Personality characteristics and neurocognitive functions in parents of children with Autism Spectrum Disorder

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1. Introduction
The increasing prevalence of autism spectrum disorder in children and the huge family burdens have caused concern in the academic field as well as society. [1-3] Kanner[4] found that the family members (e.g. parents or siblings) of autistic patients had unusual personality characteristics in their social interaction, verbal and nonverbal communication, behaviors, and interests, even though these family members did not have ASD. The severity of these personality characteristics was directly proportional to their biological relationship.[5] Lord, Rutter, and Le Counteur[6] defined this condition as broad autism phenotype (BAP). It is milder than autism, but is in the spectrum of autism in terms...
of their language, cognition, social interaction, and personality character. Furthermore, the concept of quantitative traits locus (QTLs) was proposed.\(^7\) People believe that the autistic patients and their family members have similar endophenotype. The quantity of the endophenotype in autistic patients meet the threshold for diagnostic criteria. With the development of neurocognitive science, it was found that the typical symptoms of autism may not be caused by the general cognitive impairment including intelligence, but caused by the deficiencies of specific cognitive functions.\(^8\) Some of these cognitive functions are highly correlated genetically.\(^9\)

In recent years, the etiology and mechanism of autism have been the focus of research, but the exact mechanism remains unclear. A possibility for breakthrough is to better understand the core symptoms of autism and to study the most crucial and most common endophenotype of autistic patients and their family members.\(^10\) The present study was conducted in the area of Southwest China. We evaluated the personality characteristics and neurocognitive functions of Chinese parents of autistic children who met the Diagnostic and Statistical Manual of mental disorder-IV (DSM-IV) criteria, and compared them with the parents of well-developed children. On the basis of previous findings, we hypothesized that parents of autistic children display special personal characteristics and decreased neurocognitive functions, and we hope to provide additional evidence for furthering future studies on autism.

2. Methods

2.1 Participants

From April 2009 to September 2011, 41 ethnically Han Chinese children with ASD were recruited at the outpatient clinic of the Sichuan University Western China Hospital Mental Health Center, and Chengdu Rehab Center for autistic patients. The preliminary diagnosis of ASD was made by a child psychiatrist or a clinician according to the Chinese Classification of Mental Disorders, 3\(^{rd}\) version.\(^11\) Then, the patients were evaluated by a psychiatrist who received training on the use of DSM-IV. Eventually, 41 patients met the criteria for ASD. Their 79 biological parents who met the inclusion criteria below were recruited for this study. In the meantime, 68 healthy and well-developed Han Chinese children were recruited from among first or second grade classes at a public elementary school in Chengdu. Their 80 biological parents who met the inclusion criteria below were included in the control group. The study was approved by the ethics committee of the West China Hospital of Sichuan University. All participants provided written informed consent.

Inclusion criteria for the ASD group: [1] Han Ethnicity; Age 25-45 years old. [2] At least elementary education level so that they could understand the instruction and content of the tests. [3] Their children met the diagnostic criteria for ASD according to CCMD-3 and DSM-IV.

Inclusion criteria for the normal control group: [1] Han ethnicity; At least elementary education level; Age 25-45 years old. [2] Their children had no history of mental retardation, ASD, attention-deficit/hyperactivity disorder, tic disorders, and language or other developmental disturbances. [3] They had no history of neurological or mental disorders, traumatic brain injury, or other severe medical illnesses. [4] They were not currently on benzodiazepines or other neuropsychiatric medications.

2.2 Assessment tools

2.2.1 Demographic data collection

A self-designed questionnaire was used to collect the parents’ demographic data including age, educational level and occupation.

2.2.2 Personality test

We used the Eysenck Personality Questionnaire (EPQ) for Adults - Chinese Version to evaluate personality characteristics.\(^12\) The questionnaire was devised based on the hypothesis of personality model proposed by Eysenck, H.J. and Eysenck, S.B.G.\(^13\) It measures the personality dimensions of extraversion (E), neuroticism (N), psychoticism (P) and lying (L). The examinee will complete 88 true or false questions independently in a quiet room. The scores of each dimension (score 1, 0 and -1) are calculated and transformed into a T score based on age and gender norms.

The psychotism or P dimension evaluates the oddness and paranoia of behaviors. Psychotic behaviors are characterized by impulsiveness, hostility, antisocial behavior, lack of concern, lack of empathy, and self-centeredness. Extraversion or the E dimension evaluates the extraverted aspects of personality, like being outgoing, talkative, positive, or in need of external stimulation. Neuroticism or the N dimension evaluates the stability of emotion and behavior. It is characterized by high levels of negative affect such as depression, anxiety, tenseness and lack of confidence. The Lie or L scale is used to measure to what extent the subjects are deliberately attempting to control their scores. It reflects the reliability of the questionnaire and shows the subjects’ level of social integration and maturity.

2.2.3 Neurocognitive function tests

Wechsler Adult Intelligence Scale (WAIS),\(^14\) Cattell’s Culture Fair Intelligence Test (CCFT) and Trail Making Test (TMT)\(^15\) were used to test neurocognitive functions.

In the current study, we calculated the scores of verbal IQ (VIQ), performance IQ (PIQ) and full scale IQ (FIQ) by means of the following formula. The score of block design scale was corrected to the age related score based on the norm.
Verbal IQ = 2 x (score of knowledge + score of similarity) + score of arithmetic + score of digit span
Performance IQ = 2 x (score of picture completion + score of block design) + score of digit span
Full scale IQ = verbal IQ + performance IQ

Cattell’s Culture Fair Intelligence Test (CCFT) is one of a series of individual intelligence test methods developed by Raymond B. Cattell, which mainly reflects the fluid intelligence level of one’s basic psychological process. Fluid intelligence level is based on physiological functions of cognitive ability, such as perception, memory, operation speed, and reasoning ability. The four subtests have a total of 44 questions. In the specified time to complete the test, the scores will be added, the higher the score, the higher the level of individual fluid intelligence.

TMT is a neuropsychological test of visual attention and task switching. It consists of two parts. In Part A the subject was instructed to connect a set of dots with the Arabic numbers (1, 2, 3, etc.) in sequential order as quickly as possible while still maintaining accuracy. In Part B-M, the subject was asked to connect alternatively between a set of dots with the Arabic numbers or the Chinese numbers (1, 一, 2, 二, 3, 三). The time that the subjects spend finishing the tasks was used as the score. The higher score, the worse the performance. The test can provide information about visual search speed, scanning, speed of processing, mental flexibility, as well as executive functioning.

2.3 Statistical analysis
The statistical analysis was performed with SPSS version 22.0 software. T tests were used as appropriate. Two-sided tests were adopted and α was set at 0.05.

3. Results
3.1 Demographic data
The 79 parents (40 fathers, 39 mothers) of the 41 children with ASD were put into the ASD group. The normal control group consisted of 80 parents (44 fathers, 36 mothers) of 68 well-developed children. The average age of the two groups were 32.25 and 32.34 years, and the average education level (year) of the two groups were 11.15 and 11.99 years. There were no statistically significant differences in the gender ($\chi^2=0.30$, $p=0.581$), age ($t=6.29$, $p=0.905$) and education level ($t=2.88$, $p=0.312$) between the ADS group and normal control group (see table 1).

3.2 Personality Characteristics Evaluation
The EPQ T scores in P scale of Parents of children with ASD were significantly higher than the parents of well-developed children ($t=1.68$, $p=0.039$), while their T scores in the E scale and L scale were significantly lower ($t=1.84$, $p=0.035$; $t=2.07$, $p=0.023$). There was no statistically significant difference in the T score of N scale between the 2 groups ($t=0.44$, $p=0.661$) (see table 2).
3.3 Neurocognitive Function Tests

There were no statistically significant differences in the Verbal IQ, Performance IQ and Full Scale IQ between the Parents of children with ASD and normal controls. The CCFT reflects the fluid intelligence, and there was no statistically significant difference in the CCFT total score between the 2 groups. TMT evaluates the visual search speed, scanning, speed of processing, mental flexibility, as well as executive functioning. Parents of children with ASD took significantly longer time to finish TMT Part A and Part B-M ($t=1.57$, $p=0.013$; $t=0.83$, $p=0.019$) (See table 3).

We also compared the scores of the neurocognitive function tests between the fathers and mothers, and they showed no statistically significant differences in gender. Spearman correlation analysis was used to compare the TMT scores and each EPQ scale scores between the ASD fathers and ASD mothers. It did not show any statistically significant correlations.

4. Discussion

4.1 Main findings

This study evaluated the personality characteristics and neurocognitive function phenotype of parents of children with ASD in Chengdu, China. Using EPQ and a few neurocognitive function tests, we compared the Parents of children with ASD with normal controls in terms of personality characteristics, visual attention, perceptual processing, scanning and flexibility. We found that there were statistically significant differences in the EPQ P scale, E scale, L scale and TMT scores between the two groups. We also identified that the parents of children with ASD took significantly longer time than the normal controls to complete the Trail Making Test (TMT) Part A and Part B-M.

The EPQ scores on the P scale of Parents of children with ASD were significantly higher than that of the parents of well-developed children, while their scores on the E scale and L scale were significantly lower ($p=0.032$). Compared with the parents of well-developed children, the parents of children with ASD were more likely to be emotional, irritable, unconcerned, rigid, stubborn, self-centered, and not adaptable to changes. They were more introverted, reticent, and displayed less novelty and thrill-seeking behaviors. This result is consistent with the findings of Bap’s study.[19] The age of the two groups was similar, so it implies that the parents of children with ASD had limited social skills and maturity compared with normal controls. All of these findings suggest that the personality

| Table 1. Demographic Data of parents of children with ASD and Normal controls |
|-----------------------------------------------|------|----|-------|-----|
| Gender                                      | Age (years) | Education level (years) |
| Father (No.) | Mother (No.) | $\chi^2$ | $p$ | m(sd) | $t$ | $p$ | m(sd) | $t$ | $p$ |
| ASD group | 40 | 39 | 0.30 | 0.581 | 32.3(3.8) | 11.2 (3.0) |
| Normal Control group | 44 | 36 | | | 32.3(5.0) | 12.0(4.2) |

| Table 2. Comparison of EPQ scores between Parents of children with ASD and normal controls |
|-----------------------------------------------|------|-----|
| ASD group N = 79                              | m(sd) | $t$ | $p$ |
| CON$^{1}$ N = 80                              | 49.87(7.48) | 1.68 | 0.039* |
| P scale T score                               | 52.11(6.87) | |
| E scale T score                               | 54.67(11.58) | 1.84 | 0.035* |
| N scale T score                               | 58.11(6.15) | |
| L scale T score                               | 49.08(10.73) | 0.44 | 0.661 |
| 1) Normal Controls ; *differences between the two groups were significant | 48.22(10.12) | 2.07 | 0.023* |
| 1) Normal Controls ; *differences between the two groups were significant | 46.12(9.29) | | | |
characteristics of ADS parents have similarities to autistic symptoms.\[20\] Autistic disorder is also found to be a type of neurodevelopmental disturbance. Most parental behaviors and neurodevelopmental traits can be inherited to their offspring.\[21\] Other studies have shown that parents of children with ASD deal with greater stressors in the autistic child's upbringing, care giving, and treatment.\[22\] These pressures are extremely disruptive to the lives of ASD parents and may lead to negative life events like abuse. These sorts of negative life events can result in impairment to the child’s behavioral development.\[23\] Although autistic patients usually have comorbid anxiety or other emotional disturbances \[5\], our study did not reveal significant differences in the emotional and behavioral stability between the parents of children with ASD and normal controls. Further studies need to address how the parents’ personality can impact a child developing mental illness.

4.2 Limitations
Our study found no statistically significant differences in the Verbal IQ, Performance IQ, and Full Scale IQ between the parents of children with ASD and normal control parents. The scores in the 7 items of WAIS showed no statistically significant differences either. These findings are similar to the results of past IQ tests on parents of children with ASD.\[24\] In the TMT, the visual speed and processing tests, the parents of children with ASD displayed poorer attention speed and less accuracy than the normal controls. They took longer to complete the tests when they processed the same visual information.\[25\] The frequency of accurate reaction in response to visual information was less than the normal group.\[26\] Although our study revealed no significant differences in the general cognitive functioning and executive functioning between the 2 groups, there were impairments in visual processing ability and behavioral fluency of the ASD group parents.

4.3 Implications
In conclusion, the parents of children with ASD displayed certain negative personality characteristics. There were impairments in their planning, flexibility, and visual processing functions. There are therefore similarities between impairments seen in individuals with ASD and their parents. Future research should include genetic analysis by using the cognitive functions of autistic patients and their family members as an endophenotype.

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4.5 Informed consent
All participants provided written informed consent.

4.6 Conflict of interest statement
All the authors declare no conflict of interest.

4.7 Ethical Approval
This study was approved by the ethics committee of the Sichuan University Western China Hospital Mental Health Center.

| Table 3. Comparison of neurocognitive functioning tests between parents of children with ASD and normal controls |
|-------------------------------------------------------------|-------------------------------------------------------------|---|---|
| Parents of children with ASD (n=79) | Normal Control Group (n=80) | t | p |
| CCPE total score | 28.31(5.33) | 28.46(5.38) | 0.01 | 0.879 |
| PIQ | 103.31(13.79) | 104.52(13.43) | 0.60 | 0.594 |
| VIQ | 106.65(13.82) | 105.60(16.11) | 1.73 | 0.190 |
| FIQ | 105.76(12.94) | 105.55(14.64) | 0.77 | 0.282 |
| TMT Part A (second) | 57.40(19.44) | 49.36(17.19) | 1.57 | 0.013 |
| TMT Part B (second) | 84.33(30.61) | 71.32(29.99) | 0.83 | 0.019 |
**Authors’ contribution**
Study concept and design: Dr. Xiaojing Li, Prof. Qiang Wang and Prof. Tao Li.
Acquisition of data: Dr. Xiaojing Li, Dr. Yuejing Wu, Prof. Qiang Wang, Prof. Yi Huang and Prof. Tao Li.
Analysis and interpretation of data: Dr. Xiaojing Li and Prof. Qiang Wang.
Drafting of the manuscript: Dr. Xiaojing Li, Dr. Yuejing Wu, Ms. Sherrie Wang and Prof. Qiang Wang.

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**Background:**
Children with autism spectrum disorder (ASD) face significant challenges and have a considerable impact on their families. The increasing prevalence and associated family burden have garnered attention from both academic and social communities.

**Objective:**
This study aims to explore the personality traits and neurocognitive function of parents of children with ASD compared to those of typically developing children.

**Methods:**
Based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), the study recruited 41 children meeting the diagnostic criteria for ASD and 80 children with normal development as the control group. All participants were assessed using the EPQ questionnaire and a series of neurocognitive tests.

**Results:**
Parents of children with ASD scored significantly higher on the P量表 (t=1.68, p=0.039) compared to the control group. They also scored significantly lower on the E量表 (t=1.84, p=0.035) and L量表 (t=2.07, p=0.023). Parents of children with ASD took longer to complete the TMT A部分 (t=1.57, p=0.013) and B-M部分 (t=0.83, p=0.019).

**Conclusion:**
Parents of children with ASD are more apathetic, inflexible, and reclusive and have less innovative and adventurous behaviors. They also show limited social and emotional skills. Although their overall cognitive function, including intelligence, is generally intact, their planning, flexibility, and visual processing are impaired.

**Keywords:** Autism spectrum disorder; Personality traits; Neurocognitive function; Executive function

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