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Maternal and Family Processes in Different Subgroups of Youth with Autism Spectrum Disorder

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Abstract

We compared the maternal reports on mothering and family processes between 160 youth with autism spectrum disorder (ASD) and 160 age and gender-matched typically developing (TD) youth stratified by personal characteristics from Taiwan. The ASD groups consisted of 51 'typical autism' (TA), 52 'high-functioning autism' (HFA), and 57 'Asperger syndrome (AS).' Maternal reports showed that youth with ASD obtained less affection and more protection from the mother, and had less active mother-child interactions and more behavioral problems at home. Their mothers perceived less family support when compared to mothers of TD youth. Moreover, both TA and AS groups had more maternal protection and less maternal perceived family support, whereas HFA and co-occurring ADHD were only associated with more behavioral problems at home. The maternal and family process may vary across different ASD subgroups.

Keywords ASD · Mothering · Family support · Mother-child relationships

Autism spectrum disorder (ASD) is a common neurodevelopmental condition with a prevalence rate up to

1.48–2.64% (Blumberg et al. 2013; Kim et al. 2011; Windham et al. 2011). Due to its core features of impaired social

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communication, restricted interests, repetitive behaviors and behavioral rigidities (APA 1994, 2013), parents of youth with ASD experience more psychological distress than parents of typically developing (TD) youth (Ingersoll et al. 2011; Ruiz-Robledillo and Moya-Albiol 2013). Moreover, the severity of child's ASD symptoms was reported to be associated with parenting distress (Benson 2006), where both the mothers and fathers of youth with ASD reported equal level of stress (Hastings 2003), or even a higher stress in the mothers (Lee 2009; Little 2002). The pressure may be influenced by various factors such as child's ASD symptoms and behavioral problems (Baker-Ericzen et al. 2005; Moes et al. 1992).

The family process is also affected. Families of youth with ASD have lower scores of adaptability, cohesion, and marital satisfaction (Higgins et al. 2005), and the parents lived a restricted social life to accommodate the needs of their child (Seltzer et al. 2001). Thus, child's behavior associated with ASD may actively shape family processes and vice versa. Child's behavior problems and parenting stress affect each other bidirectionally (Baker et al. 2003; Neece et al. 2012). For example, child's behavior problems may bring or exacerbate parenting stress over time; whereas, high parenting stress, which is associated with less maternal warmth and more maternal criticism, may further aggravate behavior problems in children (Baker et al. 2003), which may further impair mother-child interactions and disrupt family harmony. Moreover, a recent transactional longitudinal study showed that parenting stress is both an antecedent and consequence of child behavior problems, while simultaneously these behavior problems in childhood or adolescence are an antecedent and consequence of parenting stress (Neece et al. 2012).

ASD, or Pervasive Developmental Disorders in DSM-IV (APA 1994), is a heterogeneous condition. Higher social and language abilities and normal IQ are associated with more favorable outcomes in adulthood (Howlin et al. 2013). Although DSM-5 (APA 2013) has moved toward a dimensional approach with regards to the diagnosis of ASD, some researchers and clinicians continue to utilize ASD subtypes in their studies and practice. The subtypes are categorized by the presence/absence of intellectual disability, Intelligence Quotient (IQ) <70, and developmental language delay (Howlin 2003). 'Asperger's Syndrome (AS)' is the subtype without intellectual disability and developmental language delay, 'High-Functioning Autism (HFA)' is the subtype without intellectual disability but with developmental language delay, and 'Typical Autism (TA)' is the subtype with both intellectual disability and developmental language delay (Wing 1980). Although nosology of HFA is not formally presented in DSM-IV (APA 1994) or DSM-5 (APA 2013) and researchers often cluster participants with HFA and AS into one group (Baron-Cohen et al. 2001). HFA is rather a widely used clinical diagnosis for the individuals who meet the DSM-IV criteria for autistic disorder and do not have an intellectual

disability. Studies have also been done to compare the differences between HFA and AS (Howlin 2003; Kurita 1997; Manjiviona and Prior 1999; Montgomery et al. 2016; Pomeroy 1998). For example, the two groups have a difference in linguistic functioning (Howlin 2003; Manjiviona and Prior 1999; Pomeroy 1998) and social function (Montgomery et al. 2016). Individuals with HFA were likely to have behavioral problems, insistence on sameness, bizarre preoccupation and motor difficulties (Howlin 2003). Individuals with AS, on the other hand, tend to have special interests and superior verbal skills (Howlin 2003; Kurita 1997). Although the differences between HFA and AS tend to diminish as the children grow up, individuals with HFA may still be disadvantaged in their ability to catch up linguistically (Howlin 2003). Thus, one may be prone to speculate that parents of youth without intellectual disability and developmental language delay, such as the conventional 'Asperger's Syndrome,' may encounter less difficulty in childrearing when compared to ASD individuals with intellectual disability and developmental language delay, i.e., TA. However, although ASD symptom severity has been accounted for parental stress in families of youth with ASD (Osborne and Phil 2009), other studies have shown that parents of youth with AS have greater stress than those of youth with TA (Mori et al. 2009). Furthermore, maternal stress level of youth with AS was positively correlated with child's impairment (Epstein et al. 2008), while child characteristics such as less severe maladaptive behaviors, better health, and less social impairments predicted higher levels of mother-child relationship quality in youth with ASD (Smith et al. 2008). It is thus essential to further investigate how the language and cognition of youth with ASD are associated with family processes.

Although attention-deficit hyperactivity disorder (ADHD) has been previously precluded in the diagnosis of Pervasive Developmental Disorder in DSM-IV (APA 1994), both ICD-10 (WHO 1992) and DSM-5 (APA 2013) support the co-existing condition of ASD and ADHD. Recent studies have suggested that ADHD symptoms are commonly observed in ASD (Chien et al. 2014; Simonoff et al. 2008). Moreover, it has been shown that youth with ASD have impaired facial emotion recognition, affective prosody, and social awareness, which may contribute to social communication difficulties, and the impairment may be further exacerbated by the presence of ADHD (Factor et al. 2017; van der Meer et al. 2012). The increased impairment in social communication may then negatively impact mother-child interactions and family process. Moreover, hyperactivity symptoms in children with ASD have also been found to associate with maternal parenting stress (Allik et al. 2006). Both ASD and ADHD were associated with higher level of caregiver burden (Cadman et al. 2012) and youth with ASD comorbid ADHD had a lower quality of life, more significant cognitive delays, and more social and familial problems than youth with ASD alone (Rao and Landa 2014; Sikora et al. 2012). Hence, it is likely to

speculate families of youth with ASD comorbid ADHD may experience more parenting stress, poorer mother-child relationships and less maternal perceived family support than those families of youth with ASD without comorbid ADHD.

Although the severity and source of parental stress in families of youth with ASD have been investigated in western societies, few studies have focused on mothering and family processes, especially in older children with ASD (Smith et al. 2008; Taylor and Seltzer 2011; Woodman et al. 2015). Moreover, few studies have examined how the phenotypic heterogeneity of ASD affects family processes (Mori et al. 2009). In addition, reports on the mother-child relationship in youth with ASD have been inconsistent. Some reported positive mother-child relationships in ASD were associated with the youth's less severity in maladaptive behaviors and social impairment (Orsmond et al. 2006) and a general improvement in autism symptoms and maladaptive behaviors over a 8.5 year period in adolescents and adults with autism (Woodman et al. 2015), while others reported a halt in mother-child interaction in youth with ASD after the child exited high school (Taylor and Seltzer 2011). Lastly, although less parental affection and more parental protection and control were noted in children with ASD when compared with unaffected siblings and TD children (Gau et al. 2010a), little is known about mothering in adolescents with ASD. To clarify these pending questions, here we used a cross-sectional study design to investigate mothering, mother-child relationship, and family functions in children and adolescents with ASD, stratified into specific phenotypic subgroups: (1) by cognitive and language development (TA, HFA, AS) and (2) by the co-occurrence of ADHD. Hence, this study is set to examine parent-child interaction pattern across different subgroups in ASD to help establish optimal interaction modules for intervention programs, targeting different subpopulations. We hypothesized (1) more protective mothering and family difficulty for youth with ASD, particularly youth with TA, than TD youth; (2) more impaired maternal and family process in youth with TA than youth with HFA and AS; and (3) co-occurrence of ADHD relating to a more controlling mothering style, a poorer mother-child interaction and a higher level of family dysfunction.

Method

Participants and Procedures

The Research Ethics Committee of the National Taiwan University Hospital (NTUH) approved this study and written informed consent was obtained from the participants and their parents. We recruited youth with a clinical diagnosis of ASD, aged 6–17 years consecutively from Department of Psychiatry, NTUH, Taiwan from 2009 to 2014. The ASD group inclusion criteria included a clinical diagnosis of autistic disorder or AS by child psychiatrists according to the corresponding DSM-IV (APA 1994) diagnostic criteria for 'Pervasive Developmental Disorders' criteria and confirmed by interviewing the parents with the Chinese version of the Autism Diagnostic Interview-Revised (ADI-R) as 'autism' (Gau et al. 2011). The Chinese Kiddie Epidemiologic Version of the Schedule for Affective Disorders and Schizophrenia (K-SADS-E) (Gau et al. 2005) interview was then performed to make current (i.e., past six months) diagnosis of other psychiatric disorders, including ADHD. Among 213 eligible youth with ASD, three did not complete the ADI-R interview, and 50 did not report on mothering and family process yielding a sample of 160 youth with ASD (87.5% male; mean age, 11.31 ± 2.80 years) who had complete data. There were no significant demographic differences between 160 participants and 50 who did not participate in the study (Supplementary Table S1).

The control group included 160 age- and gender-matched TD youth (87.50% male) with a mean age of 11.15 ($SD = 2.39$) years, recruited from similar neighborhoods to the ASD group; they did not have any lifetime diagnoses of ASD, ADHD, or developmental delay. The exclusion criteria for both ASD and TD were a history of psychotic disorder, substance use disorders, mood disorders, major neurological disorders, or system disease.

Three ASD subtypes were categorized based on clinical evaluation by the child psychiatrists, who also took the results of the assessment of the current IQ (assessed with WISC-IV with Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index and Processing Speed Index) (Weschler 2003) and language developmental history (assessed with clinical evaluation and the ADI-R interview) in consideration. These ASD subtypes included 'TA' ($n = 51$, 31.9%), 'HFA' (defined by ADI-R items 9, age of first words spoken; and item 10, age of first phrases spoken; $n = 52$, 32.5%), and 'AS' ($n = 57$, 35.6%). They were also categorized according to the presence ($n = 81$, 50.6%) or absence ($n = 79$, 49.4%) of ADHD.

Measures

The Chinese Version of the ADI-R

The ADI-R (Lord et al. 1994) is a standardized, comprehensive, semi-structured, investigator-based interview covering most developmental and behavioral aspects of ASD. The ADI-R is designed to interview caregivers of children with mental ages reaching 18 months into adulthood. The caregivers were asked to recall the child's current performance

and the performance when the child was 4–5 years old. The coding of some items is converted to numeric scores "0" if no evidence of abnormality exists, "1" if some evidence of abnormality exists, and "2" if evidence of marked abnormality. Higher scores mean more severe clinical deficits. The algorithm focuses on three domains, which are based on ICD-10 and DSM-IV diagnostic criteria, including reciprocal social interaction, verbal and non-verbal communication, as well as restricted, repetitive and stereotyped patterns of behaviors.

The ADI-R was translated into Chinese led by Gau SS and approved by the Western Psychological Services in May 2007 (Gau et al. 2011). Four interviewers (YS Lin, YJ Hsu, YP Liang, WY Huang) who major in psychology and psychiatric nursing received one-year full-time intensive clinical and research training in child and adolescent psychiatry before administering the Chinese ADI-R interview. All the interviewers reached an agreement over 90% of the rating of each item in the ADI-R by a qualified ADI-R cross-site trainer and in-site trainer before implementation of this study. The Chinese ADI-R has been widely used in clinical and research settings in ethnic Chinese and Taiwanese populations (e.g., Chen et al. 2014; Chien et al. 2013; Chien et al. 2015b; Chien et al. 2011; Lin et al. 2013; Lo et al. 2013).

The Chinese Version of the K-SADS-E

The Chinese K-SADS-E (Gau and Soong 1999) is a semi-structured interview scale and a reliable and valid instrument to assess both lifetime and current DSM-IV psychiatric disorders in children and adolescents (Gau et al. 2005). The overall sensitivity and specificity of the screening interview for any Chinese K-SADS-E diagnostic category were calculated to be 78% and 98% (Gau et al. 2005; Gau et al. 2010b), the generalized kappa coefficients among interviewers ranging from 0.73 to 0.96 for all mental disorders included in the Chinese K-SADS-E. The K-SADS-E has been extensively used in Taiwan's research (e.g., Chiang et al. 2015; Chou et al. 2015; Gau et al. 2010b; Hwang-Gu and Gau 2015; Lin et al. 2014; Lin et al. 2015a; Shang et al. 2015a; Shang and Gau 2014; Wu et al. 2014).

Wechsler Intelligence Scale- 4th Edition for Children (WISC-IV)

The WISC-IV (Weschler 2003), developed by David Wechsler, is an individually administered intelligence test for children between the ages of 6 and 16. The WISC-IV contains 10 core subtests, and 5 additional subtests, that can be summed to four indexes, and one Full-Scale IQ (FIQ). The FIQ can range from 40 at the lowest to 160 at the highest. The four indexes included Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Working Memory Index (WMI) and Processing Speed Index (PSI).

The Chinese Version of Autism Spectrum Quotient (AQ)

The Chinese AQ is a self-reported 35-item questionnaire commonly used for measuring autistic characteristics, the higher the score indicates an increase in certain domain of autistic characteristics. The AQ consists of 5 subscales, namely Socialness, Mindreading, Patterns, Attention to Details and Attention Switching. Lau et al. (2013) have established the norms and psychometric properties of the Chinese version of the AQ, which demonstrates good test-retest reliability, high internal consistency, and discriminative validity.

The Chinese Version of the Social Responsiveness Scale (Chinese SRS)

The SRS developed by Constantino and colleagues is a self- or caregiver-report with a four-point Likert-scale questionnaire in regards to the frequency of each behavior (0 for never true and 3 for always true) for quantifying autistic traits. There are five subscales (Social Awareness, Social Cognition, Social Communication, Social Motivation, and Autistic Mannerisms) in SRS. The Chinese SRS was developed by the Taiwan Autism Study Group with permission from Dr. Constantino and under the approval of Western Psychological Services in 2008. The Chinese SRS has demonstrated excellent internal consistency and convergent validity (Gau et al. 2013), and has been widely used in assessing autistic-like social deficits in Taiwan studies (Chen et al. 2016; H. Y. Chien et al. 2015a).

Parental Bonding Instrument (PBI)

Mothers reported on the Chinese PBI, a 25-item instrument, (item-rated on a 4-point Likert scale from "very likely" to "very unlikely"), measuring mother's behaviors and attitudes toward their child during the child's first 16 years (Parker 1979). It consists of three principal dimensions: Affectionate/Care (12 items), Overprotection (7 items), and Authoritarian Control (6 items) (Cox et al. 2000; Gau et al. 2010a). A high score on the Affectionate/Care scale reflects affection and warmth, on the Overprotection scale reflects an overprotective parenting style and on the Authoritarian Control subscale reflects a less encouragement for a child's sense of autonomy. The Chinese PBI is a reliable instrument with Cronbach's alphas of 0.75 to 0.84 (Gau et al. 2007) and has been used widely in measuring parenting based on parental reports (Chang and Gau 2017; Chang et al. 2013; Chen et al. 2015; Gau and Chang 2013) and also used in assessing parenting in families of youth with ASD (Gau et al. 2010a). The internal consistency (Cronbach's alpha, α) of the PBI in a study of youth with ADHD, their siblings, and their mothers was high for the Affectionate/Care (Mother, $\alpha = 0.73$; Child, $\alpha = 0.89$), and Authoritarian Control (Mother, $\alpha = 0.80$;

Child, $\alpha = 0.82$) and moderate for Overprotection (Mother, $\alpha = 0.72$; Child, $\alpha = 0.67$) (Chang and Gau 2017). The internal consistency was high in the current sample (Affectionate/ Care, $\alpha = 0.84$; Authoritarian Control, $\alpha = 0.87$; Overprotection, $\alpha = 0.75$).

Social Adjustment Inventory for Children and Adolescents (SAICA)

Mothers reported on mother-child interaction and their children's behavioral problems at home using the two subscales from the Home Behaviors domain of the Chinese SAICA (S. S. Gau et al. 2006; John et al. 1987): (1) Interactions with Mother (3 items): does things with mother, is friendly/ affectionate toward mother, and talks with mother (rating from 1, very true to 4, not at all true); and (2) Problems at Home (4 items): strong negative reaction or refusal to do chores or honor restrictions, dangerous irresponsibility around home, damages home or family property, and physically threatens or attacks parents (rating from 1, not a problem to 4, a severe problem). A higher score indicates either a less active interaction with mothers or more child's behavior problems at home (John et al. 1987). The intraclass correlations for test-retest reliability and the Cronbach's alpha for internal consistency of the subscales ranged from 0.45 to 0.84 and from 0.71 to 0.86, respectively (Gau et al. 2006). In addition, the internal consistency (Cronbach's alpha, α) of the two subscales used in a study involving youth with ADHD, their siblings, and their mothers, was high for the less active interactions with mother (Mother, $\alpha = 0.82$; Child, $\alpha = 0.81$), and moderate for child's behavioral problems at home (Mother, $\alpha = 0.66$; Child, $\alpha = 0.60$) (Chang and Gau 2017). The internal consistency of the current sample was high (less active interactions with mother, $\alpha = 0.76$; behavioral problems at home, $\alpha = 0.89$). The Chinese SAICA (S. S. Gau et al. 2006) has been widely used in clinic-based (Chiang and Gau 2015; Gau et al. 2015) and school-based (Hsiao et al. 2013; Tseng et al. 2014) studies in Taiwan.

Family APGAR

Mothers also reported family support on the Family APGAR: Adaptation, Partnership, Growth, Affection, and Resolve (0 for hardly ever, 1 for some of the time, and 2 for almost always), and a higher score indicates greater perceived family support (Smilkstein et al. 1982). The Chinese Family APGAR is a reliable instrument with high internal consistency presented as Cronbach's alpha of 0.89 and has been widely used in recent clinic-based (Chang et al. 2013; Lin et al. 2015b) and community-based (Lai et al. 2010; Yang et al. 2013) studies in Taiwan. Moreover, the Cronbach's alpha for this scale in a study involving youth with ADHD, their siblings, and their mothers was high (Mother, $\alpha = 0.90$; Child, $\alpha = 0.90$) (Chang

and Gau 2017). The internal consistency of the Family APGAR was high in the current sample ($\alpha = 0.89$).

Chinese Version of the Swanson, Nolan, and Pelham Version IV Scale (SNAP-IV)

SNAP-IV, a 26-item rating instrument, includes the core DSM-IV-derived ADHD subscales of inattention, hyperactivity-impulsivity, and oppositional defiance (OD) (items 1–9, 10–18, and 19–26, respectively) (Swanson et al. 2001). Each item is rated on a 4-point Likert scale, (0 = "not at all," 1 = "just a little," 2 = "quite a lot," and 3 = "very much,"). Gau et al. (2008, 2009) have established the norms and psychometric properties of the Chinese version of the SNAP-IV, which demonstrates good test-retest reliability, high internal consistency, and discriminative validity. This questionnaire has been widely used in clinical evaluation and research in Taiwanese child and adolescent populations (e.g., Gau et al. 2015; Shang et al. 2015b; Yang et al. 2013)). We used the parent form of the Chinese version SNAP-IV to evaluate ADHD-related symptoms in participants.

Data Analyses

We used the General Linear Modeling procedure in the SAS 9.1 (SAS Institute Inc., Cary, NC, USA) program to compare the family and maternal measures, autistic and ADHD-related symptoms between the ASD and TD groups (Table 1) followed by the same approaches with stratification by the age group, maternal educational level, ASD subtypes (TA, HFA, and AS), and the presence of concurrent ADHD after controlling for confounding factors such as age and sex (see Table 2). We further directly compared the demographics and autistic and ADHD-related symptoms (Table S2) and mother-reported measures among TA, HFA, and AS (Table 3), and between the ASD with and without ADHD groups (Table S3). For the former, Bonferroni's correction was used to adjust p values in post hoc analysis for multiple comparisons (Table 3). Cohen's d was also used to compute the effect size for the group comparisons with small, medium, and large effect sizes as Cohen's d 0.2 to 0.5, 0.5 to 0.8, and ≥ 0.8, respectively. To identify the most significant predictors for maternal and family processes in ASD, we included child's demographic characteristics, maternal education, and child diagnostic subtyping altogether and the 3-way (subtype*age*sex) and 2-way (subtype*age, subtype*sex) interaction terms as predictors in the linear regression models for each measure of maternal/family processes (Table 4). Finally, we also adopted dimensional approach by

Table 1 Sample description for youths with autism spectrum disorder and typically developing youths

	ASD N = 160	TD N = 160	Statistics
Male (%)	87.5	87.5	–
Child			
Age (Mean ± SD) (Range)	11.31 ± 2.80 (6–17)	11.15 ± 2.39 (7–16)	$F_{(1,318)} = 0.30$, $p = 0.583$
Single Child (%)	23.1	15.6	$\chi^2 = 2.88$, df = 1, $p = 0.090$
Intelligence quotient (IQ)			
Full-scale IQ	97.11 ± 23.07	–	
Verbal IQ	98.17 ± 24.83	–	
Performance IQ	96.43 ± 21.13	–	
Autism Diagnostic Interview-Revised (ADIR)			
Current			
Reciprocal Social Interaction	11.89 ± 5.48	–	
Communication, Verbal	10.42 ± 4.47	–	
Communication, Nonverbal	4.79 ± 3.48	–	
Stereotyped Behaviors/Interest	5.56 ± 2.67	–	
Past (4–5 years old)			
Reciprocal Social Interaction	20.72 ± 5.56		
Communication, Verbal	16.01 ± 4.23		
Communication, Nonverbal	8.48 ± 3.10		
Stereotyped Behaviors/Interest	7.34 ± 2.69		
SNAP-IV			
Inattention	15.28 ± 6.11	4.92 ± 3.72	$F_{(1,313)} = 332.64$, $p < .001$
Hyperactivity/Impulsivity	11.26 ± 6.69	3.20 ± 3.59	$F_{(1,313)} = 179.41$, $p < .001$
Oppositional	9.56 ± 5.72	3.52 ± 3.93	$F_{(1,313)} = 120.06$, $p < .001$
Mother			
Age (Mean ± SD) (Range)	40.53 ± 5.27 (27–55)	40.74 ± 5.23 (28–52)	$F_{(1,318)} = 0.14$, $p = 0.710$
Education (%)			
College and Above	67.5	62.5	$\chi^2 = 0.88$, df = 1, $p = 0.350$
Senior High School and Below	32.5	37.5	
Employment (%)			
Employed	42.1	54.4	$\chi^2 = 4.78$, df = 1, $p = 0.030$
Unemployed	57.9	45.6	
Married and Live Together (%)	90.6	95.63	$\chi^2 = 3.12$, df = 1, $p = 0.080$
Number of Children	1.94 ± 0.72 (1–5)	2.06 ± 0.63 (1–4)	$F_{(1,318)} = 2.71$, $p = 0.101$
Family Type (%)			
Nuclear Family	75.0	55.6	$\chi^2 = 22.86$, df = 2, $p < 0.001$
Extended Family	23.1	28.8	
Joint-stem Family	1.9	15.6	

ADHD, attention-deficit hyperactivity disorder; ASD, autism spectrum disorder; ASD + ADHD, autistic spectrum disorder with co-occurring attention deficit hyperactivity disorder; ASD-ADHD, autistic spectrum disorder without co-occurring attention deficit hyperactivity disorder; Extended Family, families consisting of two parents, the children and the grandparents; Joint-stem Family, families consisting of parents, the children, grandparents and other relatives such as aunts and uncles; Nuclear Family, families consisting of two parents and their child; SD, standard deviation; TD, typically developing.

treating autistic symptoms (ADI-R) and ADHD-related symptoms (SNAP-IV) as continuous variables to predict the maternal and family measures (Supplementary Table S4).

Results

Demographics and ASD and ADHD Symptoms by the ASD and TD Groups

Males were more prevalent in both groups (87.5%, Table 1). Youth with ASD, compared to TD, had higher maternal unemployment rate, fewer siblings, and more severe ADHD-related symptoms ($p < 0.001$ for all three

symptom domains), and were more likely to have a nuclear family (see Table 1). There were no differences in other demographics (Table 1).

Demographics among ASD Subtypes

We compared the demographics and clinical symptom severity among the three ASD groups (Supplementary Table S2). Youth with TA had a lower FIQ, VIQ, and PIQ (all $ps < 0.001$) and more severe ADIR symptoms in reciprocal social interaction ($p < 0.001$), verbal communication ($p < 0.001$), and nonverbal communication ($p < 0.001$) than the HFA and AS groups with no differences in stereotyped behaviors/interest ($p > 0.05$). Moreover, we found more severe inattention in TA than

Table 2 Comparison of mothering, mother-child relationship, family support between youths with autism spectrum disorder (ASD) and typically developing youth (TD) by personal characteristics

	Affection and Care†				Overprotection†				Authoritarian Control†			
	ASD N = 160	TD N = 160	F value	Cohen's d	ASD N = 160	TD N = 160	F value	Cohen's d	ASD N = 160	TD N = 160	F value	Cohen's d
All Subjects	28.71 ± 4.99	29.83 ± 4.56	$F_{(1,318)}=4.35$[a]	−0.23	8.02 ± 3.57	6.12 ± 3.47	$F_{(1,318)}=23.20$[d]	0.54	6.38 ± 2.85	5.77 ± 2.65	$F_{(1,318)}=4.01$[a]	0.22
Age Group												
6–11 (N = 80/80)	28.56 ± 5.10	30.37 ± 4.33	$F_{(1,158)}=50.86$[a]	−0.38	8.58 ± 3.63	6.60 ± 3.09	$F_{(1,158)}=13.80$[c]	0.59	6.71 ± 2.79	6.50 ± 2.49	$F_{(1,158)}=0.24$	0.08
12–17 (N = 80/80)	28.86 ± 4.92	29.28 ± 4.74	$F_{(1,158)}=00.30$	−0.09	7.45 ± 3.44	5.64 ± 3.77	$F_{(1,158)}=10.09$[b]	0.50	6.06 ± 2.89	5.04 ± 2.62	$F_{(1,158)}=5.55$[a]	0.37
Gender												
Male (N = 140/140)	28.55 ± 4.89	29.90 ± 4.56	$F_{(1,278)}=50.70$[a]	−0.29	7.99 ± 3.60	6.05 ± 3.44	$F_{(1,278)}=21.09$[d]	0.55	6.39 ± 2.88	5.77 ± 2.71	$F_{(1,278)}=3.39$	0.22
Female (N = 20/20)	29.85 ± 5.68	29.32 ± 4.63	$F_{(1,38)}=0.10$	0.10	8.23 ± 3.41	6.60 ± 3.73	$F_{(1,38)}=2.09$	0.46	6.35 ± 2.66	5.73 ± 2.26	$F_{(1,38)}=0.63$	0.25
Mother												
Education												
College and Above (N = 108/100)	29.18 ± 4.90	30.70 ± 4.56	$F_{(1,206)}=5.40$[a]	−0.32	7.98 ± 3.49	5.80 ± 3.55	$F_{(1,206)}=19.96$[d]	0.62	6.67 ± 2.83	5.70 ± 2.74	$F_{(1,206)}=6.28$[a]	0.35
Senior High School (N = 52/60)	27.75 ± 5.11	28.37 ± 4.20	$F_{(1,110)}=0.49$	−0.13	8.09 ± 3.77	6.65 ± 3.30	$F_{(1,110)}=4.63$[a]	0.41	5.79 ± 2.83	5.88 ± 2.52	$F_{(1,110)}=0.03$	−0.03
Employment												
Employed (N = 67/87)	28.78 ± 5.10	30.30 ± 4.48	$F_{(1,152)}=30.86$	−0.32	7.90 ± 3.28	5.66 ± 3.01	$F_{(1,152)}=19.36$[d]	0.71	6.21 ± 2.75	5.76 ± 2.83	$F_{(1,152)}=1.00$	0.16
Unemployed (N = 92/73)	28.62 ± 4.95	29.27 ± 4.62	$F_{(1,163)}=00.74$	−0.14	8.11 ± 3.80	6.67 ± 3.90	$F_{(1,163)}=5.64$[a]	0.37	6.52 ± 2.94	5.78 ± 2.44	$F_{(1,163)}=3.05$	0.28
Family Type												
Nuclear Family (N = 120/89)	28.19 ± 5.33	29.86 ± 4.74	$F_{(1,207)}=5.49$[a]	−0.33	8.06 ± 3.60	6.07 ± 3.44	$F_{(1,207)}=16.20$[d]	0.56	6.57 ± 2.85	5.61 ± 2.58	$F_{(1,207)}=6.23$[a]	0.35
Others (N = 40/71)	30.28 ± 3.43	29.79 ± 4.36	$F_{(1,109)}=0.37$	0.12	7.88 ± 3.52	6.18 ± 3.53	$F_{(1,109)}=5.92$[a]	0.48	5.84 ± 2.80	5.97 ± 2.74	$F_{(1,109)}=0.06$	−0.05
ASD Subtypes												
Typical Autism (N = 51/160)	27.53 ± 4.61	29.83 ± 4.56	$F_{(1,209)}=9.77$[b]	−0.50	9.03 ± 3.73	6.12 ± 3.47	$F_{(1,209)}=26.27$[d]	0.81	7.05 ± 2.96	5.77 ± 2.65	$F_{(1,209)}=8.51$[b]	0.46
HFA (N = 52/160)	29.92 ± 4.72	29.83 ± 4.56	$F_{(1,210)}=0.02$	0.02	7.35 ± 3.56	6.12 ± 3.47	$F_{(1,210)}=4.84$[a]	0.35	6.37 ± 2.81	5.77 ± 2.65	$F_{(1,210)}=1.93$	0.22
AS (N = 57/160)	28.67 ± 5.37	29.83 ± 4.56	$F_{(1,215)}=2.47$	−0.23	7.72 ± 3.29	6.12 ± 3.47	$F_{(1,215)}=9.16$[b]	0.47	5.81 ± 2.70	5.77 ± 2.65	$F_{(1,215)}=0.01$	0.01
Presence of ADHD												
ASD + ADHD (N = 81/160)	28.40 ± 4.89	29.83 ± 4.56	$F_{(1,239)}=5.05$[a]	−0.30	8.30 ± 3.35	6.12 ± 3.47	$F_{(1,239)}=21.80$[d]	0.64	6.33 ± 3.12	5.77 ± 2.65	$F_{(1,239)}=2.17$	0.20
ASD-ADHD (N = 79/160)	29.04 ± 5.11	29.83 ± 4.56	$F_{(1,237)}=10.46$	−0.16	7.72 ± 3.79	6.12 ± 3.47	$F_{(1,237)}=10.60$[b]	0.44	6.44 ± 2.56	5.77 ± 2.65	$F_{(1,237)}=3.43$	0.26

	Difficulty in Interaction with Mother‖				Problems at Home‖				Perceived Family Function§			
	ASD N = 160	TD N = 160	F value	Cohen's d	ASD N = 160	TD N = 160	F value	Cohen's d	ASD N = 160	TD N = 160	F value	Cohen's d
All Subjects	1.75 ± 0.66	1.44 ± 0.52	$F_{(1,318)}=22.52$[d]	0.53	1.69 ± 0.44	1.29 ± 0.29	$F_{(1,318)}=89.09$[d]	1.06	6.40 ± 2.87	7.82 ± 2.37	$F_{(1,318)}=23.21$[d]	−0.54
Age Group												
6–11 (N = 80/80)	1.73 ± 0.60	1.29 ± 0.46	$F_{(1,158)}=26.95$[d]	0.82	1.69 ± 0.40	1.24 ± 0.30	$F_{(1,158)}=63.19$[d]	1.26	6.51 ± 2.83	7.76 ± 2.45	$F_{(1,158)}=80.94$[b]	−0.47
12–17 (N = 80/80)	1.77 ± 0.71	1.58 ± 0.53	$F_{(1,158)}=30.56$	0.30	1.69 ± 0.48	1.34 ± 0.28	$F_{(1,158)}=30.90$[d]	0.88	6.29 ± 2.93	7.88 ± 2.31	$F_{(1,158)}=14.49$[c]	−0.60
Gender												
Male (N = 140/140)	1.75 ± 0.65	1.44 ± 0.53	$F_{(1,278)}=18.47$[d]	0.51	1.67 ± 0.44	1.30 ± 0.30	$F_{(1,278)}=65.71$[d]	0.97	6.31 ± 2.88	7.81 ± 2.45	$F_{(1,278)}=21.82$[d]	−0.56
Female (N = 20/20)	1.77 ± 0.71	1.38 ± 0.47	$F_{(1,38)}=4.03$	0.63	1.81 ± 0.40	1.22 ± 0.22	$F_{(1,38)}=32.48$[d]	1.80	7.00 ± 2.79	7.90 ± 1.80	$F_{(1,38)}=1.47$	−0.38
Mother												
Education												
College and Above (N = 108/100)	1.69 ± 0.65	1.43 ± 0.53	$F_{(1,206)}=9.76$[b]	0.44	1.68 ± 0.42	1.28 ± 0.31	$F_{(1,206)}=58.32$[d]	1.07	6.62 ± 2.77	7.95 ± 2.47	$F_{(1,206)}=13.28$[c]	−0.51
Senior High School (N = 52/60)	1.87 ± 0.67	1.44 ± 0.50	$F_{(1,110)}=15.23$[c]	0.73	1.71 ± 0.47	1.31 ± 0.27	$F_{(1,110)}=30.88$[d]	1.03	5.94 ± 3.04	7.60 ± 2.21	$F_{(1,110)}=11.06$[b]	−0.62
Employment												
Employed (N = 67/87)	1.71 ± 0.61	1.39 ± 0.50	$F_{(1,152)}=13.12$[c]	0.58	1.64 ± 0.42	1.24 ± 0.23	$F_{(1,152)}=57.94$[d]	1.19	6.45 ± 2.84	8.06 ± 2.26	$F_{(1,152)}=15.35$[c]	−0.63
Unemployed (N = 92/73)	1.79 ± 0.69	1.49 ± 0.54	$F_{(1,163)}=8.85$[b]	0.47	1.73 ± 0.45	1.36 ± 0.35	$F_{(1,163)}=33.11$[d]	0.91	6.36 ± 2.92	7.53 ± 2.49	$F_{(1,163)}=7.49$[b]	−0.43
Family Type												
Nuclear Family (N = 120/89)	1.79 ± 0.67	1.42 ± 0.53	$F_{(1,207)}=18.15$[d]	0.61	1.71 ± 0.45	1.27 ± 0.26	$F_{(1,207)}=67.35$[d]	1.19	6.48 ± 2.93	8.03 ± 2.23	$F_{(1,207)}=17.62$[d]	−0.60
Others (N = 40/71)	1.63 ± 0.61	1.45 ± 0.51	$F_{(1,109)}=2.81$	0.32	1.63 ± 0.41	1.32 ± 0.33	$F_{(1,109)}=18.62$[d]	0.82	6.18 ± 2.71	7.55 ± 2.53	$F_{(1,109)}=7.16$[b]	−0.52

Table 2 (continued)

| | Affection and Care† | | | | Overprotection† | | | | Authoritarian Control† | | | |
---	ASD N=160	TD N=160	F value	Cohen's d	ASD N=160	TD N=160	F value	Cohen's d	ASD N=160	TD N=160	F value	Cohen's d
ASD Subgroups												
Typical Autism (N = 51/160)	1.91±0.72	1.44±0.52	$F_{(1,209)}=26.25^d$	0.76	1.77±0.45	1.29±0.29	$F_{(1,209)}=76.97^d$	1.26	6.14±2.94	7.82±2.37	$F_{(1,209)}=17.21^d$	−0.63
HFA (N=52/160)	1.63±0.62	1.44±0.52	$F_{(1,210)}=4.89^a$	0.34	1.56±0.41	1.29±0.29	$F_{(1,210)}=27.09^d$	0.75	7.31±2.36	7.82±2.37	$F_{(1,210)}=1.83$	−0.21
AS (N = 57/160)	1.72±0.61	1.44±0.52	$F_{(1,215)}=11.39^c$	0.50	1.73±0.44	1.29±0.29	$F_{(1,215)}=69.35^d$	1.17	5.81±7.60	7.82±2.37	$F_{(1,215)}=25.67^d$	−0.36
Subgroups by the Presence of ADHD												
ASD + ADHD (N = 81/160)	1.80±0.62	1.44±0.52	$F_{(1,239)}=22.97^d$	0.64	1.78±0.44	1.29±0.29	$F_{(1,239)}=106.21^d$	1.30	6.11±2.80	7.82±2.37	$F_{(1,239)}=24.60^d$	−0.66
ASD-ADHD (N = 79/160)	1.70±0.70	1.44±0.52	$F_{(1,237)}=10.92^b$	0.43	1.59±0.43	1.29±0.29	$F_{(1,237)}=40.03^d$	0.82	6.70±2.93	7.82±2.37	$F_{(1,237)}=10.10^b$	−0.42

Abbreviations: ASD, autism spectrum disorder; ADHD, attention-deficit hyperactivity disorder; AS, Asperger's syndrome; HFA, high-functioning autism; ASD + ADHD, ASD with co-occurring ADHD; ASD-ADHD, ASD without co-occurring ADHD

[a] p < 0.05
[b] p < 0.01
[c] p < 0.001
[d] p < 0.0001

†: Measured by the Parental Bonding Instrument; ¶: Measured by the subscales of the Social Adjustment Inventory for Children and Adolescents; §: Measured by the Family APGAR

HFA ($p = 0.023$), more severe hyperactivity-impulsivity in AS than HFA ($p = 0.016$), and more severe oppositional defiant symptoms in AS than HFA and TA ($p < 0.001$) (Supplementary Table S2).

Mothering in the ASD Group Vs. the TD Group

Mothers of youth with ASD, compared to mothers of TD youth, reported that they gave less affection/care ($p < 0.05$, Cohen's $d = 0.23$), and more overprotection ($p < 0.0001$, Cohen's $d = 0.54$) and authoritarian control ($p < 0.05$, Cohen's $d = 0.22$) to their children. Moreover, mothers of youth with ASD also reported that their children had less active mother-child interaction ($p < 0.0001$, Cohen's $d = 0.53$) and more behavioral problems at home ($p < 0.0001$, Cohen's $d = 1.06$), and the mothers also perceived less family support ($p < 0.0001$, Cohen's $d = 0.54$) (Table 2).

Stratified by the Child and Adolescent Groups

Further stratified analyses by age revealed that both children and adolescents with ASD, compared to TD youth, had more maternal overprotection (Cohen's $ds = 0.59, 0.50$, respectively) and more behavioral problems at home (Cohen's $ds = 0.88, 1.26$, respectively) and their mothers also perceived less family support (Cohen's $ds = −0.47, −0.60$, respectively). In addition, mothers reported lower maternal affection/care ($p < 0.05$, Cohen's $d = −0.38$), and less active mother-child interactions ($p < 0.0001$, Cohen's $d = 0.82$) in children (aged 6–11 years) with ASD than TD children; whereas authoritarian control ($p < 0.05$, Cohen's $d = 0.37$) in adolescents (aged 11–17) with ASD than TD adolescents (see Table 2).

Stratified by Maternal Education Levels

When we stratified the groups by maternal educational level: senior high and lower or college and higher, mothers reported that youth with ASD, regardless of maternal educational level, had more maternal overprotection (Cohen's $ds = 0.41, 0.62$, respectively) and problems at home (Cohen's $ds = 1.03, 1.07$, respectively), and less active mother-child interactions (Cohen's $ds = 0.73, 0.44$, respectively) compared to TD youth. Mothers of youth with ASD, regardless of maternal education level, also reported less family support (Cohen's $ds = −0.62, −0.51$, respectively) than mothers of TD youth. In addition, mothers with a college education or higher reported that youth with ASD, compared to TD, received less maternal affection/care ($p < 0.05$, Cohen's $d = 0.32$), more maternal overprotection ($p < 0.0001$,

Table 3 Comparisons of mothering between typical autism, high function autism, and asperger's syndrome subgroups

Mean ± SD	Typical Autism (TA) (N = 51)	High-Functioning Autism (HFA) (N = 52)	Asperger's Syndrome (AS) (N = 57)	Comparison*	
				$F_{(2,157)}$	Bonferroni Adjusted $P < 0.05$
Affection and Care†	27.53 ± 4.61	29.92 ± 4.72	28.67 ± 5.37	3.04	
Overprotection†	9.03 ± 3.73	7.35 ± 3.56	7.72 ± 3.29	3.27[a]	TA > HFA
Authoritarian Control†	7.05 ± 2.96	6.37 ± 2.81	5.81 ± 2.70	2.60	
Difficulty in Interaction with Mother¶	1.91 ± 0.72	1.63 ± 0.62	1.72 ± 0.61	2.48	
Problem at Home¶	1.77 ± 0.45	1.56 ± 0.41	1.73 ± 0.44	3.35[a]	TA > HFA
Perceived Family Function§	6.14 ± 2.94	7.31 ± 2.36	5.81 ± 7.60	4.19[a]	HFA > AS

AS, Asperger's syndrome; HFA, high-functioning autism; TA, typical autism

[a]: $p < 0.05$

†Measured by the Parental Bonding Instrument

¶Measured by the subscales of the Social Adjustment Inventory for Children and Adolescents

§Measured by the Family APGAR

Cohen's $d = 0.62$) and more control ($p < 0.05$, Cohen's $d = 0.35$) (Table 2).

Stratified by ASD Subgroups (TA, HFA, AS)

Mothers reported that ASD youth, regardless of subtypes (TA, HFA, AS), had more maternal overprotection (Cohen's $ds = 0.81$, 0.35 and 0.47, respectively), more behavioral problems at home (Cohen's $ds = 1.26$, 0.75, and 1.17, respectively), and a less active mother-child interaction (Cohen's $ds = 0.76$, 0.34, and 0.50, respectively). Moreover, mothers reported that youth with TA, compared to TD youth, received less affection/care ($p < 0.01$, Cohen's $d = 0.50$) and more authoritarian controls ($p < 0.01$, Cohen's $d = 0.46$). Interestingly, both mothers of youth with TA and AS, compared to mothers of TD youth, reported less perceived family support (Cohen's $d = -0.63$, -0.36, respectively) (Table 2).

Direct Comparison among ASD Subtypes

Mothers reported that among the three subtypes, youth with TA, compared to youth with HFA, had more maternal overprotection and behavioral problems at home; mothers of youth with HFA, compared to mothers of youth with AS, perceived higher family support (Table 3).

About 50.63% ($n = 81$) of the youth with ASD had co-occurring ADHD (ASD + ADHD). In general, the co-occurring ADHD did not increase the impact on impaired maternal/family measures in ASD. However, mothers reported that youths with ASD + ADHD, not youth with ASD without ADHD (ASD-ADHD), received less maternal affection/care (Cohen's $d = 0.30$) than TD youth (Table 2). Moreover, when directly comparing the two groups of ASD, mothers reported that ASD + ADHD

youths had more behavioral problems at home than ASD-ADHD youths (Supplementary Table S3).

Correlates for Maternal and Family Measures-Categorical Approach

Multiple linear regression models included gender, age, maternal educational level, three ASD subtypes, ADHD diagnosis, 3-way (subtype*age*sex) and 2-way (subtype*age, subtype*sex) interaction terms as independent variables and three dimensions of mothering, interaction with mothers, child home behavioral problems, and maternal perceived family support as dependent variables (Table 4). The reference groups for sex, mother's education, and ASD subtypes/ADHD were female, senior high, and TD, respectively. There were no 3-way interactions but some significant 2-way interactions as stated below (Table 4). The results showed that maternal education as college and above ($p < 0.01$) was positively, the TA group ($p < 0.01$) was negatively associated with maternal affection and a significant interaction term from Gender*AS ($\beta = -4.05$, $p < 0.05$) was negatively associated with maternal affection/care ($R^2 = 0.09$), which suggested that female youth with AS had more ($\beta = 2.08$) but male youth with AS ($\beta = -1.97$) had less maternal affection. Younger age of the child ($p < 0.01$), TA ($p < 0.0001$), AS ($p < 0.05$) and Age*HFA ($p < 0.05$) were significantly associated with increased maternal overprotection ($R^2 = 0.13$). For maternal authoritarian control, younger age of the child ($p < 0.05$) and TA ($p < 0.05$) were associated variables. Older age of the child ($p < 0.01$), TA ($p < 0.0001$), and AS ($p < 0.05$) were associated with increasing difficulty in mother-child interaction ($R^2 = 0.11$). All three ASD subtypes ($\beta = 0.40$, $p < 0.0001$; $\beta = 0.55$, $p < 0.01$; $\beta = 0.35$, $p < 0.0001$) and the presence of ADHD ($\beta = 0.16$, $p < 0.01$) were positively, while interaction term of Gender*HFA ($p < 0.05$) were negatively, associated with increasing child's behavioral problems at home ($R^2 =$

Table 4 Demographics and autism spectrum disorder subgroups predicting maternal and family measures

	Affection and Care†		Overprotection†		Authoritarianism Controlling†		Difficulty in Interaction with Mother¶		Problems at Home¶		Perceived Family Function§	
	β	(95% CI)	β	(95% CI)	β	(95% CI)	β	(95% CI)	β	(95% CI)	B	(95% CI)
Male vs. Female	0.70	(−1.11 2.51)	−0.62	(−1.78 0.54)	−0.15	(−1.06 0.76)	0.02	(−0.18 0.21)	0.03	(−0.10 0.17)	−0.50	(−1.36 0.36)
Age	−0.12	(−0.32 0.08)	−00.27	(−00.43 −00.10)[b]	−0.15	(−0.27 −00.03)[a]	0.03	(0.01 0.06)[b]	0.01	(0.00 0.03)	−0.0004	(−0.14 0.14)
Mother's Education	1.76	(0.68 2.85)[b]	−0.55	(−1.36 0.25)	0.32	(−0.31 0.95)	−0.06	(−0.20 0.07)	−0.02	(−0.11 0.06)	0.44	(−0.16 1.04)
Typical Autism	−2.28	(−3.97 −0.59)[b]	2.48	(1.23 3.73)[d]	1.25	(0.26 2.23)[a]	0.45	(0.24 0.66)[d]	0.40	(0.26 0.53)[d]	−5.82	(−8.94 −2.70)[c]
High-Functioning Autism	0.21	(−1.39 1.80)	−3.55	(−8.41 1.30)	0.73	(−0.20 1.66)	0.14	(−0.06 0.34)	0.55	(0.22 0.88)[b]	−0.23	(−1.11 0.65)
Asperger's Syndrome	2.08	(−1.22 5.39)	1.44	(0.22 2.65)[a]	0.09	(−0.86 1.05)	0.24	(0.03 0.44)[a]	0.35	(0.22 0.48)[d]	−1.78	(−2.68 −0.88)[c]
ADHD	−0.20	(−1.67 1.26)	0.54	(−0.54 1.62)	−0.09	(−0.94 0.76)	0.07	(−0.11 0.26)	0.16	(0.04 0.27)[b]	−2.87	(−5.70 −0.04)[a]
Gender*HFA	–	–	–	–	–	–	–	–	−0.40	(−0.74 −0.06)[a]	–	–
Gender*AS	−4.05	(−7.65 −00.46)[a]	–	–	–	–	–	–	–	–	0.42	(0.14 0.71)[b]
Age*TA	–	–	0.40	(0.002 0.80)[a]	–	–	–	–	–	–	–	–
Age*HFA	–	–	–	–	–	–	–	–	–	–	−0.30	(−0.55 −0.06)[a]
Age*ADHD	–	–	–	–	–	–	–	–	–	–		
R²	0.09		0.13		0.05		0.11		0.28		0.15	

ADHD, attention-deficit hyperactivity disorder; AS, Asperger's Syndrome; HFA, high-functioning autism; TA, typical autism

*Bonferroni adjusted p-value

[a] $p < 0.05$

[b] $p < 0.01$

[c] $p < 0.001$

[d] $p < 0.0001$

†Measured by the Parental Bonding Instrument

¶Measured by the subscales of the Social Adjustment Inventory for Children and Adolescents; §: Measured by the Family APGAR

0.28). TA ($p < 0.001$), AS ($p < 0.001$), ADHD ($p < 0.05$) and Age*ADHD ($p < 0.05$) were negatively, while Age*TA ($p < 0.01$) was positively, associated with maternal perceived family support ($R^2 = 0.15$, Table 4). These two interaction terms suggest that with age, the negative impacts of ADHD and TA increased and decreased, respectively (Table 4).

Correlates for Maternal and Family Measures-Dimensional Approach

In addition to categorical approach, we also conducted the multiple linear regression model treating the autistic symptoms (ADI-R: reciprocal social interaction, verbal communication, nonverbal communication, stereotyped behaviors/interests) and ADHD-related symptoms (SNAP-IV, inattention, hyperactivity-impulsivity, oppositional) as continuous variables to predict the maternal and family measures in the ASD group (Supplementary Table S4). We found that male sex was associated with more child's behavioral problems at home ($\beta = 0.19$, $p < 0.05$); impaired social reciprocity was associated with lower maternal affection/care ($\beta = -0.22$, $p < 0.05$), impaired mother-child interaction ($\beta = 0.04$, $p < 0.001$) and more child's behavioral problems at home ($\beta = 0.03$, $p < 0.0001$); a higher level of hyperactivity-impulsivity symptom was associated with more maternal overprotection ($\beta = 0.12$, $p < 0.05$); more oppositional symptom severity was associated with more difficulty in interactions with mothers ($\beta = 0.04$, $p < 0.0001$) and more child's behavioral problems at home ($\beta = 0.03$, $p < 0.0001$, see Supplementary Table S4). The autistic symptoms, assessed by the ADI-R interview, and ADHD symptoms, assessed by the SNAP-IV, did not demonstrate significant effects on the maternal controlling parenting style or perceived family functions.

Discussion

Major Findings

The current study is one of the first studies investigated mothering and family process in both children and adolescents with ASD (Maljaars et al. 2014) in non-western countries considering the moderating effects from personal characteristics. Our study showed that mothers of youth with ASD, compared to TD youth, reported more difficulties in mothering and family processes and that not only mothers of TA youth, but also those of AS youth, reported more difficulties, which challenges our initial hypothesis. Moreover, compatible with our second hypothesis, mothers reported that youth with TA received more maternal protection and had more behavioral problems at home than youth with HFA; mothers of youth with AS, compared to mothers of youth with HFA, reported less perceived family support. Lastly, our third hypothesis was

only partially supported: the presence of ADHD was only associated with more child's behavioral problems at home than those without ADHD. Overall, our final prediction models showed that the TA and AS groups, child's age, maternal educational level, Gender/Age*Subtype interactions, and social reciprocity and hyperactivity symptom severity were associated with maternal parenting styles. More specifically, maternal educational level as college and above predicted a more affectionate mothering than her educational level as senior high or lower. TA group (categorical approach, Table 4) and impaired social reciprocity (dimensional approach, Table S4) were related to less affection/care from the mother. Younger age and TA were related to maternal overprotection (AS and hyperactivity symptoms, too) and controlling. Older age, ASD subtypes (TA and AS, Table 4), and symptoms of impaired social interactions and oppositional defiance (Table S4) were related to impaired interactions with mothers. Three ASD subtypes and ADHD (Table 4), male, symptoms of impaired social interactions and oppositional defiance (Table S4) were related to behavioral problems at home. Categorical approach (TA, AS, and ADHD) but not symptom dimensions showed negative effects on mother's perceived family support, in which age moderated the effect of TA and ADHD.

Mothering Youth with ASD

Similar to previous findings (Gau et al. 2010a, b), mothers of youth with ASD, compared to mothers of TD youth, reported lower maternal affection/care, and more maternal overprotection and control toward their children. Regardless of age, youth with ASD received more maternal protection than TD youth; yet when stratified by age, children with ASD had less maternal affection/care, whereas adolescents with ASD received more maternal control. Since parenting younger children with ASD is associated with greater stress, mothers hence may be more susceptible to psychiatric symptoms such as depression (Schieve et al. 2011). Maternal psychopathology may in turn influence parenting style – depressive mothers often show more uninvolved and permissive parenting (Chi and Hinshaw 2002), affecting the level of maternal affection/care. On the other hand, mother's reports of low affection/care level may be affected by the child's autistic symptoms, such as difficulty in verbal communication and impaired social interaction (Hudry et al. 2013). For example, a lower level of maternal affection may also be reported by a highly affectionate mother of a child with impaired verbal communication, since she may report low ratings on the items such as "Appeared to understand his/her problems and worries" and "Enjoyed talking things over with him/her." Hence, it is important to keep in mind that family process including parenting and child's behavior is an interactive process that affects

one another in a bidirectional manner (Neece et al. 2012; Osborne and Phil 2009).
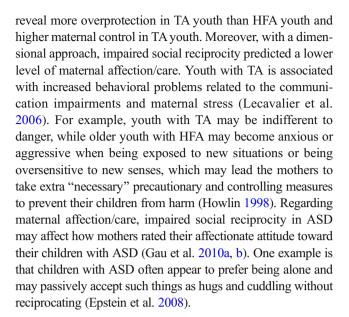
Mothering in adolescents with ASD may differ from mothering in TD adolescents. For example, although parents tend to expect adolescents with ASD to master social interaction skills due to demand (Shattuck et al. 2007), reduction in ASD characteristics in adolescence (Shattuck et al. 2007; Simonoff et al. 2008) may not lead to normal levels of overall functioning (Seltzer et al. 2004). Moreover, parents may be overwhelmed with concerns over their child's learning difficulty, lack of safety awareness, and stress-coping (Lee et al. 2008). Hence, mothers of adolescents with ASD, compared to TD youth, may encourage their child to solve the problems (Maljaars et al. 2014), yet exert control simultaneously to provide a protective environment for their child (Howlin 1998). In addition, substantial difficulties in social communication in ASD often result in interpersonal conflicts and bullying incidence (Hebron and Humphrey 2014). Thus, mothers tend to take several preemptive measures, such as lowering the noise levels of the surroundings, avoiding changes in routine and creating a generally "safe" environment, to help their child adapt to the situation. The mothers also like to take the initiative to engage their children in the activities (Freeman and Kasari 2013), which may be reported as "overprotective" and "controlling," but may rather be beneficial for youth with ASD.

Mother-Child Relationship and Family Functions in Youth with ASD

Mothers reported that youth with ASD, regardless of age or maternal educational level, had more difficult mother-child interactions, more behavioral problems at home and less maternal perceived family support. We assume that mother-child interaction in adolescence, especially in TD youth, may be complicated by other issues such as bargaining for a sense of autonomy (Collins 1990) and peer interaction (Laible et al. 2000). Moreover, child's ASD symptoms and behavioral problems may increase parenting stress (Benson 2006; Epstein et al. 2008) and contribute to high expressed emotions in mothers of youth with ASD. On the other hand, maternal high expressed emotion may increase the levels of child's maladaptive behaviors and exacerbate the autistic symptom severity over time (Greenberg et al. 2006). Hence, Taylor and Seltzer (2011) suggest that a halt of mother-child relationships in adolescents with ASD might be attributed to several factors including child's ASD characteristics and behavioral problems, the mother's parenting stress and high expressed emotions, and the long-term interaction among these factors.

ASD Subtypes and Symptoms on Mothering

Our results provide evidence not only to support inappropriate maternal parenting in youth with ASD but also specifically to reveal more overprotection in TA youth than HFA youth and higher maternal control in TA youth. Moreover, with a dimensional approach, impaired social reciprocity predicted a lower level of maternal affection/care. Youth with TA is associated with increased behavioral problems related to the communication impairments and maternal stress (Lecavalier et al. 2006). For example, youth with TA may be indifferent to danger, while older youth with HFA may become anxious or aggressive when being exposed to new situations or being oversensitive to new senses, which may lead the mothers to take extra "necessary" precautionary and controlling measures to prevent their children from harm (Howlin 1998). Regarding maternal affection/care, impaired social reciprocity in ASD may affect how mothers rated their affectionate attitude toward their children with ASD (Gau et al. 2010a, b). One example is that children with ASD often appear to prefer being alone and may passively accept such things as hugs and cuddling without reciprocating (Epstein et al. 2008).

ASD Subtypes and Symptoms on Mother-Child Relationship and Family Functions

AS and TA predicted difficult mother-child interactions. Lower levels of age-equivalence of child's language and increased repetitive behaviors commonly observed in youth with TA have been suggested to be two major factors affecting mother-child interactions (Hudry et al. 2013). Moreover, greater marital discord (Weitlauf et al. 2014) and social isolation (Lee et al. 2008; Weitlauf et al. 2014) noted in mothers of TA youth may contribute to the less family support received by the mothers. Whereas higher levels of marital and interpersonal relationship satisfaction can buffer the impact of parenting stress on maternal depression and possibly mother-child interactions and possibly mother-child interactions (Weitlauf et al. 2014). As for AS, high parental expectations for the child may also help explain the difficulties in mother-child interactions in youth with AS. Mothers may expect youth with AS, like TD youth, to be able to obtain certain milestones, such as being independent of parents, building complex friendships and peer relationships, being empathetic, expressing more about his or her thoughts, and making better judgment calls (Taylor and Seltzer 2011). And when the expectations are not met, mother-child interactions may be negatively affected.

In addition, mothers of HFA youth may obtain more support from the family because of their children's language delay noted before 3 years old than mothers of AS youth, who are more likely to be complained about not educating and caring their AS children well (Taylor and Seltzer 2011). Attributions of control are often associated with higher levels of maternal criticism (Barrowclough and Hooley 2003; Wearden et al. 2000) and lower levels of maternal warmth (Barrowclough and Hooley 2003; Wearden et al. 2000), a persistence of the child's oppositional defiant symptoms (Johnston et al. 2009),

and a negative impact on mother-child interaction. On the other hand, early intervention and services provided to children with HFA, relative to children with AS, may help to predict more positive mother-child interactions (Gulsrud et al. 2010). Nonetheless, when looking at mother-child interactions in youth with AS, the child's characteristics and behaviors also affect mother-child interactions. For example, parenting stress of parents of youth with AS is associated with the youth's demanding characteristics, heightened sensory sensitivity, impaired executive functions, and oppositional defiance symptoms (Epstein et al. 2008). Moreover, youth with AS, often misinterpret social conversation and behaviors of others, seldom seek comfort from others or respond to mothers' displays of anger or affection inappropriately (APA 1994); which altogether may further disrupt the mother-child relationship.

It should be kept in mind that some of the group differences may be attributed to the issues of development, given that certain aspects of development are likely delayed or deviant in some of the subgroups. For example, TA and AS are at the two extremes of the clinical autism spectrum (Baron-Cohen 2008), yet both share impairments in social communication, restricted interests, and behavioral rigidities. Youth with TA, compared to youth with HFA, tend to have more substantial ASD symptoms such increased impairment in social reciprocity, a lower IQ and underdeveloped linguistic skills, which may contribute to the child's inability to obey home rules and follow instructions properly. Contrariwise, improvement in the social reciprocity of the child may decrease the child's behavioral problems at home, alleviate parenting stress (Neece et al. 2012), and is predictive of a better prognosis in youth with ASD (Shattuck et al. 2007).

Youth with AS often underestimated their difficulties at school and in social relations (Epstein et al. 2008), which may lead to a lack of support for the hidden needs of this subgroup. Moreover, individuals with AS usually received their diagnosis at a much later age, some even at teenage years (Howlin and Asgharian 1999), than those with HFA (Howlin 2003) and may be deprived of the level of support that is offered to those diagnosed with HFA (Klin and Volkmar 2000). On the other hand, maternal perceived family support increases in youth with TA as the youth grows older. This improving family support may be due to the positive effect of the early intervention (Langley et al. 2017), where both the child and mother were provided at an early stage of the diagnosis and services to meet their needs.

ADHD co-Occurrence and Symptom Severity on Mothering and Family Measures

Our results further supported the association between the presence of ADHD and increased behavioral problems at home (Bauminger et al. 2010), while child's hyperactivity symptom severity predicted maternal overprotection. The effect on the child's behavioral problems at home may be attributed to oppositional defiance symptoms (Guttmann-Steinmetz et al. 2009) and inhibition deficits (Sinzig et al. 2008) in this subgroup. This finding is similar to that of youth with pure ADHD in that hyperactivity symptoms predicted maternal overprotection (Gau and Chang 2013). However, only inattention symptom severity was associated with impaired mother-child interactions and family support in youth with pure ADHD (Gau and Chang 2013). The difference between the two groups suggested that ADHD symptoms may have different impacts on the family process in different clinical samples. Furthermore, if comorbid ADHD, the child's behavioral problems increase with age.

The co-occurrence of ADHD in youth with ASD is also more likely to bring more burden and stress to the family, particularly the mother (Allik et al. 2006). This assumption is supported by our findings of the presence of ADHD decreasing the mother's perceived support from the family.

Oppositional Defiance Symptom Severity on Mother-Child Interactions and Home Behavioral Problems

Oppositional defiance symptom severity in youth with ASD predicted difficult mother-child interaction and more child's behavioral problems at home. Oppositional defiance symptoms highly correlate with ADHD symptoms (Guttmann-Steinmetz et al. 2009) and have been associated with increased parent-child conflicts, increased child's behavioral problems, and poorer social adjustments (Liu et al. 2017), which may altogether further impair the mother-child interactions.

The Effects of Personal Characteristics

Our finding of mothers with college and higher education showing an elevated level of affection toward their children can be explained as follows. Mothers who are highly educated may be more likely to access the knowledge of parenting, more skillful in engaging in activities with their children, and more likely to access the early intervention programs (Gau et al. 2010a, b). Second, maternal overprotection was associated with child's younger age, whereas maternal control was predicted by younger age. Third, difficult mother-child interaction was predicted by child's older age. Maternal parenting style may vary depending on the developmental stage of the child. If the child is young and hyperactive, the mother may need to protect her child, who is supposed to require extra supervision and guidance, or 'control,' in performing activities. On the other hand, adolescents may be less likely to have interactions with their mothers. Since the developmental milestone for adolescence is independence and intimacy outside

the family, thus older children may cut back time spend with their mothers to spend more time with their peers and have fewer conversations with their mothers, resulting in less active interaction with the mother (a high score of SAICA). Fourth, when examining family function in ASD, more child's behavioral problems at home were associated with male sex. Male youth, compared to female youth, with ASD has been reported to have more repetitive stereotyped behavior, more externalizing and interpersonal problems (Mandy et al. 2012), which may further exacerbate his behavioral problems at home.

Cultural Influences on Concepts of Mothering

One issue worth noting is the cultural influences of the concept of "authoritarian control." "Authoritarian" in the broad Chinese culture (that many Taiwanese people share) implies "caring for" and "guidance," whereas in many Western societies this refers to high parental demands for absolute obedience without questioning from their children. Furthermore, the idea of "caring for" and "guidance" as the main component of "authoritarian control" is more applicable in context of families of youth with ASD, since "caring for" and "guidance" may be viewed as a form of "directiveness," which has been shown to be rather beneficial in youth with ASD.

In addition, family relationships in Asian cultures are commonly based on age, gender and role-division, not on mutual understanding, equality or emotional closeness. The role of every family member is emphasized, for example, mothers are the ones commonly expected to sacrifice their professional life and career to provide guidance and care for her child and are often criticized for their child's maladaptive behaviors. On the other hand, western cultures emphasize more on the concept of independence and the sharing of feelings. Thus, such cultural difference should be taken into account when assessing mothers' perception on family support and the child's behavior problems.

Limitation

The major aim of our study is to describe the different mother-child interaction patterns across different ASD subtypes. The findings should be interpreted in the light of this, the mothering and family measurements taken in this study should be interpreted within the context of families of youth with ASD. For example, controlling mothering measured by PBI in TD youth may indicate a more authoritarian style of parenting negatively, but such control in youth with ASD, especially TA, have been proven to be beneficial for the child's development. In addition, early intervention programs for ASD have instructed parents to show more required "directiveness." Hence, bidirectional relationship between the child's characteristics including behavior and maternal parenting and

reactions should be kept in mind when interpreting study findings on mothering and family process. Moreover, the diagnosis of ASD was based on clinical and ADI-R interviews without using the Autism Diagnostic Observation Scale (ADOS). One other limitation is that we did not assess maternal psychopathology, such as broad autism phenotype, resulting in a lack of analysis examining the effect of maternal psychopathology on mothering and family process. Moreover, we only interviewed mothers, which limit the sources of data regarding family processes. Future studies should provide a more comprehensive perspective, incorporating cultural aspects, on parenting practices and family function by also including other informants. In this study, we also did not have the data on the family socioeconomic status. However, we recruited subjects from the same neighborhood to ensure similar urbanization and school districts so that socioeconomic status would not be a covariant of mothering and family process in ASD. Lastly, since this is a cross-sectional study, the findings are limited to conclude whether mothering has been impacted by the child's symptoms, or whether mothers adjusted their parenting styles to help the child with ASD function optimally. Therefore, along with careful, precise and rigorous quantitative studies, a qualitative approach to mothering in ASD in the future is warranted.

Conclusion

Different subtypes of ASD show both similar and different associations with mothering and family processes. Programs targeting maternal and family processes for different subgroups of youth with ASD, with recognition of specific challenges faced by the mothers and acknowledgment of the efforts made by the mothers to effectively nurture their children with ASD, should be developed. Moreover, early intervention and psychoeducation programs regarding parenting difficulties at the beginning of the ASD diagnosis, especially AS, should be implemented. Furthermore, emotional awareness programs should be provided to enhance mothers and families' wellbeing. Future studies can be extended to investigate mothering and family processes for siblings, as well as paternal parenting and family process in the different subgroups of youth with ASD.

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Compliance with Ethical Standards

Conflict of Interest   There is no conflict of interest with regard to this work.

Ethical Approval   This study has been approved by the Research Ethics Committee of National Taiwan University Hospital Institutional Review Board, and therefore all procedures performed in studies involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent   Written informed consent was obtained from all individual participants and their mothers included in the study.

References

Allik, H., Larsson, J. O., & Smedje, H. (2006). Health-related quality of life in parents of school-age children with Asperger syndrome or high-functioning autism. *Health and Quality of Life Outcomes, 4*, 1. https://doi.org/10.1186/1477-7525-4-1.

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders, fourth edition (4th ed.). Washington DC: American Psychiatric Association.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders, fifth edition (5th ed.). Arlington: American Psychiatric Association.

Baker, B. L., McIntyre, L. L., Blacher, J., Crnic, K., Edelbrock, C., & Low, C. (2003). Pre-school children with and without developmental delay: Behaviour problems and parenting stress over time. *Journal of Intellectual Disability Research, 47*, 217–230.

Baker-Ericzen, M. J., Brookman-Frazee, L., & Stahmer, A. (2005). Stress levels and adaptability in parents of toddlers with and without autism Spectrum disorders. *Research and Practice for Persons with Severe Disabilities, 30*, 194–204.

Baron-Cohen, S. (2008). Autism and Asperger syndrome (the facts*)* (First ed.). New York: Oxford University Press.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "reading the mind in the eyes" test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, 42*, 241–251.

Barrowclough, C., & Hooley, J. M. (2003). Attributions and expressed emotion: A review. *Clinical Psychology Review, 23*, 849–880.

Bauminger, N., Solomon, M., & Rogers, S. J. (2010). Predicting friendship quality in autism spectrum disorders and typical development. *Journal of Autism and Developmental Disorders, 40*, 751–761. https://doi.org/10.1007/s10803-009-0928-8.

Benson, P. R. (2006). The impact of child symptom severity on depressed mood among parents of children with ASD: The mediating role of stress proliferation. *Journal of Autism Developmental Disorders, 36*, 685–695. https://doi.org/10.1007/s10803-006-0112-3.

Blumberg, S. J., Bramlett, M. D., Kogan, M. D., Schieve, L. A., Jones, J. R., & Lu, M. C. (2013). Changes in prevalence of parent-reported autism spectrum disorder in school-aged U.S. children: 2007 to 2011-2012. *National Health Statistics Reports* (65), 1-11, 1 p following 11.

Cadman, T., Eklund, H., Howley, D., Hayward, H., Clarke, H., Findon, J., et al. (2012). Caregiver burden as people with autism spectrum disorder and attention-deficit/hyperactivity disorder transition into adolescence and adulthood in the United Kingdom. *Journal of American Academy of Child and Adolescent Psychiatry, 51*, 879–888. https://doi.org/10.1016/j.jaac.2012.06.017.

Chang, J. P., & Gau, S. S. (2017). Mother-child relationship in youths with attention-deficit hyperactivity disorder and their siblings. *Journal of Abnormal Child Psychology, 45*, 871–882. https://doi.org/10.1007/s10802-016-0218-9.

Chang, L. R., Chiu, Y. N., Wu, Y. Y., & Gau, S. S. (2013). Father's parenting and father-child relationship among children and adolescents with attention-deficit/hyperactivity disorder. *Comprehensive Psychiatry, 54*, 128–140. https://doi.org/10.1016/j.comppsych.2012.07.008.

Chen, C. H., Huang, C. C., Cheng, M. C., Chiu, Y. N., Tsai, W. C., Wu, Y. Y., et al. (2014). Genetic analysis of GABRB3 as a candidate gene of autism spectrum disorders. *Molecular Autism, 5*, 36. https://doi.org/10.1186/2040-2392-5-36.

Chen, Y. L., Chen, S. H., & Gau, S. S. (2015). ADHD and autistic traits, family function, parenting style, and social adjustment for internet addiction among children and adolescents in Taiwan: A longitudinal study. *Research in Developmental Disabilities, 39*, 20–31. https://doi.org/10.1016/j.ridd.2014.12.025.

Chen, H. I., Chien, Y. L., Liao, H. M., Chien, W. H., Chen, C. H., Chen, Y. C., & Gau, S. S. (2016). Dosage of copy number variation at 22q11.2 mediates changes in cognition, social function and brain structure in autism spectrum disorder. *Journal of Formosan Medical Association, 115*, 577–582. https://doi.org/10.1016/j.jfma.2016.02.005.

Chi, T. C., & Hinshaw, S. P. (2002). Mother-child relationships of children with ADHD: The role of maternal depressive symptoms and depression-related distortions. *Journal of Abnormal Child Psychology, 30*, 387–400.

Chiang, H. L., & Gau, S. S. (2015). Comorbid psychiatric conditions as mediators to predict later social adjustment in youths with autism spectrum disorder. *Journal of Child Psychology and Psychiatry.* https://doi.org/10.1111/jcpp.12450.

Chiang, H. L., Chen, Y. J., Lo, Y. C., Tseng, W. Y., & Gau, S. S. (2015). Altered white matter tract property related to impaired focused attention, sustained attention, cognitive impulsivity and vigilance in attention-deficit/ hyperactivity disorder. *Journal of Psychiatry Neuroscience, 40*, 325–335.

Chien, Y. L., Wu, Y. Y., Chiu, Y. N., Liu, S. K., Tsai, W. C., Lin, P. I., et al. (2011). Association study of the CNS patterning genes and autism in Han Chinese in Taiwan. *Progress in Neuropsychopharmacology and Biol Psychiatry, 35*, 1512–1517. https://doi.org/10.1016/j.pnpbp.2011.04.010.

Chien, W. H., Gau, S. S., Chen, C. H., Tsai, W. C., Wu, Y. Y., Chen, P. H., & Shang, C. Y. (2013). Increased gene expression of FOXP1 in patients with autism spectrum disorders. *Molecular Autism, 4*, 23. https://doi.org/10.1186/2040-2392-4-23.

Chien, Y. L., Gau, S. S., Chiu, Y. N., Tsai, W. C., Shang, C. Y., & Wu, Y. Y. (2014). Impaired sustained attention, focused attention, and vigilance in youths with autistic disorder and Asperger's disorder. *Research in Autism Spectrum Disorders, 8*, 881–889. https://doi.org/10.1016/j.rasd.2014.04.006.

Chien, H. Y., Lin, H. Y., Lai, M. C., Gau, S. S., & Tseng, W. Y. (2015a). Hyperconnectivity of the right posterior Temporo-parietal junction predicts social difficulties in boys with autism Spectrum disorder. *Autism Research, 8*, 427–441. https://doi.org/10.1002/aur.1457.

Chien, Y. L., Gau, S. S., Shang, C. Y., Chiu, Y. N., Tsai, W. C., & Wu, Y. Y. (2015b). Visual memory and sustained attention impairment in youths with autism spectrum disorders. *Psychological Medicine, 45*, 2263–2273. https://doi.org/10.1017/S0033291714003201.

attention-deficit/hyperactivity disorder. *PLoS One, 10*, e0127157. https://doi.org/10.1371/journal.pone.0127157.

Ingersoll, B., Meyer, K., & Becker, M. W. (2011). Increased rates of depressed mood in mothers of children with ASD associated with the presence of the broader autism phenotype. *Autism Research, 4*, 143–148. https://doi.org/10.1002/aur.170.

John, K., Gammon, G. D., Prusoff, B. A., & Warner, V. (1987). The social adjustment inventory for children and adolescents (SAICA): Testing of a new semistructured interview. *Journal of American Academy of Child and Adolescent Psychiatry, 26*, 898–911.

Johnston, C., Hommersen, P., & Seipp, C. M. (2009). Maternal attributions and child oppositional behavior: A longitudinal study of boys with and without attention-deficit/hyperactivity disorder. *Journal of Consulting and Clinical Psychology, 77*, 189–195. https://doi.org/10.1037/a0014065.

Kim, Y. S., Leventhal, B. L., Koh, Y. J., Fombonne, E., Laska, E., Lim, E. C., et al. (2011). Prevalence of autism spectrum disorders in a total population sample. *American Journal of Psychiatry, 168*, 904–912. https://doi.org/10.1176/appi.ajp.2011.10101532.

Klin, A., & Volkmar, F. R. (2000). *Treatments and intervention guidelines for individuals with Asperger syndrome*. New York: The Guildfold Press.

Kurita, H. (1997). A comparative study of Asperger syndrome with high-functioning atypical autism. *Psychiatry and Clinical Neuroscience, 51*, 67–70.

Lai, M. C., Chiu, Y. N., Gadow, K. D., Gau, S. S., & Hwu, H. G. (2010). Correlates of gender dysphoria in Taiwanese university students. *Archives of Sexual Behavior, 39*, 1415–1428. https://doi.org/10.1007/s10508-009-9570-y.

Laible, D. J., Carlo, G., & Raffaelli, M. (2000). The differential relations of parent and peer attachment to adolescent adjustment. *Journal of Youth and. Adolescent, 29*, 45–49.

Langley, E., Totsika, V., & Hastings, R. P. (2017). Parental relationship satisfaction in families of children with autism spectrum disorder (ASD): A multilevel analysis. *Autism Research, 10*, 1259–1268. https://doi.org/10.1002/aur.1773.

Lau, W. Y., Gau, S. S., Chiu, Y. N., Wu, Y. Y., Chou, W. J., Liu, S. K., & Chou, M. C. (2013). Psychometric properties of the Chinese version of the autism Spectrum quotient (AQ). *Research in Developmental Disabilities, 34*(1), 294–305. https://doi.org/10.1016/j.ridd.2012.08.005.

Lecavalier, L., Leone, S., & Wiltz, J. (2006). The impact of behaviour problems on caregiver stress in young people with autism spectrum disorders. *Journal of Intellectual Disability Research, 50*, 172–183.

Lee, G. K. (2009). Parents of children with high functioning autism: How well do they cope and adjust? *Journal of Developmental and Physical Disabilities, 21*, 93–114.

Lee, L. C., Harrington, R. A., Louie, B. B., & Newschaffer, C. J. (2008). Children with autism: Quality of life and parental concerns. *Journal of Autism Dev Disord, 38*, 1147–1160. https://doi.org/10.1007/s10803-007-0491-0.

Lin, P. I., Kuo, P. H., Chen, C. H., Wu, J. Y., Gau, S. S., Wu, Y. Y., & Liu, S. K. (2013). Runs of homozygosity associated with speech delay in autism in a taiwanese han population: Evidence for the recessive model. *PLoS One, 8*, e72056. https://doi.org/10.1371/journal.pone.0072056.

Lin, H. Y., Gau, S. S., Huang-Gu, S. L., Shang, C. Y., Wu, Y. H., & Tseng, W. Y. (2014). Neural substrates of behavioral variability in attention deficit hyperactivity disorder: Based on ex-Gaussian reaction time distribution and diffusion spectrum imaging tractography. *Psychological Medicine, 44*, 1751–1764. https://doi.org/10.1017/S0033291713001955.

Lin, H. Y., Hwang-Gu, S. L., & Gau, S. S. (2015a). Intra-individual reaction time variability based on ex-Gaussian distribution as a potential endophenotype for attention-deficit/hyperactivity disorder.

Acta Psychiatrica Scandinavica, 132, 39–50. https://doi.org/10.1111/acps.12393.

Lin, Y. J., Lo, K. W., Yang, L. K., & Gau, S. S. (2015b). Validation of DSM-5 age-of-onset criterion of attention deficit/hyperactivity disorder (ADHD) in adults: Comparison of life quality, functional impairment, and family function. *Research in Developmental Disabilities, 47*, 48–60. https://doi.org/10.1016/j.ridd.2015.07.026.

Little, L. (2002). Differences in stress and coping for mothers and fathers of children with Asperger's syndrome and nonverbal learning disorders. *Pediatric Nursing, 28*, 565–570.

Liu, C. Y., Huang, W. L., Kao, W. C., & Gau, S. S. (2017). Influence of disruptive behavior disorders on academic performance and school functions of youth with attention-deficit/hyperactivity disorder. *Child Psychiatry & Human Development, 48*, 870–880.

Lo, Y. C., Chou, T. L., Fan, L. Y., Gau, S. S., Chiu, Y. N., & Tseng, W. Y. (2013). Altered structure-function relations of semantic processing in youths with high-functioning autism: A combined diffusion and functional MRI study. *Autism Research, 6*, 561–570. https://doi.org/10.1002/aur.1315.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorder, 24*, 659–685.

Maljaars, J., Boonen, H., Lambrechts, G., Van Leeuwen, K., & Noens, I. (2014). Maternal parenting behavior and child behavior problems in families of children and adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorder, 44*, 501–512. https://doi.org/10.1007/s10803-013-1894-8.

Mandy, W., Chilvers, R., Chowhury, U., Salter, G., Seigal, A., & Skuse, D. (2012). Sex differences in autism spectrum disorder: Evidence from a large sample of children and adolescents. *Journal of Autism and Developmental Disorder, 42*, 1304–1313. https://doi.org/10.1007/s10803-011-1356-0.

Manjiviona, J., & Prior, M. (1999). Neuropsychological profiles of children with Asperger syndrome and autism. *Autism, 3*, 327–356.

Moes, D., Koegel, R. L., Schreibman, L., & Loos, L. M. (1992). Stress profiles for mothers and fathers of children with autism. *Psychological Reports, 71*, 1272–1274. https://doi.org/10.2466/pr0.1992.71.3f.1272.

Montgomery, C. B., Allison, C., Lai, M. C., Cassidy, S., Langdon, P. E., & Baron-Cohen, S. (2016). Do adults with high functioning autism or Asperger syndrome differ in empathy and emotion recognition? *Journal of Autism and Developmental Disorders, 46*, 1931–1940. https://doi.org/10.1007/s10803-016-2698-4.

Mori, K., Ujiie, T., Smith, A., & Howlin, P. (2009). Parental stress associated with caring for children with Asperger's syndrome or autism. *Pediatric International, 51*, 364–370. https://doi.org/10.1111/j.1442-200X.2008.02728.x.

Neece, C. L., Green, S. A., & Baker, B. L. (2012). Parenting stress and child behavior problems: A transactional relationship across time. *American Journal of Intellectual and Developmental Disabilities, 117*, 48–66. https://doi.org/10.1352/1944-7558-117.1.48.

Orsmond, G. I., Seltzer, M. M., Greenberg, J. S., & Krauss, M. W. (2006). Mother-child relationship quality among adolescents and adults with autism. *American Journal of Mental Retardation, 111*, 121–137. https://doi.org/10.1352/0895-8017(2006)111[121:MRQAAA]2.0.CO;2.

Osborne, L. A. R., & Phil. (2009). The relationship between parenting stress and behavioral problems of children with autistic spectrum disorders. *Exceptional Children, 76*, 54–73.

Parker, G. (1979). Parental characteristics in relation to depressive disorders. *British Journal of Psychiatry, 134*, 138–147.

Pomeroy, J. C. (1998). *Subtyping pervasive developmental disorder*. New York: Plenum.

Rao, P. A., & Landa, R. J. (2014). Association between severity of behavioral phenotype and comorbid attention deficit hyperactivity

disorder symptoms in children with autism spectrum disorders. *Autism, 18*, 272–280. https://doi.org/10.1177/1362361312470494.

Ruiz-Robledillo, N., & Moya-Albiol, L. (2013). Self-reported health and cortisol awakening response in parents of people with asperger syndrome: The role of trait anger and anxiety, coping and burden. *Psychological Health, 28*, 1246–1264. https://doi.org/10.1080/08870446.2013.800517.

Schieve, L. A., Boulet, S. L., Kogan, M. D., Yeargin-Allsopp, M., Boyle, C. A., Visser, S. N., et al. (2011). Parenting aggravation and autism spectrum disorders: 2007 National Survey of Children's health. *Disability and Health Journal, 4*, 143–152. https://doi.org/10.1016/j.dhjo.2010.09.002.

Seltzer, M. M., Greenberg, J. S., Floyd, F. J., Pettee, Y., & Hong, J. (2001). Life course impacts of parenting a child with a disability. *American Journal of Mental Retardation, 106*, 265–286. https://doi.org/10.1352/0895-8017(2001)106<0265:LCIOPA>2.0.CO;2.

Seltzer, M. M., Shattuck, P., Abbeduto, L., & Greenberg, J. S. (2004). Trajectory of development in adolescents and adults with autism. *Mental Retardation and Developmental Disability Research Review, 10*, 234–247. https://doi.org/10.1002/mrdd.20038.

Shang, C. Y., & Gau, S. S. (2014). Association between the DAT1 gene and spatial working memory in attention deficit hyperactivity disorder. *Internationa Journal of Neuropsychopharmacology, 17*, 9–21. https://doi.org/10.1017/S1461145713000783.

Shang, C. Y., Chiang, H. L., & Gau, S. S. (2015a). A haplotype of the norepinephrine transporter gene (SLC6A2) is associated with visual memory in attention-deficit/hyperactivity disorder. *Progress in Neuropsychopharmacology and Biological Psychiatry, 58*, 89–96. https://doi.org/10.1016/j.pnpbp.2014.12.010.

Shang, C. Y., Pan, Y. L., Lin, H. Y., Huang, L. W., & Gau, S. S. (2015b). An open-label, randomized trial of methylphenidate and atomoxetine treatment in children with attention-deficit/hyperactivity disorder. *Journal of Child and Adolescent Psychopharmacology, 25*, 566–573. https://doi.org/10.1089/cap.2015.0035.

Shattuck, P. T., Seltzer, M. M., Greenberg, J. S., Orsmond, G. I., Bolt, D., Kring, S., et al. (2007). Change in autism symptoms and maladaptive behaviors in adolescents and adults with an autism spectrum disorder. *Journal of Autism and Developmental Disorders, 37*, 1735–1747. https://doi.org/10.1007/s10803-006-0307-7.

Sikora, D. M., Vora, P., Coury, D. L., & Rosenberg, D. (2012). Attention-deficit/hyperactivity disorder symptoms, adaptive functioning, and quality of life in children with autism spectrum disorder. *Pediatrics, 130*, S91–S97. https://doi.org/10.1542/peds.2012-0900G.

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of American Academy of Child and Adolescent Psychiatry, 47*, 921–929. https://doi.org/10.1097/CHI.0b013e318179964f.

Sinzig, J., Morsch, D., Bruning, N., Schmidt, M. H., & Lehmkuhl, G. (2008). Inhibition, flexibility, working memory and planning in autism spectrum disorders with and without comorbid ADHD-symptoms. *Child and Adolescent Psychiatry and Mental Health, 2*, 4. https://doi.org/10.1186/1753-2000-2-4.

Smilkstein, G., Ashworth, C., & Montano, D. (1982). Validity and reliability of the family APGAR as a test of family function. *Journal of Family Practice, 15*, 303–311.

Smith, L. E., Greenberg, J. S., Seltzer, M. M., & Hong, J. (2008). Symptoms and behavior problems of adolescents and adults with autism: Effects of mother-child relationship quality, warmth, and praise. *American Journal of Mental Retardation, 113*, 387–402. https://doi.org/10.1352/2008.113:387-402.

Swanson, J. M., Kraemer, H. C., Hinshaw, S. P., Arnold, L. E., Conners, C. K., Abikoff, H. B., et al. (2001). Clinical relevance of the primary findings of the MTA: Success rates based on severity of ADHD and ODD symptoms at the end of treatment. *Journal of American Academy of Child and Adolescent Psychiatry, 40*(2), 168–179.

Taylor, J. L., & Seltzer, M. M. (2011). Changes in the mother-child relationship during the transition to adulthood for youth with autism spectrum disorders. *Journal of Autism and Development Disorders, 41*, 1397–1410. https://doi.org/10.1007/s10803-010-1166-9.

Tseng, W. L., Kawabata, Y., Gau, S. S., & Crick, N. R. (2014). Symptoms of attention-deficit/hyperactivity disorder and peer functioning: A transactional model of development. *Journal of Abnormal Child Psychology, 42*, 1353–1365. https://doi.org/10.1007/s10802-014-9883-8.

van der Meer, J. M., Oerlemans, A. M., van Steijn, D. J., Lappenschaar, M. G., de Sonneville, L. M., Buitelaar, J. K., & Rommelse, N. N. (2012). Are autism spectrum disorder and attention-deficit/hyperactivity disorder different manifestations of one overarching disorder? *Cognitive and symptom evidence from a clinical and population-based sample. Journal of American Academy of Child and Adolescent Psychiatry, 51*(1160–1172), e1163. https://doi.org/10.1016/j.jaac.2012.08.024.

Wearden, A. J., Tarrier, N., & Davies, R. (2000). Partners' expressed emotion and the control and management of type 1 diabetes in adults. *Journal of Psychosomatic Research, 49*, 125–130.

Weitlauf, A. S., Vehorn, A. C., Taylor, J. L., & Warren, Z. E. (2014). Relationship satisfaction, parenting stress, and depression in mothers of children with autism. *Autism, 18*, 194–198. https://doi.org/10.1177/1362361312458039.

Weschler, D. (2003). The Wechsler intelligence scale for children- *fourth edition*. London: Person.

Windham, G. C., Anderson, M. C., Croen, L. A., Smith, K. S., Collins, J., & Grether, J. K. (2011). Birth prevalence of autism spectrum disorders in the San Francisco Bay area by demographic and ascertainment source characteristics. *Journal of Autism and Developmental Disorder, 41*, 1362–1372. https://doi.org/10.1007/s10803-010-1160-2.

Wing, L. (1980). Childhood autism and social class: A question of selection? *British Journal of Psychiatry, 137*, 410–417.

Woodman, A. C., Smith, L. E., Greenberg, J. S., & Mailick, M. R. (2015). Change in autism symptoms and maladaptive behaviors in adolescence and adulthood: The role of positive family processes. *Journal of Autism and Developmental Disorder, 45*, 111–126. https://doi.org/10.1007/s10803-014-2199-2.

World Health Organization. (1992). *ICD-10 classifications of mental and Behavioural disorder: Clinical descriptions and diagnostic guidelines*. Geneva: World Health Organization.

Wu, Y. H., Gau, S. S., Lo, Y. C., & Tseng, W. Y. (2014). White matter tract integrity of frontostriatal circuit in attention deficit hyperactivity disorder: Association with attention performance and symptoms. *Human Brain Mapping, 35*, 199–212. https://doi.org/10.1002/hbm.22169.

Yang, H. N., Tai, Y. M., Yang, L. K., & Gau, S. S. (2013). Prediction of childhood ADHD symptoms to quality of life in young adults: Adult ADHD and anxiety/depression as mediators. *Research in Developmental Disabilities, 34*, 3168–3181. https://doi.org/10.1016/j.ridd.2013.06.011.