Child, Maternal and Demographic Factors influencing caregiver-reported autistic trait symptomatology in toddlers

Abbreviated title: Factors influencing caregiver report of autistic traits

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Abstract

Current research on children's autistic traits in the general population relies predominantly on caregiver-report, yet the extent to which individual, caregiver or demographic characteristics are associated with informants' ratings has not been sufficiently explored. In this study, caregivers of 396 Singaporean two-year-olds from a birth cohort study completed the Quantitative Checklist for Autism in Toddlers (Q-CHAT).

Children's gender, cognitive functioning and birth order, maternal age, and ethnic group membership were not significant predictors of caregiver-reported autistic traits. Poorer child language development and higher maternal depressive symptoms significantly predicted more social-communicative autistic traits, while lower maternal education predicted more behavioural autistic traits.

Children's language and informants' educational level and depressive symptomatology may need to be considered in caregiver-reports of autistic traits.

Keywords: autistic traits, measurement, informant, child, demographic, predictors.

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Introduction

Autism Spectrum Disorder (ASD) is a heterogeneous lifelong neurodevelopmental condition [1] characterized by varying degrees of social, communication and behavioral impairments (American Psychiatric Association, 2013). There is increasing evidence that subclinical autistic traits (Baron-Cohen et al., 2001), defined as "habitual patterns of behaviour, thought, and emotion which are stable over time and exist in all individuals to a varying degree" (Bolte, Westerwald, Holtmann, Freitag & Poustka, 2011), are heritable, quantifiable, normally distributed in the general population and elevated in relatives of individuals with ASD (Bishop et al., 2006; Constantino & Todd, 2005; Maxwell et al., 2013; Posserud et al., 2006; Taylor et al., 2013; Virkud et al., 2009; Wheelwright et al., 2010), with individuals with ASD more likely to lie at the extreme end of this continuum (Ruzich et al., 2015; Baron-Cohen et al, 2001; Wheelwright et al, 2006; Allison et al., 2008; Constantino & Todd, 2003; Hoekstra et al., 2007; Skuse et al., 2005; Hurst et al., 2007; Wakabayashi et al., 2006).

A range of measures has been developed to measure and quantify autistic traits and related symptoms dimensionally across the general and clinical populations (Sucksmith, Roth & Hoekstra, 2011)[2]. When used in children, most rely on caregiver

[1] A number of researchers (i.e. Lai et al., 2015), clinicians and advocates prefer the use of the term Condition (Autism Spectrum Condition; ASC) instead of Disorder (ASD), as it is a less stigmatizing term. We advocate for the use of this term too, but have used the term ASD in this paper to be consistent with most existing literature and the DSM-5.

[2] These include the Quantitative Checklist for Autism in Toddlers (Q-CHAT; Allison et al., 2008); the Autism Spectrum Quotient – Child (AQ-Child; Auyeung, Baron-Cohen, Wheelwright & Allison, 2008), Adolescent (AQ-Adol; Baron-Cohen et al., 2006) and Adult Versions (AQ; Baron-Cohen et al., 2001); the Social and Communication Disorders Checklist (SCDC; Skuse et al., 2005), the Social Communication Questionnaire (SCQ; Berument et al., 1999), the Social Responsiveness Scale-2 (SRS-2; Constantino, 2012) and the Childhood Autism Spectrum Test (CAST; Scott, Baron-Cohen, Bolton & Brayne 2002).

reports, as this is a cost-effective way to gather information, and parents are generally reliable informants of their children's behaviors (Charman et al., 2004; Lee et al., 2010; Sikora et al., 2008; Lee et al., 2010). However, caregiver reports of autistic traits may also be influenced by other child, caregiver or environment differences (Norris & Lecavalier, 2010). The clinical utility of such "rapid phenotyping" approaches (Ryland et al., 2014) was explored by Warren and colleagues (2012). Parents of 333 children aged 4 to 17 years with and without a clinical diagnosis of ASD rated their children's social and non-social behaviours on the SCQ – Lifetime (Rutter, Bailey & Lord, 2003) and the SRS. Ten to twenty percent of children without a clinical diagnosis of ASD were identified as having ASD (false positives), while 5-25% of children with ASD were false negatives. The authors suggested that this discrepancy between parent-report and clinical diagnosis was likely due to parent reporting being influenced by other parent and children characteristics and that the use of expert clinical validation should prevail alongside rapid phenotyping procedures (Warren et al., 2012). It is therefore important to explore more systematically the extent to which child, caregiver or social/ demographic characteristics influence caregivers' reporting of children's autistic traits.

Child characteristics potentially influencing caregiver-reported autistic traits

Gender. Three UK studies in unselected as well as clinical samples (Allison et al., 2008; Auyeung et al., 2010; Wong et al., 2014) all found that boys were reported by their caregivers to have significantly more autistic traits than girls, with small effect size differences. In a study of 1,913 unaffected siblings of children with ASD, males had higher parent-reported SRS raw scores than females with a small effect size difference (Hus et al., 2013). Gender remained a significant predictor of maternally-reported AQ-Child scores, accounting for 23% of the variance after controlling for other covariates (Auyeung, et al., 2009).

Cognitive functioning. In a study by Hoekstra and colleagues (2009), children who performed in the bottom 5% of IQ scores at age 7 were significantly more likely to be reported by their caregivers to present with autistic traits in the top 5% of CAST scores at 8 years), while the negative correlation between IQ at 7, 9 and 12 years and CAST scores at 8, 9, 12 years was modest (Hoekstra et al., 2010).

Verbal/ language functioning. After controlling for gender and cognitive functioning, language scores at 2 and 3 years remained significant predictors of overall and social autistic traits at 8 years using the caregiver reported CAST (Dworzynski et al., 2007). In 1,913 unaffected school-aged siblings of probands with ASD, Hus et al. (2013) also reported that greater language impairments were a significant predictor of more caregiver reported social-communicative autistic traits on the SRS.

Birth order. To our knowledge, no study has to date systematically examined whether caregiver-reported autistic traits may differ by children's birth order. In children with ASD, Gardener and colleagues (2009) conducted a meta-analysis of nine epidemiological studies, most of which indicated that a diagnosis of ASD was more likely in either firstborn or later-born children (birth order $\geqslant$ 3), with risk of ASD 61% greater for firstborn than for later-born children (Gardener et al., 2009). More recent studies have also found ASD to be more likely diagnosed in firstborn compared to children of later birth order (Bilder et al., 2009; Durkin et al., 2008; King et al., 2009; Leonard et al., 2011; Sasanfar et al., 2010). However, parents tend to have fewer children when their firstborn is diagnosed with ASD, resulting in an overrepresentation of either firstborn children with ASD in families of two children, or later-born children with ASD who were among the youngest of larger families (Gardener et al., 2009).

Caregivers' characteristics potentially influencing report of autistic traits

Maternal age at childbirth. In a large study of Australian toddlers with ASD (Ronald, Pennell & Whitehouse, 2011), and in another study of maternal CAST ratings of toddlers without ASD (Auyeung et al., 2009), maternal age was not a significant predictor of caregiver-reported autistic-related behaviours. In a longitudinal study by Robinson and colleagues (2011b), no significant association was found between maternal age and caregiver reported social-communicative autistic traits on the SCDC across the whole sample of 5,246 7-year-old children from the general population, controlling for paternal age, socioeconomic status, gestational length, pregnancy complications and maternal psychiatric history. While higher maternal age may be associated with higher risk for a diagnosis of ASD (Durkin et al., 2008; Grether et al., 2009; King et al., 2009), it was only marginally associated with extreme autistic traits in an undiagnosed sample (Russell, Steer & Golding, 2010).

Caregivers' mental health. Caregivers of children with ASD are more likely to experience higher depressive symptoms (Bennett et al., 2012; Daniels et al., 2008; Estes et al., 2009), and increased depressive symptoms may influence parental identification, report and interpretation of child behaviors as "problematic" (Bennett et al., 2012; Ordway, 2011). Gartstein & Fagot (2003) found that maternally reported depressive symptoms explained the greatest variance in mothers' ratings of their 5-year old children's externalizing behaviours, more than the children's gender or the family's socioeconomic index.

In clinical samples, maternal reports of autistic symptoms of Canadian preschoolers with ASD using the SRS were significantly higher for mothers who reported depressive symptoms above the 90th percentile in a depressive symptom checklist compared to mothers whose depressive symptoms fell below the 90th

percentile (Bennett et al., 2012; see also related findings by Hastings et al., 2005; and Ronald et al., 2011).

Demographic characteristics potentially influencing caregiver-report of autistic traits

Educational Level. In an unselected sample of 142 three to four-year-olds from the UK, Russell and colleagues (2010) found that lower maternal educational level was associated with more parent-reported autistic traits.

Culture/ ethnic group membership. Cultural differences in the processing of social situations, in the expression and interpretation of emotions and social behaviors and in parental expectations (Freeth et al., 2013; Norbury & Sparks, 2013) may influence what parents deem normative, as well as the extent to which they rate certain child behaviors as more or less frequent, severe, or inappropriate (William & Holmes, 2004). For example, Matson and colleagues (2011) found differences in 145 parents from the US, UK, South Korea and Israel in caregiver reports of communication, social interaction and behaviors in youth who met research criteria for ASD. Although autistic traits and behaviours relating to ASD in one culture may not be recognized as atypical in another (Matson et al., 2011), this study was limited by the small sample size and limited control of other possible individual differences between the samples.

The present study: Rationale, Aims & Research Questions

As ratings on informant-based measures can be influenced by individual and demographic characteristics (Warren et al., 2012), the present study aimed to explore the relationship between caregiver-reported autistic traits and a range of individual child, maternal and socio-cultural variables in an multi-ethnic Asian preschool sample from a birth cohort study.

Furthermore, most studies have examined the relationships between child or caregiver variables and overall/ total autistic trait scores, despite increasing evidence that autistic traits are organized in clusters of symptoms in unselected samples (Robinson et al., 2011a; 2011b). Most factor analytic studies have found that autistic traits compose of more than a single underlying construct (Shuster, Perry, Bebko & Toplak, 2014), while population based twin studies of autistic traits measured dimensionally as well as at the quantitative 5% extremes show that the different clusters of autistic symptoms are all heritable, but likely caused by different genetic influences (Ronald & Hoekstra, 2014), suggesting that it would be important to consider different clusters of autism-related symptoms separately. In a factor analytic study by Magiati and colleagues (2015), a three-factor solution was found. Thus, the relationship of child, maternal and demographic variables was explored separately for social/ communication and non-social/ behavioral autistic traits in the present study.

The following research questions were examined:

1. Are, and to what extent, child characteristics (gender, birth order, cognitive and verbal functioning), informant characteristics (maternal age and level of depressive symptomatology), or demographic characteristics (education level and ethnic group membership) associated with caregiver-reported Q-CHAT scores in a non-clinical sample of toddlers?
2. To what extent do these characteristics, when considered together, predict caregiver reported Q-CHAT total and social/ behavioral cluster scores?

Methods

Participants

Recruitment. Participants were selected from a nationally representative sample of mothers and children recruited into an ongoing longitudinal birth cohort

study in Singapore (GUSTO – Growing Up in Singapore Towards Healthy Outcomes; see Soh et al., 2013) from the two largest public maternity units in the country. Pregnant mothers were recruited at their first trimester antenatal ultrasound scan and mother-child pairs have been followed up at regular intervals from 12 weeks of gestation onwards. Currently, the children are 5-6 years of age, with follow-up assessments planned to extend to later childhood.

Figure 1 summarizes the flow chart of recruitment of participants in the present study. A subsample of 649 children was selected for neurodevelopmental phenotyping (the "GUSTO Neurodevelopment cohort"[3]) and their cognitive, language, motor, emotional and behavioural development was regularly assessed.

INSERT FIGURE 1 ABOUT HERE

Inclusion/ Exclusion criteria. Participants were recruited into the GUSTO study if they were Singapore Citizens or Permanent Residents; intended to deliver in either one of the two participating hospitals; intended to live in Singapore for the next 5 years; and both parents were of the same racial/ ethnic background[4].

As part of their GUSTO study participation, caregivers completed the Q-CHAT when the children were 18 and 24 months old. Response rates were 57% (n = 368) and 61% (n = 396) at 18 and 24 months respectively. 294 participants (45%) had data at both time points. Respondents were predominantly mothers (n = 359, 90.7%). As data on maternal depressive symptoms and children's IQ were collected at 24 months, the analyses in this study used Q-CHAT data at 24 months.

[3] Inclusion into the GUSTO Neurodevelopment cohort was prioritized for families who were willing to participate in regular assessments during centre and home visits.

[4] Pregnancies that ended in miscarriage, mothers with Type I diabetes mellitus or those receiving chemotherapy or on psychotropic medication were not included.

Participants' characteristics.

INSERT TABLE 1 ABOUT HERE

This study's participants (see *Table 1*) were compared to the full active GUSTO sample on various demographic variables. They did not differ significantly from the full active GUSTO sample on maternal age, maternal education or household monthly income (all effect sizes small). However, there were more Malay and Chinese, and fewer Indians in the 24-month Q-CHAT compared to the full GUSTO sample ($\chi^2(2) = 7.35$, $p = .03$), but the effect size was small ($w = .14$)[5]. Thus, the Q-CHAT sample was broadly representative of the full GUSTO sample.

Measures

Autistic Traits. The Q-CHAT (Allison et al., 2008) is a 25-item caregiver-report screening tool for autistic traits in toddlers aged 18-24 months. The presence of autistic-traits or the relative absence of normative early social-communication behaviours are rated on a dimensional 0-4 point Likert scale (with higher ratings indicating more autistic traits). Thirteen items are reverse scored (total score range 0-100)[6].

In an unselected sample of 754 toddlers from the UK, Q-CHAT scores were normally distributed, had excellent test-retest reliability after one month ($r = .82$) and internal consistency was $\alpha = .67$ for the total score, while there was also preliminary evidence for good discriminant validity (Allison et al., 2008).

[5] The population of Singapore consists of 74.3% ethnically Chinese, 13.4% Malay and 9.1% Indians (Singapore Statistics, 2015), and as such Malay and Indian participants were over-sampled in the GUSTO study.

[6] Example items include: "How easy is it for you to get eye contact with your child?"; "If you or someone else in the family is visibly upset, does your child show signs of wanting to comfort them (e.g. stroking their hair, hugging them)?"; and "Does your child do the same thing over and over again (e.g. running the tap, turning the light switch on and off, opening and closing doors)?".

An exploratory factor analysis of the Q-CHAT at 18 months in the present study's sample of toddlers demonstrated the loading of 22 out of 25 items onto three factors explaining 38.1% of the total variance: (i) social-communicative autistic traits (10 items; α = .69 at 24 months), (ii) behavioural autistic traits (8 items; α = .71); and (iii) speech/ language development (4 items; α = .63; *name of authors et al.* , 2015). Correlations between the three factor scores were small (r = -.14 to .19), indicating these are largely independent of one another. Because the third language/ speech factor comprised only four items, and was more broadly developmental in focus, rather than autistic-trait specific, analyses focused on first two factors.

Child Characteristics. We examined (i) gender; (ii) Full IQ score; (iii) Verbal IQ, and (iv) birth order (firstborn, second-born, third- to fifth-born). Full IQ and Verbal IQ respectively were measured at 24 months using Standard Scores (normative mean=100; SD=15) from the Cognitive Scale and the Language Scale respectively of the *Bayley Scales of Infant Development Third Edition* (Bayley-III; Bayley, 2006), a widely used standardized measure of developmental functioning for infants and young children aged 1-42 months.

Maternal Variables. Maternal variables analyzed were:

(i) maternal age at childbirth (in years);

(ii) maternal education level;

(iii) ethnicity (Malays versus Chinese; Indians versus Chinese[7]); and

(iv) self-reported maternal depressive symptoms at 24 months, as measured by the total raw score of the *Beck Depression Inventory* (BDI-II; Beck, Steer & Brown, 1996; score range 0-63; higher scores=more symptoms).

[7] Singapore population comprises approximately 74% Chinese, 13% Malay, 9% Indian and 3.3% others, according to Singapore Statistics 2014; thus, the reference group is Chinese.

Procedure

Data were collected by a team of trained research assistants, supervised by GUSTO's principal investigators. Main maternal and family demographic variables were collected at the first trimester antenatal scan. Maternal age at childbirth and the child's gender were gathered at childbirth. Q-CHAT data were collected at 18 and 24 months, while the Bayley Scales and the maternal BDI were collected at 24 months. The Bayley Scales were administered at the toddlers' own homes by trained research coordinators.

Ethical considerations. Ethical approval for the GUSTO study, within which this study was embedded, was provided by the SingHealth Centralized Institutional Review Board (CIRB) and the National Healthcare Group Domain Specific Review Board (DSRB), and was approved by the National University of Singapore IRB. Participant eligibility information and consent were obtained at the 1st trimester of pregnancy. There was no obligation to take part in the study and participants could withdraw at any point without their standard medical care being affected in any way. Each family was reimbursed with SG100 vouchers at each center or home visit and SG 20 vouchers for completion of parent-completed questionnaires.

Missing Data and Statistical Analyses

Following the recommendations of Allison et al. (2008), incomplete or ambiguously answered Q-CHAT items were conservatively scored '0' and questionnaires with seven or more missing items were excluded (N = 3 at 24 months). Preliminary analyses involved examining the inter-correlations between child and maternal/ SES variables of interest to this study. For the main analyses, multiple regressions were performed with all maternal, child and demographic variables

examined to elucidate their combined and independent role in predicting the variance in caregiver-reported Q-CHAT scores at 24 months.

Results

Table 1 presents descriptive statistics for all key variables.

Preliminary analyses

Inter-correlations between child and caregiver/ demographic variables (see *Table 2*).

INSERT TABLE 2 ABOUT HERE

Preliminary inter-correlation analyses (see Table 2) indicated that while the children's overall cognitive functioning was not significantly associated with their gender, better language development was associated with being female and with higher maternal education. Mothers who had attained higher educational levels tended to be older at childbirth, and to have children of lower birth order enrolled in the study. Significant ethnic differences were also identified in terms of maternal education level and age at childbirth, although most of these relationships were of small or medium effect sizes. These findings were taken into account in the main analyses and interpretation of findings.

Main analyses

Child characteristics and their relationship with caregiver-reported autistic traits. More Q-CHAT social-communication autistic traits were reported for boys than girls with a small effect size (*Table* 3). Lower Bayley cognitive and composite language standard scores were significantly associated with more social/ communication as well as behavioral Q-CHAT autistic traits, with small to medium effect sizes, while birth order was not significantly associated with any of the Q-CHAT factor scores (Table 3).

INSERT TABLES 3 & 4 ABOUT HERE

Maternal characteristics and their relationship with caregiver-reported autistic traits. Higher educated mothers reported significantly fewer Q-CHAT behavioural autistic traits (*Table 3*). Higher BDI maternal depression scores were also correlated with more Q-CHAT social-communicative autistic traits, with small effect sizes. There was no significant association between maternal age at childbirth or ethnicity and any of the Q-CHAT factor scores (see Tables 3 & 4).

Child, maternal and demographic characteristics predicting autistic traits. Multiple regression analyses were then carried out to determine whether child and maternal factors examined predicted variance in Q-CHAT social-communicative and behavioral autistic traits. The regression models were both statistically significant, explaining 13% of the variance in social-communicative and 6% of the variance in behavioural autistic trait scores respectively (see *Table 5*).

Predictors of caregiver-reported social-communicative autistic traits. When all child, maternal and demographic predictors were entered together, higher Bayley language composite scores predicted fewer (i.e. less severe) social-communication autistic traits. Increased maternal depressive symptoms were also a significant predictor of higher (i.e. more severe) Q-CHAT social-communicative autistic traits. Lower birth order (i.e. being firstborn rather than later-born) and male gender approached, but did not reach, statistical significance in predicting more Q-CHAT social-communicative autistic traits (see *Table 5*).

Predictors of caregiver-reported behavioural autistic traits. When all maternal, child and demographic factors were considered together, only higher maternal education emerged as a significant predictor of fewer Q-CHAT behavioural autistic traits (*Table 5*).

INSERT TABLE 5 ABOUT HERE

Discussion

Summary of main findings

We examined whether a number of child, maternal or demographic variables were associated with, or predicted, caregiver reports of children's autistic traits in a large unselected sample of 24-month-old Singaporean toddlers. The regression models explained statistically small (6 – 13%), but significant, amounts of variance in Q-CHAT social/ communication and behavioral autistic traits. Children's gender, cognitive standard scores and birth order, maternal age at childbirth, and ethnic group membership were not significant predictors of autistic traits. Only poorer child language development and higher maternal self-reported depressive symptoms significantly predicted more caregiver-reported social-communicative autistic traits, while only lower maternal education predicted more parent-reported behavioural/ non-social autistic traits.

Poorer child language development as a predictor of more social-communicative autistic traits

When both gender and language development were considered together, language development retained its predictive value, whereas gender only approached statistical significance. These results are consistent with findings by Hus and colleagues (2013) who identified greater language impairment as a predictor of more caregiver reported autistic traits on the SRS. In their study of children with ASD and their unaffected siblings, gender continued to be a significant predictor, although the authors acknowledged that the measure they employed to assess language development (the caregiver-reported Vineland Expressive Communication V-score) had restricted range of scores in their sample, and was also a caregiver-reported measure. In our study, we

used the clinician-administered Bayley language composite scores, although it should be noted that this has not been normed with Singaporean toddlers. It is also possible that the absence of gender as a predictor of social-communicative traits in the present study may reflect multi-collinearity effects resulting from the significant association of better language acquisition and being female (Wallentin, 2009).

Higher maternal depressive symptoms as a predictor of more caregiver-reported social-communicative autistic traits in children

In line with our findings, existing literature has consistently identified maternal self-reported depressive symptoms as predictors of caregiver-reported child behaviours associated with developmental concerns in unselected samples (Ronald et al., 2011). Bennett et al (2012) compared maternal-rated children's SRS scores to a gold-standard clinician-rated diagnostic interview for which the information was provided by caregivers, as well as to independently clinician-administered and rated semi-structured observational diagnostic assessment scores. They found that children of self-rated 'depressed' as compared to 'non-depressed' mothers did not differ significantly in ASD severity scores on clinician- rated assessments. In other words, elevated scores were only evident when mothers with more depressive symptoms were involved directly in rating or reporting their children's autistic presentations themselves. At the same time, and as this is a cross-sectional study, it is also possible that more autistic traits in children may make parenting more demanding or less rewarding, thereby contributing to higher caregiver-reported depressive symptoms, or that the relationship is to some extent bi-directional. It should also be noted, that despite the significant findings, maternal depressive symptoms only explained small amounts of variance in this domain, suggesting that although statistically significant, such influences are likely small.

Higher maternal education as a predictor of fewer caregiver-reported behavioural autistic traits in children

Higher maternal education emerged as the only variable predicting fewer caregiver-reported behavioural autistic traits in this birth cohort sample when all child, maternal and demographic factors were considered together. Hus et al. (2013) also found that higher maternal education was associated with fewer caregiver reported autistic traits as measured by the total SRS raw score, but they did not further examine this relationship separately for specific SRS symptom clusters/ factors.

Mothers with higher education may report fewer behavioral autistic traits in their children for a number of reasons. They may be more accurate in rating different observable child behaviors described in the Q-CHAT. Another possibility is that some of the Q-CHAT behavioral items (such as whether the child can adapt to changes in routine, or whether the child does the same thing over and over again) may present less in children of more educated mothers because of the ways in which higher maternal education may impact parenting or the home environment (for example, more highly educated mothers may create more structured home environments and routines). Such potential influences of demographic variables on parenting resources, access to parenting education and information or the environments within which the children develop may affect the expression and/ or report of behavioral components of autistic traits more than social or communication ones.

In addition, the fact that child language and cognitive composite scores did not predict behavioural autistic traits could be due to the moderating effect of maternal education, which was significantly and positively associated with both language and cognitive development in this study (see also Grantham-McGregor et al., 2007; Hoff, 2003).

Ethnic differences in caregiver reports of social-communicative autistic traits?

In our study, no statistically significant differences were found in total or factor Q-CHAT scores between the study's three main ethnic groups. Although ethnic differences have been found and reported in some other studies of mainly adult participants from the general population who completed self-report measures of autistic traits (Freeth et al., 2013), these have been found predominantly when participants from Western and Eastern cultures have been compared, whereas all participants in our study were of different Asian ethnic groups.

Summary, limitations, and implications/ recommendations for "rapid phenotyping" research on autistic traits and related symptomatology

This study provides further evidence that child, caregiver, and demographic factors likely to some extent influence caregiver reporting of autistic traits on the Q-CHAT in unselected samples. However, only small amounts of variance (i.e. 6-13%) were explained and effect sizes were all small, suggesting that, on the whole, caregivers (mostly mothers in the present study) appear to be rating autistic traits largely independently of other child characteristics (such as their IQ, language, gender, or birth order) and of their own experiences (such as their ethnicity, educational opportunities or current mental health).

Future studies employing caregiver reporting of autistic traits are encouraged to control for caregiver depressive symptoms and informants' education level and to consider the children's language abilities, the three variables found to predict caregiver reported autistic traits in the present study.

Furthermore, different variables were found to predict social-communicative and non-social/ behavioral autistic traits respectively, lending further support to the importance of examining the different domains of autistic traits independently (Shuster

et al., 2014; Mandy & Skuse, 2008). Finally, the current study extends earlier findings of child, caregiver, and demographic variables influencing caregiver reports of autistic traits or symptoms from Western-based samples to an unselected Asian community sample providing stronger cross-cultural support with regards to the role of different variables influencing caregiver report of autistic traits.

Rapid phenotyping approaches for measuring autistic traits including informant- and self-report have been widely used in existing research because they offer reasonable levels of accuracy and reliability, while being more time-efficient and cost-effective than direct assessment methods. Our results provide preliminary support for the use of caregiver reports to quantify autistic traits in children in unselected samples, but suggest that future studies aiming to use rapid phenotyping should aim to collect and control for key indicators of child and informant functioning (e.g., child language, respondents' educational level and depressive symptoms). In order to further validate the use of rapid phenotyping, future studies should compare caregiver reports of autistic traits with direct, observational, behavioural, or experimental data on child behavior, functioning or performance in tasks conceptually and empirically relevant to autistic traits, so that we can more clearly disentangle whether such factors influence the actual prevalence, or the reporting, of autistic traits and related symptoms. Future work should also explore whether these characteristics also influence caregiver reporting of autistic symptoms in toddlers with existing diagnoses of ASD, or in toddlers who will subsequently be diagnosed with ASD, as it is possible that existing findings are only generalizable to reporting of autistic traits in unselected samples. Finally, future studies can explore the potential influences of other variables not examined in the present study, such as children's behavioral problems, autistic traits in parents, or parenting stress, which may also affect the reliability of rapid phenotyping measurement of autistic traits.

Key Points

- Most current research on children's autistic traits relies on caregiver report, yet little is known about whether the child's, informants' or other demographic characteristics influence ratings of autistic traits. We examined this using the Quantitative Checklist for Autism in Toddlers (Q-CHAT).
- Children's gender, cognitive functioning and birth order, maternal age, and ethnic group membership were not significant predictors.
- Poorer child language development and higher maternal depressive symptoms predicted more parent-reported social-communicative autistic traits.
- Lower maternal education predicted reporting more behavioural autistic traits.
- Researchers should consider controlling for children's language and informants' educational level and depressive symptomatology when utilizing caregiver reports of autistic traits.

Compliance with Ethical Standards

Ethical standards: All procedures performed in this study which involved human participants were in accordance with the ethical standards of the institutional research board. Ethical approval for the larger study, within which this study was embedded, was provided by the Singhealth Centralized Institutional Review Board (CIRB) and the National Healthcare Group Domain Specific Review Board (DSRB), and was approved by the National University of Singapore. Informed consent were obtained from all participants at recruitment. There was no obligation to take part in the study and participants could withdraw at any point without their standard medical care being affected in any way.

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Conflicts of interest: The fourth and fifth authors are the developers of the measure investigated in the present study (the Q-CHAT), however the measure is freely available and non-copyrighted and therefore the authors have no financial interests stemming from this research study. The other authors report no conflicts of interest.

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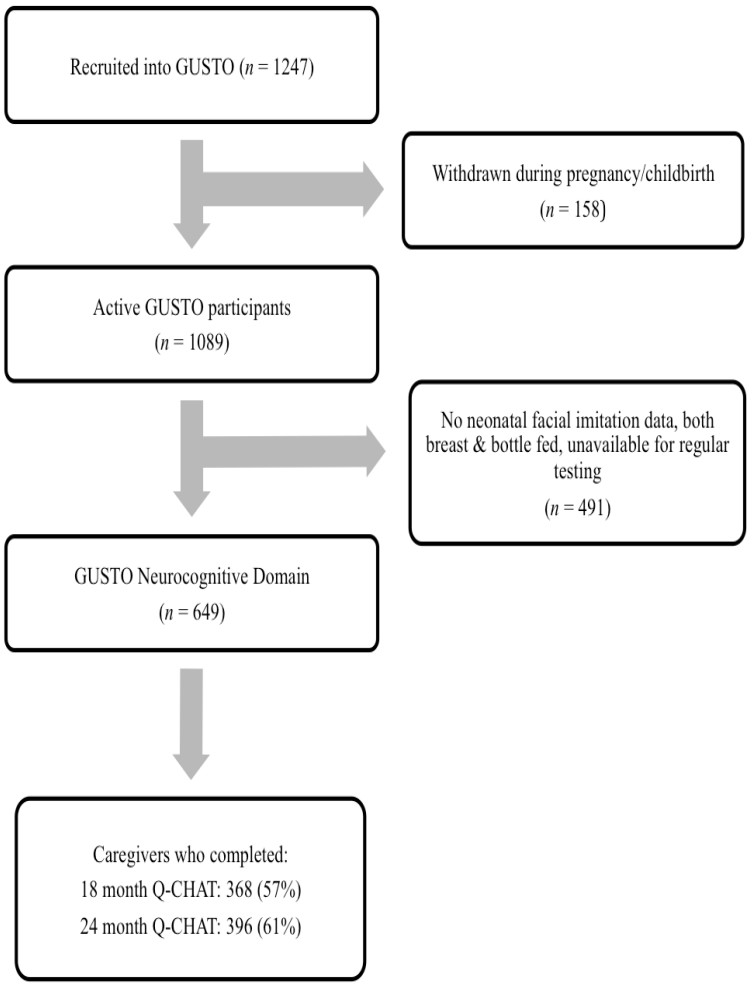

Figure 1. Flowchart of recruitment and participation

Table 1. Child, maternal and demographic variables at 24 months (N = 396, unless otherwise indicated)

		N (%), or Mean (SD) [Range]
Child variables	Gender	
	Males	205 (51.8%)
	Females	191 (48.2%)
	Bayley Composite IQ score (*n* = 368)	102.58 (12.67) [55 - 145]
	Bayley Composite language score (*n* = 365)	95.44 (14.08) [50 – 138]
	Birth order	
	Firstborn	179 (45.2%)
	Second born	121 (30.6%)
	Third and higher	96 (24.2%)
Maternal & demographic variables	Age at childbirth	30.5 (5.2) [19 – 46]
	Highest Education	
	None/Primary	16 (4.1%)
	Secondary/Tech. Ed.	139 (35.2%)
	'A' levels/Polytechnic/Others	96 (24.3%)
	University	144 (36.5%)
	BDI depressive symptoms raw score	7.39 (7.28) [0 – 34]
	Ethnicity	
	Chinese	232 (58.6%)
	Malay	113 (28.5%)
	Indian	51 (12.9%)
Q-CHAT at 24 months	Total score	33.20 (7.70) [9 – 59] α = .60
	Social-communicative traits factor score	10.62 (4.51) [2 – 33] α = .75

	Behavioural traits factor score	10.80 (5.14) [0 – 26] α = .71
	Speech/language factor score	7.28 (1.73) [1 – 12] α = .63

α=Cronbach's alpha.

Table 2. Associations between child, maternal and sociocultural variables examined in the present study

	Child's gender	Child's cognitive development	Child's language development	Child's birth order	Maternal age at childbirth	Maternal education	Maternal depressive symptoms
Child's gender							
Child's Full IQ (Bayley)	r_{pb} = .09						
Child's language composite score (Bayley language)	$\mathbf{r_{pb} = .17^{**}}$	$\mathbf{r = .66^{***}}$					
Child's birth order	$\chi^2(2) = 2.58$	r_s = -.09	r_s = -.12*				
Maternal age at childbirth	r_{pb} = .03	r = .06	r = .06	r_s = .01			
Maternal education	$\chi^2(3) = 1.42$	$\mathbf{r_s = .19^{***}}$	$\mathbf{r_s = .30^{***}}$	$\boldsymbol{\tau = -.22^{***}}$	r_s = .12*		
Maternal depressive symptoms	r_{pb} = .01	r = -.00	r = -.05	r_s = -.04	r = .02	r_s = -.11*	
Ethnicity	$\chi^2(2) = .55$	$t(2) = .04$	$t(2) = .55$	$\chi^2(4) = 7.53$	$\mathbf{t(2) = 19.10^{***}}$	$\boldsymbol{\chi^2(6) = 24.22^{***}}$	$t(2) = .11$

*$p < .05$, **$p < .01$, ***$p < .001$; *Pearson's correlation coefficient (r), point biserial correlation coefficient (r_{pb}), Spearman's correlation coefficient (r_s), Kendall's tau (τ), chi-square test of association (χ^2(degrees of freedom)), one way ANOVA (t(degrees of freedom))*

Table 3. Unadjusted correlations between child, maternal, sociocultural variables and autistic traits at 24 months

	Q-CHAT Social-communicative traits	Q-CHAT Behavioural traits
Child variables		
Gender [b]	**-.16****	-.00
Bayley Composite Cognitive Score [a]	**-.17*****	**-.14****
Bayley Language Composite Score [a]	**-.27*****	**-.17*****
Birth order [c]	-.07	-.01
Maternal variables		
Age at childbirth [a]	-.01	-.04
Educational level [c]	-.04	**-.22*****
BDI Depressive symptoms [a]	**.19*****	.08

*$p < .05$, **$p < .01$, ***$p < .001$; *Pearson's r [a], Point biserial [b], Spearman's rho [c]*

Table 4. Q-CHAT total and factor scores for the whole sample and by ethnic group membership

	All participants (*n* = 396)	Chinese (*n* = 232)	Malay (*n* = 113)	Indian (*n* = 51)	Statistics for ethnic group differences; F (*p*) η^2
Q-CHAT Social-communicative traits	10.62 (4.51)	10.97 (4.73)	10.35 (4.25)	9.65 (3.92)	2.09 (.13) .01
Q-CHAT Behavioural traits	10.80 (5.14)	10.51 (5.1)	11.07 (5.39)	11.51 (4.71)	1.01 (.37) .01
Q-CHAT Total score	33.20 (7.70)	33.17 (8.1)	33.43 (7.34)	33.43 (7.34)	.13 (.88) .00

All scores: M (SD)

Table 5. Regression models for Q-CHAT factor scores

	Q-CHAT Social-communicative traits				Q-CHAT Behavioural traits			
	β	*p*	R^2	ΔF	β	*p*	R^2	ΔF
Child variables			.13	5.71***			.06	2.52**
Gender	-*.09*	*.08*			.03	.61		
Bayley cognitive composite score	.00	.97			-.04	.59		
Bayley language composite score	**-.25**	**.00**			-.10	.18		
Birth order	-*.09*	*.11*			-.05	.41		
Maternal variables								
Age at childbirth	-.03	.57			-.01	.94		
Highest education	-.01	.91			**-.16**	**.01**		
BDI depressive symptom score	**.18**	**.00**			.08	.14		
Ethnicity:								
Chinese vs. Malays	*.09*	.14			-.00	.98		
Indians vs. Malays	-.04	.50			.04	.49		

*Note: Malays were used as the reference group for ethnicity; *p < .05, **p < .01, ***p < .001*; in bold significant independent predictors; in italics, predictors approaching statistical significance.