The Relationship of Social Function with Motor and Speech Functions in Children with Autism

Hung-Chih Hsu, MD; Chia-Ling Chen, MD, PhD; Pao-Tsai Cheng, MD; Chia-Hui Chen, MEd; Chia-Ying Chong, MD; Yi-Ying Lin

Background: Autism is a pervasive developmental disorder, characterized by pervasive impairment in several areas of development, including social interactions and communication skills. The purpose of this study was to investigate the development profiles and determine the relationship of social function with motor and speech functions in children with autism.

Methods: We collected the medical records of 32 children with autism. We used the Chinese Children Developmental Inventory (CCDI) to assess eight functional domains including: gross motor (GM), fine motor (FM), expressive language (EL), concept comprehension (CC), social comprehension (SC), self help (SH), personal social (PS), and general development (GD). The children were classified into group A if the PS development quotient (DQ) was equal to or higher than 50%, or they were classified into group B if the PSDQ was lower than 50%. We compared the DQ between the two groups. A value of $p < 0.05$ was considered statistically significant.

Results: The developmental functions, including motor, speech, and self help functions in the autism group with high social function were better than those in the autism group with low social function. The DQs of all developmental function in group A (60-88%) were higher than those in group B (28-57%) ($p < 0.01$). The gross motor and fine motor functions were better than speech and social function by 20 to 37% in both groups. Correlation analysis among developmental functions showed significant correlation (r=0.46-0.94, $p < 0.01$). Using a stepwise linear regression test, the PS function was highly correlated with SC ($r2 = 0.832$, $p < 0.001$).

Conclusions: Autism is a multifaceted and disproportional developmental disorder. Social communication may play the dominant role in determining the social functions in children with autism.

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Key words: **autism, developmental function, risk factor, developmental delay.**

Autism is a pervasive developmental disorder that occurs during early childhood. It typically manifests during the first 3 years of a child's life and is characterized by severe and pervasive impairment in

From the Department of Physical Medicine and Rehabilitation, Chang Gung Memorial and Children's Hospital, Taipei.
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Address for reprints: Dr. Chia-Ling Chen, Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital. No. 5, Fushing St., Gueishan Shiang, Taoyuan, Taiwan 333, R.O.C. Tel.: 886-3-3281200 ext. 8147; Fax: 886-3-3281200 ext. 2667; E-mail: a7634245@ms21.hinet.net, ccl1374@adm.cgmh.org.tw

several areas of development, including social interaction and communications skills. Children with autism typically have difficulties in verbal and nonverbal communication, social interactions, and play activities.[1] It is now accepted as a multifaceted developmental disorder which is present at birth and does not result from family stress and inadequate parenting.[2,3] Nowadays speech dysfunction and language disorder is also considered an important part of autism.[4] However, the motor functions of autistic children are also affected, including oculomotor dysfunction.[5,6] Clinical evidence suggests that specific motor speech limitations are also a significant factor.[7,8] Until now, few researchers have investigated all of the developmental profiles, including motor, speech, and social function in children with autism.

The personal social development in healthy children is noticed from birth, including expressing various innate, universal facial expressions,[9,10] discriminating mother's face from a that of a stranger,[11] and discriminating and imitating facial expressions.[12] The personal social function drives are also seen in the newborn's preference for human voices over other sounds, especially its mother's voice.[13,14] However, children with autism may fail to engage both in the verbal and nonverbal social interactions typically seen in healthy children,[15,16] including not engaged in attention-sharing behaviors, such as pointing or showing objects,[17] use of primarily vowel-like vocalization, difficulty in sequencing speech sounds in multisyllabic productions, echolalia, and few instances of spontaneous speech.[18] Impaired development of speech in autistic children were most often attributed to the social-cognitive impairment. Only a few researchers have investigated the dominant factors to determine the social functions in children with autism.

The risk factors related to deviant intrauterine growth or fetal distress are important in the pathogenesis of autism, including daily smoking during early pregnancy, Cesarean delivery, low birth weight for gestational age, 5-minute Apgar score below 7, and congenital malformations.[19,20] In addition, there were higher incidence of maternal uterine bleeding, higher incidence of maternal vaginal infection, and less maternal use of contraceptives during conception.[22] Genetic factors (chromosomes 7q31-35, 15q11-13 and 16p13.3) and immune dysfunction also play a role in autism pathogenesis.[20,21,23]

The diagnosis of autism requires knowledge of normal growth and development patterns as well as the characteristics of other childhood psychiatric disorders.[6] Early diagnosis of this disorder is essential to ensure timely access to interventions known to improve outcomes for children with autism.[7] Children with autism have impairments in several aspects of development function. We hypothesized there was a relationship between social function and motor and speech functions in children with autism. The purpose of this study was to investigate the development profiles, analyze the types of risk factors, and determine the relationship of social function with motor and speech functions in children with autism. We also tried to identify the dominant factors in determining the social functions in children with autism.

METHODS

A total of 32 children with a diagnosis of autism meeting the DSM- IV criteria (which includes delayed or abnormal functioning in at least one of the following including, social interaction, language and symbolic or imaginative play) were enrolled in this study. The children underwent the assessment of functional development, related diseases, and risk factors. To assess the functional development, we used the Chinese Children Developmental Inventory (CCDI) to assess eight functional domains including: gross motor (GM), fine motor (FM), expressive language (EL), concept comprehension (CC), social comprehension (SC), self help (SH), personal social (PS) and general development (GD).[9] The development quotient (DQ) was determined as a percentage of the development age divided by the chronological age. Based on the clinical assessments combined with the results of CCDI and other evaluation tests, all children were classified into two groups according to the DQ of social function. The children were classified into group A if the PS DQ was equal to or higher than 50%, or were classified into group B if the PS DQ was below 50%.

To survey the related risk factors in children with developmental delay (DD), all children underwent detailed birth history taking, chart reviews, and prospective clinical investigations. The risk factors contributing to DD were categorized into 6 factors including: prematurity or low birth body weight

(BBW), genetic defect or congenital anomaly, neonatal insult, CNS lesions caused by diseases or trauma, environmental-related factors and unknown causes. Gestational age (GA) below 32 weeks was defined as prematurity and BBW under 2000 grams was defined as low BBW. Those who had chromosome or genetic abnormality, craniofacial anomaly, spinal bifida, congenital heart disease and limbs deformity/deficiency were placed in the genetic defect or congenital anomaly group. The neonatal insults included related factors that occurred before, during and after pregnancy, such as low Apgar score (below score 5 at 5 minutes), infantile spasm, and severe hyperbilirubinemia post transfusion. CNS lesions consisted of hydrocephalus, intracranial hemorrhage, hypoxic encephalopathy, infection, and seizure disorder.[19,21,22] The conditions which consisted of parent's mental or psychological disorder, child abuse, economic status less than NT$150,000/year or higher education level of parents less than middle school were defined as environmental-related factors. The risk factors not clearly determined were categorized as unknown factors. In addition, the age, body weight (BW), body height (BH), gender, educational, occupational and economic status, GA, BBW, and delivery modes during pregnancy were also recorded. The parental education levels were categorized into three grades (low: less than high school, middle: high school, and high: university or higher). The parental economic status were categorized into three grades (low: less than 370,000 NT dollars per year, middle: 370,000 to 990,000 NT dollars per year, and high: higher than 990,000 NT dollars per year). The occupational statuses were categorized into three classes: labor/farmer/fisher, clerk/self-employment/service industry, and professional such as physician, lawyer, professor, manager, etc. The higher education or occupational statuses of parents were included in the analysis.

Differences in the continuous data (age, BH, BW, BBW, GA) between the two groups were compared using a *t*-test. Differences in the categorical data (gender and delivery mode) between the two groups were determined using the Chi-square or Fisher's exact test if at least one of the expected cell counts was less than 5. Mann-Whitney U test was used to determine the differences in the risk factors, educational, occupational, and economic status between two groups. The Pearson's correlation was used to determine the relation of developmental functions. A stepwise linear regression test was used to determine the most significant associations of the PS function with other developmental functions. A p value of < 0.05 was considered statistically significant.

RESULTS

The children with autism had male predominance (84%) in both groups. There were 27 boys (mean age, 44.5 months) and five girls (mean age, 44.9 months) in our study. The educational level of most of the parents was high school degree or higher (70%). The economic status of most of the parents was in the middle or high (87%) range, and most of the parents were employed as clerks, self-employment, worked in the service industry, or held professional occupations (69%). A total of 44% of the children had risk factors at birth, including prematurity, genetic disorders, neonatal insults, and central nervous system lesions. A total of 22% of the children had environmental factors. A total of 25% of the children were delivery by cesarean delivery. There were no significant differences among the demographic data between group A and group B (Table 1).

Table 1. Demographic Data and Family Status of Group A and Group B

Data	Group A (N=15)	Group B (N=17)
Age (years)	3.7±0.9	3.7±1.0
Body height (cm)	100.9±7.9	102.3±8.6
Body weight (Kg)	16.8±3.0	17.9±3.3
Gender		
Male	14	13
Female	1	4
Parent's education level		
Low: <high school	5	4
Middle: high school	5	8
High: university or higher	3	5
Family economic status (NT$ /year)		
Low: <370,000	3	1
Middle: 37-990,000	10	12
High: >990,000	2	4
Parent's occupation status		
labor/farmer/fisher	5	5
clerk/self-employment/service industry	8	9
professional	2	3

The education level, economic status, and occupational status showed no significant differences between the two groups. There were no significant differences of birth characteristics and data (gestational age, birth body weight, and delivery mode) between the two groups (Table 2). The associated risk factors including prematurity, genetic, neonatal insults, CNS lesions, environmental factors, and other factors also disclosed no significant differences between the two groups.

The DQs of all of the developmental functions in group A (GM: 85.7±19.8%; FM: 87.6±20.0%; EL: 50.7±23.6%; CC: 60.2±28.9%; SC: 79.1±20.2%; SH: 81.5±16.7%; PS: 65.6±12.5%; GD: 72.1±19.8%) were higher than those in group B (GM: 56.7±22.9%; FM: 50.9±21.8%; EL: 29.3±8.9%; CC: 31.0±12.8%; SC: 35.7±14.3%; SH: 43.3±17.9%; PS: 28.1±9.4%; GD: 41.6±10.5%) ($p<0.01$; Fig. 1). The gross motor and fine motor functions were better than speech and social function by 20-37% in group A. Similarly, the gross motor and fine motor functions were better than speech and social functions by 22-29% in Group B.

The Pearson's correlation coefficient ranged from 0.46-0.94, showing that all achieved statistical significance (Table 3). Using a stepwise linear regression test, the results showed the PS function was highly correlated with SC (PS DQ=5.51+(0.91 ×SC DQ), $r2=0.832$, $p<0.001$). The remaining variables of GM, FM, EL, CC, SH and GD did not significantly increase the association.

Table 2. Birth Data of Group A and Group B

Data	Group A (N=15)	Group B (N=17)
Gestational age (months)	38.6±1.2	39.2±1.3
Birth body weight (grams)	2970±702	3400±449
Delivery mode		
Natural	10	14
Cesarean section	5	3
Risk factor		
Biological		
Premature	1	0
Genetic	0	2
neonatal insults	1	3
CNS lesions	2	5
Other	1	2
Environment	3	4

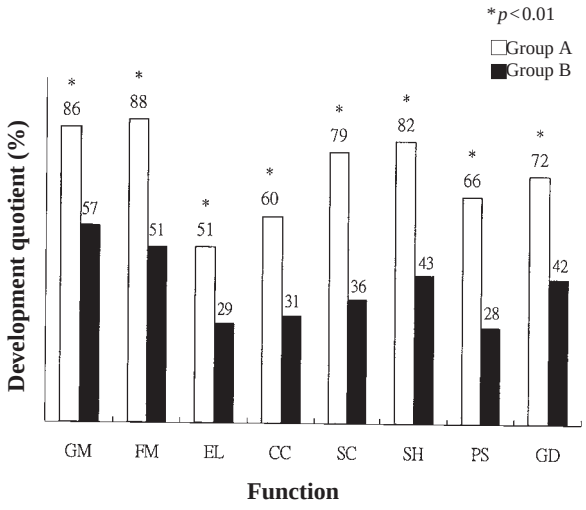

Fig. 1 The development quotient (DQ) of different functions in autism within group A and group B. GM: gross motor; FM: fine motor; EL: expressive language; CC: concept comprehension; SC: social comprehension; SH: self help; PS: personal social; GD: general development. * $p<0.01$

Table 3. Correlation Coefficient among Developmental Functions

	DQPS	DQEL	DQGM	DQFM	DQCC	DQSC	DQSH	DQGD
DQPS		0.721*	0.593*	0.767*	0.78*	0.912*	0.847*	0.82*
DQEL	0.721*		0.499*	0.634*	0.938*	0.738*	0.705*	0.862*
DQGM	0.593*	0.499*		0.774*	0.46*	0.751*	0.648*	0.698*
DQFM	0.767*	0.634*	0.774*		0.68*	0.823*	0.831*	0.79*
DQCC	0.78*	0.938*	0.46*	0.68*		0.81*	0.793*	0.885*
DQSC	0.912*	0.738*	0.751*	0.823*	0.81*		0.895*	0.898*
DQSH	0.847*	0.705*	0.648*	0.831*	0.793*	0.895*		0.835*

Abbreviations: DQ: development quotient; GM: gross motor; FM: fine motor; EL: expressive language; CC: concept comprehension; SC: social comprehension; SH: self help; PS: personal social; GD: general development.
* $p<0.01$

DISCUSSION

Children with pervasive developmental disorder (PDD) had disproportional development patterns in motor, speech, and social domains. In this study, children with autism had development delays not only in the speech and social functions, but also in the motor functions. However, they had disproportional development delays in motor, speech, and social functions. The developmental patterns in autism with high and low social funtion were similar. The gross motor and fine motor functions were better than speech and social function by 20-37% in both groups. Minshew et al. suggested the neuropsychologic profile in autism is consistent with a selective impairment in complex information processing that does not involve visual-spatial processing.[24] The profile includes impairments in skilled motor, complex memory, complex language, and reasoning domains, and by intact or superior performance in the attention, simple memory, simple language, and visual-spatial domains. That is, the profile of autism is not consistent with a single primary deficit, but with multiple primary deficits in which the deficit pattern within and across domains is reflective of the complexity of the information processing demands. The neurophysiologic characterization of autism is a late information processing disorder that spares early information processing.[24,25] Therefore, the developmental profiles in PDD are not consistent with mental retardation or with general deficit syndromes, but rather with a more selective impairment in some functions, especially in language and social domains. Our findings suggest autism is a multifaceted and disproportional developmental disorder. Children with such disproportional development patterns should be taken into the differential diagnosis of PDD. Therefore, we should provide comprehensive assessment and transdisciplinary therapy for children with PDD.

The personal social function is an important developmental function in children with autism. We found all developmental functions including motor, speech, and self help functions in autism with high social function were better than those in autism with low social function. Children with autism show lack of social knowledge and fail to acquire social knowledge, which is shown by the inability to engage in spontaneous symbolic play,[28] inability to form context-relevant communicative intentions,[29] and inability to generate original actions in play.[30] The impaired social function in PDD further deprived the experiences of social communication and social motor functions, such as competitive or playing activities. The impaired speech and motor functions also compromised the social functions. Therefore, there were complicated interactions among motor, speech, and social functions in children with autism.

Social communication may play the dominant role in determining the social functions in children with autism. In this study, the social comprehension factor correlated the most with personal social functions using a stepwise regression. Some recent studies applied "social communication" as a spectrum variable, and factor analysis of the "social communication" results in three domains including affective reciprocity, joint attention, and theory of mind.[26,31-34] Affective reciprocity represented the behavioral propensity of the children to use facial, gestural, vocal, and body language cues in two-way communication with others. Theory of mind appeared to represent "social knowledge" in the broad sense.[31] All the three domains have been proved to be correlated with autism,[32] including autistic children do not show joint attention,[33] and they fail to develop a theory of mind.[26] The most severely affected autistic children had moderate to severe abnormalities in all three domains.[34] Autistic children do not seem to be able to recognize the emotional and contextual meaning of facial expression, gestures, and the nonverbal vocalizations of emotion.[25] They rarely use emotional gestures, though they can initiate them upon request.[26] As for the speech function, autistic children do not know the rules of interpersonal communication, such as how to start a question, choose a topic to discuss, and make turns for conversation or how to end a conversation.[27] Our findings may suggest the early intervention should focus on the social comprehension if we want to improve the social function in children with autism.

We found that the children with autism had a male predominance in both groups. Most parents had educational levels higher than high school, economic levels higher than the middle range, and the occupational status included clerks, self-employment, service industry and professionals. A total of 44% of the children had biological risk factors at birth, and 22% of the children had environmental risk factors. A

total of 25% of the children were delivery via cesarean section. Other researchers have suggested that perinatal risk factors for autism include daily smoking in early pregnancy, maternal birth outside Europe and North America, cesarean delivery, being small for gestational age, a 5-minute Apgar score below 7, and congenital malformations.[19] There were no significant differences of demographic data, family status, or birth data between group A and group B in this study.

In conclusion, autism is a multifaceted and disproportional developmental disorder. The developmental functions include motor, speech, and self help functions in autism with high social function were better than those in autism with low social function. Social communication may play the dominant role in determining the social functions in children with autism. Therefore, we should provide comprehensive assessment and transdisciplinary therapy for children with PDD. Early intervention should focus on the social comprehension if we want to improve the social function in children with autism. Future detailed studies about autism, including genetic and molecular biology and functional MRI studies may be promising in the understanding of actual normal brain-behavior relationships.

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自閉症兒童之社會性功能與運動及語言功能之相關性

許宏志 陳嘉玲 鄭寶釵 陳嘉惠 鍾佳英 林宜穎

背 景：自閉症爲兒童期的一種廣泛性發展疾患，其特點是在社會性互動，溝通等方面有嚴重缺損，並且在活動度和興趣方面有受限制傾向。本研究爲研究自閉症兒童之社會性功能與運動及語言功能之相關性。

方 法：連續收集32位自閉症兒童，並且根據中華兒童發展量表的來評估八方面的功能並記錄其分數：粗動作、細動作、語言表達、觀念理解、社會理解、生活自理、人際社會及一般發展。並且以人際社會發展指數的高低分爲兩組，高於50%爲A組，低於50%爲B組。針對兩組並進行相關性分析，並比較其他指數的差異性，p值小於0.05爲統計上有意義。

結 果：在發展指數中，包括運動、語言、和生活自理等方面，A組 (60~88%) 比B組 (28~57%) 發展商數都要來的高（p值小於0.01）。而在兩組當中，粗動作和細動作的分數都要比語言和社會功能的分數高20~37%。各項發展指數間的關聯性分析顯示了具統計意義的關聯 ($r=0.46\text{-}0.94$, $p<0.01$)。階段性的線性回歸分析顯示，人際社會發展指數和社會理解有最高相關 ($r2=0.832$, $p<0.001$)。

結 論：自閉症爲一多面向及不對稱性的發展遲緩。在決定自閉症兒童的社會功能中，社會理解可能扮演最主要的角色。因此對於自閉症的兒童，我們應該提供完整的評估並且提供跨專業領域的治療。

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關鍵字：自閉症，發展功能，危險因子，發展遲緩。

長庚紀念醫院　台北院區　兒童復健科
受文日期：民國92年12月22日；接受刊載：民國93年7月12日
索取抽印本處：陳嘉玲醫師，長庚紀念醫院　兒童復健科。桃園縣333龜山鄉復興街5號。Tel.: (03)3281200轉8147; Fax: (03)3281200轉2667; E-mail: a7634245@ms21.hinet.net; ccl1374@adm.cgmh.org.tw