severely impaired, male and female were equally represented. Although still controversial, it is suggested that we should pay attention to the intervention based on the intelligence level of ASD children of different genders. Meanwhile, more research is needed on the gender and intelligence levels of autistic children [19], thought IQ scores can be erratic in children with ASD, especially in early childhood. It's worth mentioning that most of ASD children aged from 24 to 36 months were mainly in the marginal state or mildly deficient [20], and we found ASD children at 24 to 36 months of age were more likely to be in borderline state than being at other months of age ($P<0.05$). The GDS severity was milder in younger ASD children compared to older ones. This may be related to several reasons: First, it could be related to changes in the symptoms of ASD himself. A study found that cognitive development in ASD children grew more slowly than in low-risk children between 12 and 36 months [21], but we don't know if the same is true for older ASD children. However [22], draws conclusions by reviewing a large number of literature reports the majority of studies state that IQ points of ASD children will remain the same, which suggests the stability of IQ scores [1], systematic reviews how that although social functioning, cognitive ability and language skills remained relatively stable in some studies, others reported deterioration over time. Second, this result also might be partially related to the fact that the respondents of our survey come from southwest China where the economy is less developed. Parents have less awareness of ASD, which may delay the diagnosis and treatment of ASD children and make them fail to receive timely intervention and generally serious. Last, the results may also be related to that parents have increased their awareness of early recognition of ASD, and early intervention has promoted the developmental outcomes of rehabilitation and behavior in the past two years. All in all, this requires a larger cohort study of ASD children to explore. And the important implication for us is that early, sustained, regular, and intensive interventions may improve the prognosis of ASD children.

Although intellectual disability is not one of ASD core symptoms, we found that the relationship between ASD symptom severity and GDS total severity was some positive correlation. Same as previous studies [23,24], research shows that there is a substantial overlap between the genetic factors that influence individual variation in autistic traits and IQ. Though he thought many findings about the relationship between ASD symptom and intellect largely depend on what instruments were used to measure autistic traits. We also found severe ASD children had lower levels of intellectual development than those mild to moderate ASD children, which might further indicate that the relationship between ASD symptom severity and GDS total severity was some positive correlation. This may, in part, indicate that many diagnostic and dimensional measures of ASD symptomatology include a mixture of developmental abilities or skills and frank atypical behaviors, in particular for children and adolescents. Alternatively, individuals with ASD with higher cognitive ability might develop compensatory or alternative strategies to develop social communication skills resulting in slightly reduced symptom presentation [25].

Based on the above results, we further analyzed data, found the GDS scores of severe ASD children was significantly lower than that of mild-moderate ASD children except for gross motor functional domain, which may indicates that the clinical severity

was significantly effect on every functional domain of ASD children except for gross motor.

All the scores of ASD children every functional domain were generally at the level of moderate to severe defects (25 points~40points~54points). This is close to the reported IQ of more than half of ASD children below 55 [26]. The score of various functional domains of ASD children with the same severity was compared: gross motor score > fine motor score > adaptive behavior score or personal-social behavior score > language score. However, we can't ignore the lower scores may be also associated with communication disorders among ASD children themselves, which could lead to bias in GDS test results [1], language functional domain scored lowest, which may also bring about adaptive behavior score or personal-social behavior scores lower to some extent(some items of them are touch on language competence).

Further analysis of the language development level found that the language function domain DA of children with mild to moderate ASD was mainly 12 to 24 months, while the language development level of children with severe ASD was lower, mainly at < = 18 months of age level, in which 40.1% is lower than 12 months. Studies have found that most children with ASD suffer from serious language defects, which reflects the most obvious clinical manifestation of such children, and is also the main reason for the treatment of children with ASD [27,28]. Parents only beginning to be alarmed when their child doesn't start speaking [29]. Research shows the greatest gains, even into adulthood, are made by children who have begun to make progress in language and have about average non-verbal skills by 3 years of age. Preschool years as a window in the natural history of language development during which more change might be occurring which include more dramatic shifts in trajectories that result in catching up to overall age-group average levels [30,31]. We found those children with autism, who are clinically more severe, have significantly lower language skills. More attention should be paid to the language problems of different symptom severity ASD children during 2 to 6 years of age and explore more individualized language intervention scheme to improve prognosis of ASD children.

CONCLUSION

Although intellectual disability is not a core symptom of autism, our findings could help to develop intervention programs for ASD children. The intervention of ASD children should not only focus on their core symptoms, but also pay attention to their clinical phenotype severity with cognition and behavioral development level during 2 to 6 years of age, considering the impact between the two factors, especially their language ability in different symptom severity, and formulate an more individualized, comprehensive intervention programs to improve prognosis of children with autism.

The study also has several limitations. Firstly, this study is a cross-sectional study. It is not possible to dynamically observe changes in the level of cognition and behavioral development of autistic children at different times. Secondly, the enrolled subjects were from several special education institutions in our city, which may make the overall symptoms of the included subjects generally heavier.

In general, these findings help us to understand the relationship between clinical presentation and behavioral development in ASD children. It also provides a scientific basis for us to develop more effective and appropriate training programs for ASD children of different clinical severity and cognitive development levels.

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