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## Relationship of autistic traits between parents and children with and without autism spectrum disorder

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### ABSTRACT

**Background:** Although parents with a child with autism spectrum disorder (ASD) have usually been identified as having the “broader autism phenotype”, empirical research on the differences in autistic-like characteristics between parents with and without ASD children has yielded inconsistent results.

**Method:** This survey of the autistic traits of parents and children was conducted in 119 parents with ASD children and 108 parents with typically developing (TD) children. Parents' autistic traits were quantified using the Autism-Spectrum Quotient and children's autistic traits were quantified using the Autism Spectrum Quotient—Children's Version.

**Results:** The autistic traits of ASD children were significantly higher than those of the TD children; however, autistic traits were similar between parents in the two groups. Furthermore, the correlations of autistic traits between parents and children were only significant for the TD group and not for the ASD group.

**Conclusions:** The current findings indicate that the relationship of autistic traits between parents and children exists in the TD group, and that the Autism-Spectrum Quotient may be used for parents as a screening aid to identify children who should be further screened for autistic traits.

## 1. Introduction

Autism spectrum disorder (ASD) is a type of developmental disorder, diagnosed on the basis of difficulties in social interactions, the presentation of repetitive behavior and activities, as well as unusually narrow, strong interests (American Psychiatric Association, 2013). ASD involves a large number of behaviors and symptoms that vary across individuals. In the clinical condition, the severity of ASD presents across a continuum, and the quantifiable features of the full autism phenotype (i.e. autistic traits) included in the ASD core deficits are continuously distributed in typically developing (TD) individuals (Lazar, Evans, Myers, Moreno-De Luca, & Moore, 2014).

The main measurement tools for autistic traits include The Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), the Broader Phenotype Autism Symptom scale (BPASS; Dawson et al., 2007), the Social Responsiveness Scale (SRS; Constantino, 2002), and the Broad Autism Phenotype Questionnaire (BAPQ; Hurley, Losh, Parlier, Reznick, & Piven, 2007). One of the most widely used instruments for quantifying autistic traits in non-clinical adults of normal intelligence is AQ

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(Ruzich et al., 2015). The AQ is a self-report questionnaire consisting of 50 items, with five sub-scales (Social Skills, Attention Switching, Attention to Detail, Communication, and Imagination) representing five different aspects of the behaviors and cognitive difficulties that are most commonly found in individuals with ASD. The AQ has been found to show good reliability and validity across cultures, including in China (Zhang et al., 2016). The Autism Spectrum Quotient-Children's Version (AQ-Child) (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2008) is one of the most widely used parent-reported instruments for quantifying autistic traits in children 4–11 years old. The AQ-Child similarly has 50 items with five identical sub-scales to the AQ. There is strong support for the validity of the AQ-Child in both Western (Auyeung et al., 2008) and Eastern (Rudra et al., 2014; Sun et al., 2019) cultures.

Some early theories have suggested that genetic factors may be responsible for the fact that first-degree relatives of ASD individuals exhibit elevated levels of autistic traits, so that parents of a child with ASD (Parents-ASD) have usually been identified as having the "broader autism phenotype" (BAP) (e.g., Bolton et al., 1994). However, empirical research on the differences in autistic-like characteristics between Parents-ASD and parents with a TD child (Parents-TD) has been inconsistent. Although some studies have found that, relative to Parents-TD, Parents-ASD showed higher AQ scores (Kose et al., 2013; Wheelwright, Auyeung, Allison, & Baron-Cohen, 2010; Zhang et al., 2016), and performed worse on eye contact (Ruser et al., 2007), the unexpected outcomes test (Camodeca, 2019), and the social cognition (Losh et al., 2009), other studies have found that Parents-ASD were not significantly worse than Parents-TD on AQ scores (Scheeren & Stauder, 2008), recognizing any of the basic emotions (Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013), or reading the mind in the eyes test (Camodeca, 2019; Tajmiriyahi, Nejadi, Pourtemad, & Sepehr, 2013).

Although the etiology of ASD is known to have a strong genetic component (Hallmayer et al., 2011), no study to the best of our knowledge has contrasted the relationship of autistic traits between parents and children between the ASD and TD groups. One study recruited adult participants with and without ASD, as well as their parents, to complete self- and parent-report versions of the AQ to judge the autistic traits of the participants, respectively. However, without separating the two groups of participants, they only reported a significant relationship between the results of the two versions of the AQ with all participants involved (Poon, Shu, Chan, Leung, & Leung, 2020). Thus, there is still an open question: Is the relationship between the autistic traits of parents and children in the ASD group different from that in the TD group? Within this framework, the aim of the present study was to investigate autistic traits and their correlations in parents and children in the ASD and TD groups, as well as to advance utility of AQ as a screening aid for parents to identify children who should be further screened for a diagnosis of ASD.

## 2. Methods

### 2.1. Participants

Participants were all Chinese parents aged 23–48 with at least one child aged 4–10 (see Table 1). Participants agreed to participate in the study, which was in accordance with the Declaration of Helsinki; all procedures were approved by the Chongqing Normal University research ethics committee.

The Parents-ASD group consisted of 119 parents (mean = 33.43 years, SD = 4.85 years) with ASD children (mean = 5.08 years, SD = 1.67 years) recruited from the Affiliated Hospital of Jining Medical University and the Zaozhuang Comprehensive Rehabilitation Center for the Disabled in Shandong, China. These children all had a pre-existing diagnosis of ASD provided by licensed pediatricians in the hospital, based on the criteria of the *Diagnostic and Statistical Manual of Mental Disorders-fifth edition* (DSM-5). The children's ASD diagnosis were reconfirmed at the time of this study using the Autism Behavior Checklist (ABC) (Frye & Walker, 1998; Krug, Arick, & Almond, 1980) and the Child Autism Rating Scale (CARS) (Schopler, Reichler, DeVellis, & Daly, 1980; Zhou et al., 2017).

The parents-TD group consisted of 108 parents (mean = 32.41 years, SD = 3.39 years, matched in age and educational level with the Parents-ASD group) with TD children (mean = 5.17 years, SD = 1.38 years) recruited randomly from kindergartens and primary schools in Chongqing, China. They did not report mental health problems in either themselves or their children. The states of these parents and children were reconfirmed by licensed researchers in this study.

### 2.2. Measures

#### 2.2.1. The Autism Spectrum Quotient—Children's Version

The Autism Spectrum Quotient—Children's Version (AQ-Child) (Auyeung et al., 2008) is a parent-reported questionnaire that quantifies autistic traits in children 4–11 years old. It is comprised of 50 items, with 10 items in each of the 5 subscales (social skills, attention switching, attention to detail, communication, and imagination). Parents rated items on a 4-point Likert-type scale (0 =

**Table 1**  
Psychometric variables for participants in all groups (M ± SD).

Group	Gender (Female/Male)	Age (years)
<b>Parents</b>		
Parents-TD group	88/20	32.41 ± 3.39
Parents-ASD group	99/20	33.43 ± 4.85
<b>Children</b>		
TD group	54/54	5.17 ± 1.38
ASD group	12/107	5.08 ± 1.67

*definitely agree*, 1 = *slightly agree*, 2 = *slightly disagree*, or 3 = *definitely disagree*) based on the behavior of their children. Items were reverse-scored as necessary (26 out of the 50 items). Subscale scores were calculated by summing scores of ten items in each of the subscales. Total AQ-Child scores were calculated as the sum of all item scores. The minimum AQ-Child score (0) indicates no autistic traits were observed of the children; the maximum AQ-Child score (150) indicates all autistic traits were observed as fully present.

### 2.2.2. The Autism-Spectrum Quotient

The autistic traits of the parents themselves were measured using the Autism-Spectrum Quotient (AQ) (Baron-Cohen et al., 2001) Mandarin version (Liu, 2008). The AQ is a self-report questionnaire designed to measure the extent of autistic traits in individuals with normal intelligence, which was used in many previous studies (e.g., Li, Zhang, Xiang, & Meng, 2019; Meng, Li, & Shen, 2017, 2020; Meng, Shen, Li, & Peng, 2019). In this study, parents were instructed to rate their autistic traits with the answer categories the same as for the AQ-Child (0 = *definitely agree*, 1 = *slightly agree*, 2 = *slightly disagree*, or 3 = *definitely disagree*). Like the AQ-Child, the AQ is comprised of 50 items, with 10 items in each of the 5 subscales. The subscales of AQ (social skills, attention switching, attention to detail, communication, and imagination) are identical to those of the AQ-Child. The original dichotomizing scoring procedure of the AQ (Baron-Cohen et al., 2001) was to score responses indicating autistic-like behavior (definitely or slightly agree) as 1 point and responses not referring to autistic-like behavior (definitely or slightly disagree) as 0 points. The minimum AQ score (0) indicates that no autistic traits were reported for the parents; the maximum AQ score (50) indicates that all autistic items were reported. In this study, an alternative scoring procedure was adopted: the scoring scheme used in the AQ-Child (Auyeung et al., 2008) by which the AQ score is determined by averaging the 4-point response scale. This scoring procedure has shown improved validity in both the general population and ASD samples (McKenzie et al., 2018). This method was used because (1) scores for the AQ and the AQ-Child need to be compared based on the same scoring procedure and (2) additional information for each item can be retained. Thus, the minimum AQ score (0) indicates no autistic traits; the maximum AQ score (150) indicates all autistic traits were reported as fully present.

### 2.3. Data analysis

Data analyses were performed using SPSS 15.0. In the preliminary analyses, the AQ and AQ-Child scores were analyzed, including descriptive statistics analyses, correlation analysis (relationship between autistic traits and parents' educational level and childbearing age), and ROC curve analysis.

In the main analyses, two analyses of variance (ANOVA) were conducted. First, the AQ-Child and AQ scores were compared via a two-way ANOVA with 2 between-participants factors of "questionnaire" (AQ-Child vs. AQ) and "group" (ASD vs. TD). Second, as the gender distribution of the two groups were not consistent, the genders of parents and children were included in subsequent analyses, the AQ and AQ-Child scores were compared via a four-way repeated-measures ANOVA, with three between-participants factors of "gender of the parents" (mother vs. father), "gender of the child" (girl vs. boy), and "group" (ASD vs. TD), as well as the within-participants factor of "questionnaire" (AQ-Child vs. AQ). In both ANOVA analyses, the interactions with "group" were explored. As we were interested in the differences in AQ-Child scores between ASD and TD children, as well as the differences in AQ scores between Parents-TD and Parents-ASD, when a significant interaction effect with "group" was found, comparisons between the two groups were performed for each condition in the simple effect analyses. To account for the multiple comparison problem, the *p* values were corrected using a false discovery rate (FDR) procedure (Benjamini & Hochberg, 1995).

In the correlation analysis, in order to explore the relationship of autistic traits between children and their parents, partial correlation was conducted between the AQ and AQ-Child scores in the two groups. Genders of the parents and children were considered as covariates (control variables).

## 3. Results

### 3.1. Preliminary analyses

Summaries of the descriptive statistical analyses of the AQ and AQ-Child scores can be seen in Table 2 and Fig. 1. The Cronbach's alpha coefficients (i.e., internal consistency) of both the AQ and AQ-Child questionnaires were satisfactory (0.678 and 0.663, respectively). Although no significant correlation between AQ scores and education level was found for either fathers ( $r = -0.030, p = 0.653$ ) or mothers ( $r = -0.039, p = 0.557$ ), the AQ-Child scores of the children and the educational level of both fathers ( $r = -0.270, p < 0.001$ ) and mothers ( $r = -0.274, p < 0.001$ ) were negatively correlated. Although no significant correlation between the AQ-Child scores and childbearing age was found for either fathers ( $r = 0.002, p = 0.977$ ) or mothers ( $r = 0.119, p = 0.073$ ), the absolute value of the age difference between the parents was significantly positively correlated with AQ-Child scores in the ASD group ( $r = 0.222, p =$

**Table 2**  
Summary of descriptive statistical analysis of AQ and AQ-Child scores.

		ASD group	TD group
AQ	Mother	60.18 ± 12.30	61.67 ± 8.57
	Father	63.25 ± 17.94	63.75 ± 6.14
AQ-Child	Girl	86.50 ± 8.71	62.56 ± 9.66
	Boy	91.91 ± 12.74	62.89 ± 11.86

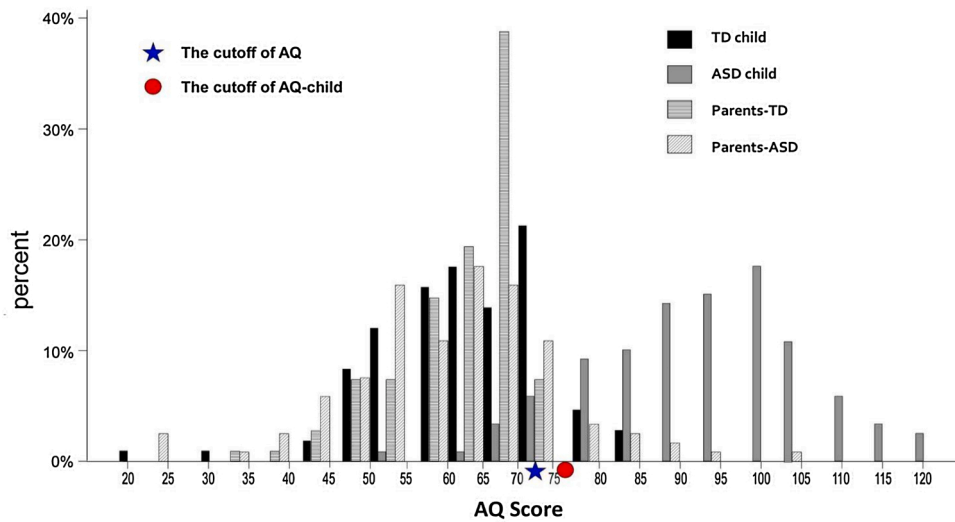


Fig. 1. Scoring patterns for AQ-Child and AQ by group.

0.015).

Results of the receiver operating characteristic (ROC) curve analysis showed that the AQ and AQ-Child scores reached an area under the ROC curve (AUC) of 0.543 and 0.961, respectively. The AUC of AQ did not demonstrate good discriminative power in discriminating parents of children with ASD compared to parents without a child with ASD, while the AUC of AQ-child showed good discriminative power in children with ASD compared to children without ASD. The AUC of the latter was significantly larger than that of the former ( $z = 11.03, p < 0.0001$ , see Fig. 2). To strike a balance between false positives and false negatives, cut-offs (total score) at 71 (with sensitivity 80.67 % and specificity 100 %) and 76 (with sensitivity 86.55 % and specificity 93 %) were used for the AQ and AQ-child groups, respectively.

### 3.2. Main analyses

The results (Fig. 3) of the two-way ANOVA with 2 between-participants factors of “questionnaire” (AQ-Child vs. AQ) and “group” (ASD vs. TD) showed significant “group” ( $F_{(1, 225)} = 153.60, p < 0.001, \eta_p^2 = 0.41$ ) and “questionnaire” ( $F_{(1, 225)} = 221.96, p < 0.001, \eta_p^2 = 0.50$ ) main effects. The scores of the ASD groups ( $76.03 \pm 0.76$ ) were significantly higher than those of the TD groups ( $62.39 \pm 0.80$ ), and the scores of the AQ-Child scores ( $77.04 \pm 0.78$ ) were significantly higher than those for the AQ scores ( $61.38 \pm 0.75$ ). More importantly, the scores were significantly modulated by the interaction of “questionnaire” and “group” ( $F_{(1, 225)} = 203.47, p < 0.001, \eta_p^2 = 0.48$ ) (see Fig. 3). Simple effect analysis indicated that, for the AQ-Child scores, the ASD children’s scores ( $91.36 \pm 1.07$ ) were significantly higher than scores for the TD children ( $62.72 \pm 1.13$ ) ( $p < 0.001$ ). However, for the AQ scores, no significant difference was found between the ASD ( $60.70 \pm 1.03$ ) and the TD ( $62.06 \pm 1.08$ ) parents ( $p = 0.363$ ).

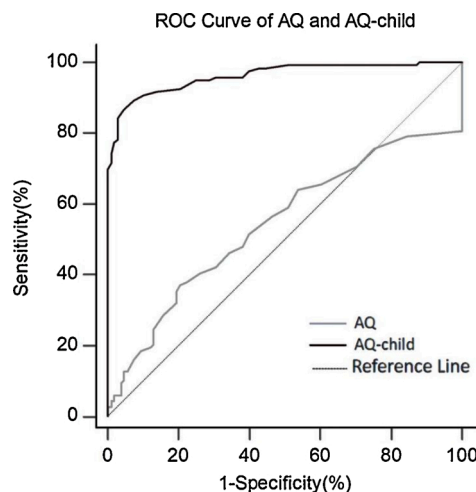


Fig. 2. ROC curves of AQ and AQ-child.

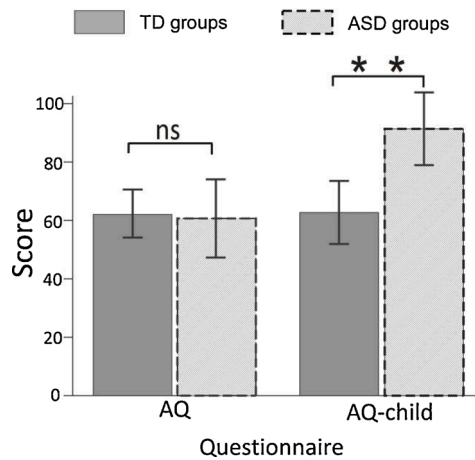


Fig. 3. Bar charts of the results of “questionnaire” × “group” interaction.

The results of four-way repeated-measures ANOVA with factors of “gender of the parents” (mother vs. father), “gender of the child” (girl vs. boy), “group” (ASD vs. TD), and “questionnaire” (AQ-Child vs. AQ) showed significant “group” ( $F_{(1, 219)} = 32.23, p < 0.001, \eta_p^2 = 0.13$ ) and “questionnaire” ( $F_{(1, 219)} = 72.66, p < 0.001, \eta_p^2 = 0.25$ ) main effects. The scores of the ASD groups ( $74.38 \pm 1.70$ ) were significantly higher than those of the TD groups ( $62.98 \pm 1.07$ ), and the scores of the AQ-Child scores ( $76.80 \pm 1.42$ ) were significantly higher than those for the AQ scores ( $60.57 \pm 1.35$ ). The scores were significantly modulated by the interaction of “questionnaire” and “group” ( $F_{(1, 219)} = 68.42, p < 0.001, \eta_p^2 = 0.24$ ). Simple effect analysis indicated that, for the AQ-Child scores, scores for the ASD children ( $90.37 \pm 2.40$ ) were significantly higher than scores for the TD children ( $63.22 \pm 1.52$ ) ( $p < 0.001$ ). However, for the AQ scores, no significant difference was found between the parents with ASD ( $58.40 \pm 2.28$ ) and the TD ( $62.74 \pm 1.44$ ) children ( $p = 0.108$ ). Results are shown in the Table 3 and Supplementary Information, SI. Table 1.

3.3. Correlation analysis

The relationship of autistic traits between the children and their parents was specifically examined by testing the partial correlation between AQ and AQ-Child scores in the two groups, in which the gender of the parents and the gender of the children were used as control variables. The total correlation between the AQ and AQ-Child scores of both the ASD and TD groups was not significant ( $r = -0.003, p = 0.968$ ) (see the left panel in Fig. 4). The correlation between the AQ and AQ-Child scores was significant for the TD group ( $r = 0.392, p < 0.001$ ) (see the middle panel in Fig. 4), but not significant for the ASD group ( $r = -0.124, p = 0.183$ ) (see the right panel in Fig. 4). These results suggest a positive relationship of autistic traits between the TD children and their parents.

4. Discussion

The aim of the present study was to explore the autistic traits of ASD and TD children and their parents. The results showed that the AQ-Child scores of children with ASD were significantly higher than those for TD children; however, AQ scores were similar between

Table 3  
Summary of statistical analysis of AQ and AQ-Child scores.

	F	p	$\eta_p^2$
<b>questionnaire</b>	<b>72.66</b>	<b>&lt;0.001</b>	<b>0.25</b>
<b>group</b>	<b>32.23</b>	<b>&lt;0.001</b>	<b>0.13</b>
gender of the parents	0.04	0.846	<0.001
gender of the child	1.30	0.256	0.01
<b>group × questionnaire</b>	<b>68.42</b>	<b>&lt;0.001</b>	<b>0.24</b>
group × gender of the parents	0.53	0.468	0.002
group × gender of the child	2.42	0.121	0.01
group × questionnaire × gender of the parents	1.71	0.193	0.01
group × questionnaire × gender of the child	0.77	0.382	0.003
group × gender of the parents × gender of the child	0.76	0.386	0.003
group × questionnaire × gender of the parents × gender of the child	3.30	0.071	0.02

Note: Table 3 shows parts of the results of four-way repeated-measures ANOVA with factors of “gender of the parents” (mother vs. father), “gender of the child” (girl vs. boy), “group” (ASD vs. TD), and “questionnaire” (AQ-Child vs. AQ). As we are interested in the effects of “group”, only the main effects and interaction effects with “group” are shown in the table. Results of all main and interaction effects are shown in the Supplementary Information, SI. Table 1. Significant comparisons ( $p < 0.05$ ) are shown in boldface.

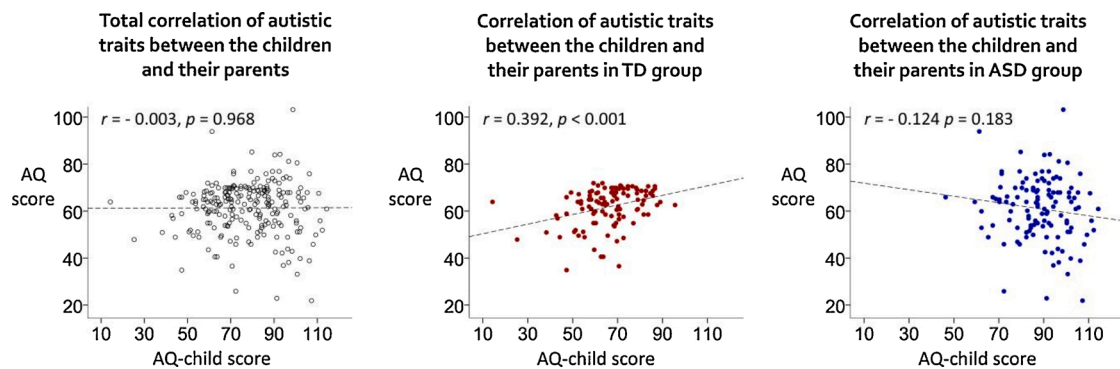


Fig. 4. The scatter plots of correlation between the AQ-Child and AQ scores.

parents with and without ASD children. Furthermore, the correlations of autistic traits between parents and children were significant for the TD group but not for the ASD group.

In agreement with previous studies (Auyeung et al., 2008; Sun et al., 2019), our data showed that the AQ-Child scores could clearly distinguish ASD children from TD children in China (AUC = 0.961). In addition, higher AQ-Child scores were found in ASD children than in TD children. This result confirms that AQ-Child is a measure with high specificity and sensitivity, which can be used to quantify autistic traits of children aged 4–10 years in clinical practice (Wakabayashi et al., 2007). A cut-off score of 76 showed high sensitivity (86.55 %) and specificity (93 %) for screening ASD children in the population. Thus, children with AQ-Child scores higher than this cut-off may have a high risk of ASD, and it is suggested that they receive further diagnostic evaluation from pediatricians.

However, the AQ scores did not show good discriminative power (AUC = 0.543) for parents with and without ASD children. In addition, no significant difference in AQ scores was found between the two groups of parents. These results suggest that parents with ASD children may not show different autistic traits from parents with TD children. One possible explanation for those findings would be that a diagnosis of ASD and autistic traits may not result from just a genetic component, but may be influenced by other factors (London & Etzel, 2000; Lord et al., 2020). However, we acknowledge that alternative explanations for these findings may be possible. It might be possible that the AQ is less sensitive to predict autistic traits of parents with ASD children than other tools, such as the SRS. In addition, the small number of fathers in the present study may be a factor in the findings.

Interestingly, the correlations between AQ and AQ-Child scores were significant for the TD group but not for the ASD group, which indicates that in the ASD group, the correlation of autistic traits between parents and children was not significant. This may not be entirely unexpected, as previous studies have also found that emotion-related abilities of parents are associated with their children's core symptoms of autism in TD group (Morris, Silk, Steinberg, Myers, & Robinson, 2007) but not in ASD group (Hu et al., 2018). One potential explanation for these different findings between the ASD and TD group is the social interactions between children and parents. It was noted that TD children may learn social skills and attitudes from their interactions with their parents, while the quality of parent-child interactions in children diagnosed with autism may be qualitatively different. Thus, the relationship of autistic traits between children and parents was only found in the TD group in the present study.

The present study suffers from several limitations. First, the children were not matched by IQ between two groups, although the majority of ASD children are marked by lower IQ than TD children, and thus intelligence difference may play an important role in our results. Second, the AQ is a self-reported instrument while the AQ-Child is a parent-reported measure. Parents may have over- or underestimated their own or their children's symptoms, eventually leading to the presence of biases in the results. Third, many demographic variables, such as sex, are potentially involved in the difference in autistic traits between the ASD and TD groups. However, they were not included in the present research. Finally, although the correlations were found between AQ-child scores and the parents' education levels and ages in the present study, the underlying mechanisms remain unclear. Further studies with stricter matched control groups and a longitudinal design are warranted to clarify the relationship between autistic traits of parents and children among both the ASD and TD groups.

## 5. Conclusions

In conclusion, this study investigated the autistic traits of parents and their children in the ASD and TD groups and revealed the relationship between them. The current findings indicate that the relationship between the autistic traits of parents and children existed in the TD group. Thus, AQ may be used in parents as a screening aid to identify children who should be further screened for autistic traits.

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## Author contribution

Jing Meng, Zuoshan Li, and Lin Shen contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Hengheng Tao and Chao Huo. The first draft of the manuscript was written by Jing Meng and all authors commented on previous versions of the manuscript. All authors read, made corrections and suggestions, and approved the final manuscript.

## Declaration of Competing Interest

The authors declare that they have no competing interests.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.rasd.2022.101914>.

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