

The characteristics and factors of the internalizing and externalizing behaviours of children at high risk for autism spectrum disorder

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1 **The characteristics and factors of the internalizing and externalizing behaviours of**
2 **children at high risk for autism spectrum disorder**

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38

39

40 **Abstract**

41 **Background:** Children with autism spectrum disorder (ASD) are at risk of developing
42 internalizing and externalizing problems. However, information on the early development of
43 behavioural problems and the contributing role of parent-child interactions among infants at
44 high risk for ASD is lacking. We tested whether parent-child interactions and parenting

45 characteristics were associated with behavioural problems during the infant and toddler
46 periods and examined the effects of the intervention on behavioural problems.

47 **Methods:** This study collected data from 91 infants at high for risk ASD and 68 matched
48 typically developing (TD) infants. At baseline, behavioural observation was performed
49 during free play with all the enrolled families, and in the ASD group, a second behavioural
50 observation was performed after 12 weeks of the Play-based Communication and Behavior
51 Intervention (PCBI). The coding of parent-child interactions was based on the behaviour of
52 parents and children during free play. These data included the child's engagement with each
53 parent and behavioural problems.

54 **Results:** During free play, infants in the ASD group showed more internalizing behaviours
55 ($p < 0.001$) and externalizing behaviours ($p < 0.05$) and less positive engagement ($p < 0.01$) than
56 TD infants. After 12 weeks of intervention, we found that infants at high for risk ASD had
57 reduced internalizing behaviours ($p < 0.001$), increased parent positive engagement ($p < 0.001$),
58 and improved parent-child interactions ($p < 0.001$). In the regression analysis, we found that
59 parenting stress had an impact on infants' externalizing behaviours ($\Delta R^2 = 0.215$). Parent
60 negative engagement had an impact on infants' internalizing behaviours ($\Delta R^2 = 0.451$).

61 **Conclusions:** The findings on the contribution of both parent negative engagement and
62 parent-child interactions to behavioural problems suggests that the amelioration of parent
63 negative engagement is an important factor for the mitigation of behavioural problems. The
64 amelioration of parenting stress is associated with externalizing behaviours. Early
65 intervention and parental factors are important for preventing behavioural problems and
66 possible comorbidity problems in the future.

67

68 **Keywords:** autism spectrum disorder, parent-child interactions, early intervention,
69 internalizing behaviour, externalizing behaviour

70

71

72 **Background**

73 Autism spectrum disorder (ASD) is a developmental disability marked by early-onset social
74 communication deficits and repetitive sensory-motor behaviours [1-4]. The comorbidity of
75 psychiatric symptoms in children with ASD is receiving increasing attention in the literature
76 [5, 6]. Many studies have focused on emotional and behavioural problems (EBPs), including
77 internalizing behaviours (e.g., social dysfunction, anxiety, depression, cognitive problems and
78 avoidance symptoms) as well as externalizing behaviours (e.g., impaired concentration,
79 hyperactivity, aggression and behavioural disorders) [5, 7-9]. Regarding the development of
80 internalizing and externalizing problems in young children with ASD, only a few studies are
81 available, and their findings are mixed.

82 ASD children are generally considered to exhibit less positive engagement, more
83 negative engagement [10], and a lower ability to express emotionality compared with their
84 typically developing (TD) peers. Previous studies on the behavioural development of ASD
85 children (e.g., the development of internalizing and externalizing behaviours) have focused
86 mainly on behavioural neuroscience [1, 4], highlighting the significance of researching this
87 phenomenon as early as possible. With age, children develop greater emotional complexity
88 and become more capable of predicting negative events. Carter et al. [11] examined the

89 development of internalizing problems such as anxiety and depression in children with ASD
90 compared with that of their TD peers and found an increase in the development of these
91 problems in early childhood. Regarding externalizing problems, Fanti and Heinrich [12] have
92 reported mixed findings, namely, either a stable or decreasing pattern in development among
93 most TD children. The discrepancy may have occurred because the different studies included
94 children of different ages and examined different externalizing symptoms. As revealed from
95 parents' recollections of their children's behaviours before diagnosis and from analyses of
96 family videos, early abnormal development occurs during the first 1-2 years of life; this
97 abnormal development manifests as extreme passiveness; obvious irritability [13, 14]; and a
98 lack of response to parental voices, attempts to play and interactions [15, 16]. Children's
99 internalizing and externalizing behaviours make their parents more likely to experience
100 negative emotionality, and the consequent increase in mutual negative emotionality reduces
101 interactions, thereby aggravating behavioural problems [17].

102 The daily management of children with ASD is a major challenge for parents,
103 particularly during early childhood. Quite a few studies have reported higher stress levels
104 among parents of children with a developmental disability [3, 18]. Higher parenting stress
105 levels have been shown to reduce the effectiveness of early intervention programmes and
106 parent-child interactions, thereby impairing clinical improvement in emotional expression,
107 behavioural problems and social functioning. Recent research suggests that infant regulatory
108 problems can be best understood in a relational context and that disturbances of parent-child
109 interactions and parenting stress are significant risk factors for infant EBPs [19, 20]. ASD
110 children tend to ignore emotional expressions from others [21, 22]. These studies evaluating

111 parental stress suggested that the severity of autistic traits could also be related to parenting
112 stress and highlighted the daily management of behavioural problems and children's
113 characteristics (age, adaptive behaviours, and gender) as relevant sources of parenting stress
114 [3, 23-25]. The behaviours of ASD children may create challenges for caregivers due to the
115 disorder's interference with help-seeking behaviours, which affects the long-term prognosis
116 [22, 26].

117 Although internalizing and externalizing problems are well recognized in the mental
118 health profiles of children with ASD, information on the role of their parents and early
119 intervention, particularly in infancy, is scarce [27, 28]. The literature has shown that early
120 intervention and positive parenting (involving praise, encouragement, and affection) are
121 strongly associated with children's positive engagement, high child self-esteem and
122 interaction tendency and are protective against later behavioural problems and comorbidity
123 [29]. Early research showed that parenting and family interaction variables explained up to
124 30% to 40% of child behavioural problems [30], and more recent research suggests that many
125 family correlates of aggressive child behaviours are present in infancy before the onset of
126 such coercive cycles [31]. Mental disorders and behavioural comorbidities of ASD children
127 can cause serious adverse effects [4, 21, 22, 32, 33]. Diagnosis and early intervention that
128 occur before emotional, behavioural, and social issues are entrenched in children can
129 significantly improve parents' mental health, which maximizes family acceptance of and
130 adaptability to children's problems and the impact of diagnosis and intervention on children's
131 functioning [32-34].

132 The current study had three aims. First, we compared the level of child engagement

133 states, parent-child interactions, and the correlates of emotion and behavioural problems
134 between children with ASD and their TD peers during free play. Second, we explored the
135 factors that contribute to emotional and behavioural problems, such as parenting stress and
136 parent-child interactions. Third, after early intervention (The Play-based Communication and
137 Behaviour Intervention) for infants and parents, we investigated if infants' emotional
138 expression and problem behaviours had improved.

139

140 **Methods**

141

142 *Participants*

143 The participants were members of the Children's Mental Health Research Center of the
144 Nanjing Brain Hospital affiliated with Nanjing Medical University from October 2017 to
145 February 2020 who were invited to participate in a very early intervention cohort study. A
146 total of 159 children participated in this study. The sample included 91 infants at high risk for
147 autism (70 boys; age range, 8-30 months) and 68 TD infants (40 boys; age range, 8-30
148 months). All children underwent behavioural observation during free play at baseline with
149 their parent. The high-risk children were observed again during free play at the end of the
150 intervention.

151 *The ASD at-risk group* were selected on a clinical assessment by two child
152 psychiatrists based on of the following: i) the Autism Diagnostic Observational Schedule
153 (ADOS) [35], ii) the Autism Diagnostic Interview-Revised (ADI-R) [36], and, iii) all cases
154 satisfied either Risk criteria for ASD (if under 24 months of age at intake) or DSM-5 criteria

155 for ASD diagnosis [37] if over 24 months of age at intake, and received both: iv) Positive M-
 156 CHAT assessment results [38], and v) Scores above 30 on the Childhood Autism Rating
 157 Scale (CARS) [39].

158 *The TD group* included 68 infants (40 boys; age range, 8-30 months) and their
 159 parents. The TD infants had no neuropsychiatric disorders and were matched with the ASD
 160 group on mental age and the ratio of boys to girls. TD participants were screened for ASD
 161 using the M-CHAT and CARS. The groups were matched on the raw scores of the Gesell
 162 Developmental Assessment (DQ), a standardized test assessing IQ in children aged 6 months
 163 and older. The DQ scores in the TD group were higher than 80. The exclusion criteria were as
 164 follows: any genetic syndromes or neurological conditions; a history of craniocerebral
 165 trauma; chronic medical conditions; or visual, hearing or motor impairments. No intervention
 166 other than parental health education was undertaken during the participation period. Table 1
 167 provides further demographic information.

168 **Table 1.** Demographic Characteristics

Variable	ASD group (N=91)	TD group (N=68)	<i>t/x²</i>
<i>Child measures</i>			
Age (months)	18.20(8.451)	16.11(5.336)	1.754
Sex			0.366
<i>Female</i>	21	20	
<i>Male</i>	70	48	
Gesell (DQ)			

<i>Language behaviour</i>	53.78(21.574)	92.51(10.757)	-13.502**
<i>Personal-social behaviour</i>	71.14(18.093)	96.73(9.358)	-14.806**
ADOS	12.03(3.906)	N/S	
<i>Parent measures</i>			
BAPQ	111.54(12.102)	98.14(17.227)	5.727**
PSI	77.82(15.176)	66.91(17.044)	4.255**

169 *p < 0.05; **p < 0.01; ***p < 0.001.

170

171 ***Ethical Considerations***

172 All parents signed an informed consent form. Ethical approval for the study was granted by
 173 the China Clinical Trial Registration Center (Name of the Ethic Committee: Nanjing Brain
 174 Hospital Ethics Committee), ChiCTR-OPC-1701 1995. The study was approved the Nanjing
 175 Brain Hospital Ethics Committee (Approval certificate number: 2017-KY098-01).

176

177 ***Procedure***

178

179 ***Diagnostic and Cognitive Assessment***

180 All children were screened at enrolment and at the end of the intervention with the M-CHAT,
 181 the Autism Behaviour Checklist (ABC, Krug et al. [40]) and the CARS [39]. The ABC is a
 182 well-established parent-report checklist used to screen for and diagnose autism. The Gesell
 183 Developmental Schedules [41] assess five domains of cognitive abilities: adaptive behaviour,

184 gross motor behaviour, language behaviour, fine motor behaviour and personal-social
185 behaviour. The TD children were screened at enrolment. The average raw scores of three of
186 the domains (adaptive behaviour, gross motor behaviour and fine motor behaviour) were
187 above 80 in both groups; there were group differences in the scores of the other two domains
188 (language behaviour and personal-social behaviour).

189

190 *Parent Measures*

191 The Broad Autism Phenotype Questionnaire (BAPQ) is a helpful assessment of personality
192 and language characteristics [42]. The Parenting Stress Index Short Form (PSI-SF) is a self-
193 report questionnaire with 36 items used to evaluate parenting stress on a 5-point Likert-type
194 scale [43,44].

195

196 *Child Intervention*

197 From 2013 to 2015, the Children's Center of Nanjing Brain Hospital developed a very early
198 intervention programme for children at high for risk ASD (8-30 months) and compiled a
199 unified operation manual based on strategies proven to be effective internationally. The
200 programme was consistent with development theory and behaviour management strategies.

201 The foundation of behaviour training refers to the “ABC” theory, where A, B and C represent
202 the antecedent of a behaviour, the behaviour, and the consequence of the behaviour,
203 respectively. Behavioural training was classified into three major themes (i.e., “Focus on
204 positive behaviours”, “Treatment of problem behaviours”, and “Formulation and execution of
205 training plans”). The PCBI involved training parents or other caregivers to effectively

206 perform vital intervention techniques with ASD children[45].

207

208 *Parent-Child Free Play*

209 Parent-child interactions were videotaped at baseline and after 12 weeks during a semi-
210 structured 15-min play session in a room built for the participants at the study site in the
211 Children's Center of Nanjing Brain Hospital. First, children played with 3 toys of the parent's
212 choice for the first 5 min. Then, children played with their mother or father with a standard
213 set of toys for the following 10 min, as they would at home (as described in National Institute
214 of Child Health and Human Development – Early Childcare and Youth Development
215 NICHD-ECCRN [10]).

216

217 *Coding*

218

219 Parent-child interactions

220 The NICHD Research Handbook of Early Child Care [10, 46-48] was used to measure
221 parent-child interactions. All parenting codes were rated on a global 3-point scale, ranging
222 from 1 (not at all characteristic) to 3 (highly characteristic). *Internalizing and externalizing*
223 *behaviours*. Internalizing and externalizing behaviours were measured based on the 6 factors
224 of the Child Behavior Checklist for 2- to 3-year-old children [49-51] and in terms of 7
225 syndromes (i.e., emotional responses, anxiety/depression, physical complaints, loneliness,
226 sleep problems, attention problems and aggressive behaviours) and 5-DSM orientations (i.e.,
227 depression, anxiety, loneliness spectrum, attention deficit hyperactivity disorder,

228 confrontation and aggression). Parent and child behaviours were coded every 10 sec with the
229 Noldus Observer 12.0 XT software (Noldus Inc., Netherlands).

230 The codes were as follows: *child positive engagement*, which included the child's
231 positive or neutral affect, vocalizations, or positive body posture; *child negative engagement*,
232 which included the child's impatience, anger, distressed vocalizations and negative body
233 posture, crying, or pushing the parent away; *child withdrawal*, which referred to the child's
234 withdrawal from a joint activity by expressing sadness or anxiety; *child object exploration*,
235 which referred to the child's independent exploration of toys without interaction with the
236 parent; *parent positive engagement*, which included the child's expression of positive or
237 neutral affect, vocalizations and behaviours, or smiling while playing games; *parent negative*
238 *engagement*, which included the parent's angry, hostile, irritable, or negative vocalizations;
239 *parent intrusiveness*, which referred to the parent's dominance, physical manipulation,
240 hostility, or criticism; *parent limit setting*, which referred to the parent's persistent effort to
241 engage the child, appropriate construction of interaction, or warm limit setting; *dyadic*
242 *reciprocity*, which included the parent's or child's mutual adaptation to the other's state, give-
243 and-receive reciprocity, or fluent and rhythmic interactions; *internalizing behaviours*, which
244 referred to the child's disobedience, defiance of orders, reluctance to speak, shyness or
245 timidity, or blank staring; and *externalizing behaviours*, which included the child screaming,
246 stomping, crying, throwing a tantrum, letting himself or herself fall suddenly, making a
247 gesture of hitting, grabbing, knocking his or her head against a wall, tearing clothes up and
248 ignoring calls from others.

249 The parent-child interaction state was independently coded by two trained research

250 assistants. The interrater reliability for participation status among parents and children was
251 90.79% and 92.10%, respectively. Any differences in code specifications were resolved
252 through discussion.

253

254 *Statistical Analysis*

255 The data analyses were conducted using the statistical package SPSS for Windows, version
256 24. Significant results are reported at the $p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$ levels.

257 Demographic characteristics were investigated using the chi-squared test for independence
258 (sex) and an independent sample t-test (age, IQ and parent factors such as PSI and BAPQ

259 scores). Intervention effects were investigated using the paired-sample t-test for the child

260 engagement state and parent engagement state in the ASD group. A Pearson bivariate

261 correlation analysis was conducted to determine the association between child engagement

262 state and parent engagement state at baseline. Finally, a hierarchical multiple regression

263 analysis was performed to predict the proportion of variance in the dependent variable

264 (behavioural problems) at baseline that could correspond to the independent variables (age,

265 PSI score, parent negative engagement, and parent-child interactions (dyadic reciprocity)) at

266 baseline. Blocks of predictors were entered into the model in four steps. The baseline model

267 (model 1) included age as an independent variable at baseline and as a control variable for the

268 subsequent analyses. The PSI score was added to model 2, parent negative engagement was

269 added to model 3, and parent-child interactions (dyadic reciprocity) were added to model 4.

270 The increase in variance (ΔR^2) was assessed for each block.

271

272 **Results**

273

274 *Demographic Characteristics*

275 The descriptive statistics for all study variables are presented in Table 1. As a preliminary
276 measure to identify developmental covariates for subsequent multivariate analyses, bivariate
277 correlations were conducted between all study variables and developmental scores (age,
278 language behaviour, personal-social behaviour, BAPQ and PSI) for each group. We found no
279 difference in sex between the two groups ($\chi^2= 0.366, p=0.235$). The DQs for language
280 behaviour and personal-social behaviour from the Gesell Developmental Schedules differed
281 significantly between the two groups ($p < 0.001$), but those for adaptive behaviour,
282 gross motor behaviour and fine motor behaviour did not differ between the ASD group and
283 the TD group. The average BAPQ score in the ASD group was 111.54 (± 12.102). The
284 developmental assessment showed that the children's average language score was 53.63 (\pm
285 21.649) and that the social contact score was 71.14 (± 18.093).

286

287 *Behaviours During Parent-Child Interactions*

288 The means and SDs of all interactive variables for the two groups of children and their
289 parents appear in Table 2.

290 **Table 2.** Parent, Child and Behavioural Problems in the ASD and TD Groups

Variable	ASD group		TD group		<i>t</i>	Effect size
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Child positive engagement	15.18	5.687	21.85	4.473	-7.816**	1.287

Child negative engagement	4.62	5.806	2.71	2.015	2.933*	0.440
Child withdrawal	3.87	3.045	5.21	2.256	-3.050**	0.500
Child object exploration	7.57	4.568	4.19	1.781	5.779***	0.975
Externalizing behaviours	2.96	4.763	1.85	1.175	1.866*	0.317
Internalizing behaviours	4.21	3.107	2.72	1.443	3.663***	0.415
Parent positive engagement	19.35	5.396	21.60	5.044	-2.676**	0.431
Parent negative engagement	4.02	3.467	2.40	1.805	3.522*	0.586
Parent intrusiveness	4.34	1.688	2.87	1.171	6.170***	1.011
Parent limit setting	6.40	4.816	6.63	4.581	-0.224	0.049
Dyadic reciprocity	11.90	6.139	15.99	5.916	-4.215***	0.678

291 *p < 0.05; **p < 0.01; *** p < 0.001.

292

293 *Parent Interactive Behaviour*

294 Using independent-sample t-tests, we examined group (ASD and TD) and parent differences

295 in the following parental behaviours: positive engagement, negative engagement,

296 intrusiveness, and limit setting. The results revealed a main effect for parent intrusiveness, p

297 < 0.001, ES = 1.011. The independent-sample t-tests indicated that TD parents showed

298 appropriate negative engagement (p < 0.05) and greater positive engagement (p < 0.01)

299 compared with ASD parents.

300

301 *Child Interactive Behaviour*

302 The independent-sample t-tests of child behaviours including positive engagement, negative
303 engagement, withdrawal and child object exploration yielded no significant group effect.

304 Children with ASD exhibited less positive engagement ($p < 0.001$), more negative
305 engagement ($p < 0.01$), more withdrawal ($p < 0.01$), and more child object exploration ($p <$
306 0.001) compared with the TD group. The ASD group also exhibited more internalizing
307 behaviours ($p < 0.01$) and more externalizing behaviours ($p < 0.01$) than did the TD group.

308

309 *Dyadic Reciprocity*

310 The independent-sample t-test showed a main effect for group, $p < 0.001$, $ES = 0.678$. TD
311 children and parents were observed to be more reciprocal compared with the ASD group.

312

313 *Intervention with Children and Parents*

314 Table 3 lists the children's engagement states and parents' engagement states in the ASD
315 group before and 12 weeks after the intervention. After the intervention, we found significant
316 improvements in child positive engagement ($p < 0.001$), child object exploration ($p < 0.001$),
317 and child internalizing behaviours ($p < 0.05$). Significant differences were found in parent
318 positive engagement ($p < 0.001$), parent negative engagement ($p < 0.001$), and dyadic
319 reciprocity ($p < 0.001$).

320 **Table 3.** Parent, Child Engagement and Parent-Child Interactive-Behaviours at Baseline (T1)

321 and - Postintervention (T2)

Variable	Time 1	Time 2	<i>t</i>	<i>P</i>
Child positive engagement	15.14	18.53	-5.080	0.000***
Child negative engagement	4.20	3.86	0.466	0.642
Child withdrawal	3.87	3.53	0.789	0.432
Child object exploration	7.57	5.30	3.897	0.000***
Internalizing behaviours	4.21	3.07	2.791	0.006***
Externalizing behaviours	2.96	2.30	1.284	0.203
Parent positive engagement	19.35	22.24	-3.864	0.000***
Parent negative engagement	4.02	2.16	4.714	0.000***
Dyadic reciprocity	11.90	15.86	-5.761	0.000***
CARS	34.45	31.31	3.455	0.001**
ABC	61.56	48.64	3.376	0.003**

322 * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

323

324 *Correlations Between Child Factors and Parent Factors*

325 The simple correlations and summary statistics for all variables are presented in Table 4.

326 Parent negative engagement and the PSI score were found to be significantly related to

327 several measures of child negative engagement and child behavioural problems (ranging from

328 0.205 to 0.833, $p < 0.05$). Parent-child interactions were correlated with more behavioural

329 problems during free play in children at high for risk ASD. Parent positive engagement was

330 strongly correlated with child positive engagement ($r^2 = 0.831$, $p < 0.05$), and child negative

331 engagement showed weaker but nonetheless substantial correlations with the other parenting

332 variables. Less parent negative engagement, less child negative engagement and greater
 333 parent positive engagement were associated with fewer internalizing behaviours and
 334 externalizing behaviours. Parent negative engagement was correlated with internalizing
 335 behaviours ($r^2 = 0.205$, $p < 0.05$) and with externalizing behaviours ($r^2 = 0.252$, $p < 0.05$).
 336 Greater parent-child interactions were correlated with child positive engagement ($r^2 = 0.833$,
 337 $p < 0.05$) and parent positive engagement ($r^2 = 0.753$, $p < 0.05$). Finally, child negative
 338 engagement was correlated with a higher PSI score ($r^2 = 0.210$, $p < 0.05$), parent negative
 339 engagement during free play ($r^2 = 0.426$, $p < 0.05$), and more child externalizing behaviours
 340 ($r^2 = 0.442$, $p < 0.05$).

341 -

342 **Table 4.** -Bivariate Associations (Spearman's rho) Between the Main Study Variables and
 343 Behaviours Problems

Variabl e	Age	PSI	BAP Q	C-pos	C- negative	P-pos	P-neg	Inter-	Exter-	D-rec
Age	-									
PSI	-	-								
	0.037									
BAPQ	-	-0.067	-							
	0.019									
C-pos	-	-0.068	0.043	-						
	0.044									

	-			-						
C-neg		0.210*	-0.151			-				
	0.177			0.420**						
P-pos	0.031	-0.108	0.093	0.831**	-0.312**					
		0.426*								
P-neg	0.059		-0.015		0.352**	-0.253*				
		*		0.324**						
Inter-	0.120	0.103	-0.065		0.071		0.205*			-
				0.346**		0.379**				
Exter-	0.121	0.147	-0.110		0.442**		0.252*	0.560**		-
				0.468**		0.399**				
D-rec		-0.078	0.129	0.833**	-0.359**	0.753**				-
	0.052						0.357**	0.322**	0.483**	
P-limit		0.118	0.078	0.001	0.110	-0.010	0.166	-0.126	-0.067	
	0.092									0.108

344 **p < 0.01; *p < 0.05.

345 0.2 < r < 0.4 low correlations, 0.4 < r < 0.6 moderate correlations, 0.6 < r < 0.8 high correlations

346 C-pos: Child positive engagement; C-neg: Child negative engagement; P-pos: Parent positive

347 engagement; P-neg: Parent negative engagement; Inter-: Internalizing behaviours; Exter-:

348 Externalizing behaviours; D-rec: Dyadic reciprocity; P-limit: Parent limit setting

349

350 *Regression of Parent Factors on Behavioural Problems*

351 A hierarchical multiple regression analysis was performed to predict the proportion of

352 variance in the dependent variable (internalizing behaviours) that could be attributed to the

353 independent variables (PSI score, parent negative engagement, and dyadic reciprocity). The
 354 results from the hierarchical regression are presented in Table 5. The results when the PSI
 355 score was entered into the baseline (age) model were as follows: $\Delta R^2 = 0.013$, $\Delta F = 1.169$,
 356 $p = 0.283$. Adding parent negative engagement into the model significantly improved model
 357 fit ($\Delta R^2 = 0.451$, $\Delta F = 75.457$, $p < 0.001$). Finally, the inclusion of dyadic reciprocity did
 358 not significantly improve model fit ($\Delta R^2 = 0.002$, $\Delta F = 0.268$, $p = 0.606$). The results from
 359 the hierarchical regression on externalizing behaviours are presented in Table 6. Adding the
 360 PSI score to the baseline (age) model in significantly improved model fit ($\Delta R^2 = 0.215$, ΔF
 361 $= 24.078$, $p < 0.001$). The model fit also significantly improved when parent negative
 362 engagement was entered into the model ($\Delta R^2 = 0.071$, $\Delta F = 8.755$, $p = 0.004$). Finally, the
 363 inclusion of dyadic reciprocity moderately improved the model ($\Delta R^2 = 0.128$, $\Delta F = 18.755$,
 364 $p < 0.001$).

365 -

366 **Table 5.** Summary of the Hierarchical Regression Analysis of Child Internalizing Behaviours
 367 at Baseline (n = 91)

Variable	Model 1		Model 2		Model 3		Model 4	
	<i>B</i>	<i>t</i>	<i>B</i>	<i>t</i>	<i>B</i>	<i>t</i>	<i>B</i>	<i>T</i>
Constant	4.258	4.607***	1.935	0.828	0.355	.205	0.854	0.430
Age	0.054	1.173	0.063	1.351	0.050	1.464	0.050	1.445
PSI			0.028	1.081	0.014	.726	0.013	0.682
P-negative					0.721	8.687	0.696	7.261
D-reciprocity							-.0280	-0.518

R2	0.015	0.028	0.480	0.481
F	1.376	1.274	26.720***	19.939***
△R2		0.013	0.451	0.002
△F		1.169	75.457***	0.268

368 The table displays the unstandardized regression coefficients for the four models. *p < 0.05.

369 **p < 0.01. ***p < 0.001. P-negative: parent negative engagement; D-reciprocity: Dyadic
370 reciprocity.

371

372 **Table 6.** Summary of the Hierarchical Regression Analysis of Child Externalizing

373 Behaviours at Baseline (n = 91)

Variable	Model 1		Model 2		Model 3		Model 4	
	<i>B</i>	<i>T</i>	<i>B</i>	<i>T</i>	<i>B</i>	<i>T</i>	<i>B</i>	<i>T</i>
Constant	6.620	4.087***	-9.862	-	-10.954	-	-3.245	-
				2.698		3.107*		0.883
Age	-0.027	-0.332	0.038	0.522	0.029	0.419	0.023	0.356
PSI		3.008	0.196	4.907	0.186	4.848	0.175	4.979
P-negative					0.498	2.947	0.118	0.668
D- reciprocity							-0.434	-
								4.331
R2	0.001		0.216		0.287		0.415	
F	0.110		12.108***		11.673**		15.230***	
△R2			0.215		0.071		0.128	

△F

24.078***

8.755**

18.755***

374 The table displays the unstandardized regression coefficients for the four models. P-negative:
375 parent negative engagement; D-reciprocity: Dyadic reciprocity. *p < 0.05. **p < 0.01, ***p <
376 0.001.

377

378 **Discussion**

379 This study was among the first to examine the development of behavioural problems,
380 contributing factors and intervention effects in infants aged 8-30 months with or without
381 ASD. With this sample of very young children (8–30 months of age), the study aimed to
382 examine children’s behavioural problems and influencing factors such as parent engagement
383 status, parenting stress, and parent-child interactions. We explored the intervention outcomes
384 for the behavioural problems and the quality of dyadic reciprocity. The results suggested that
385 children’s engagement states were influenced by their parents’ characteristics. These results
386 contribute to the growing body of work suggesting that at a very early age in children’s
387 development, the level of parent-child interactions shows significant development and
388 already shows links to parent (e.g., parenting stress, parent negative engagement) and
389 individual characteristics and factors. Our main findings are as follows. First, children at high
390 risk for ASD exhibited more severe internalizing and externalizing problems and less parent
391 positive engagement than did the TD group. Second, we did not find an age effect on
392 internalizing or externalizing problems for toddlers with and without ASD. After the
393 intervention, we observed more child positive engagement and fewer internalizing
394 behaviours. For parents, we found more positive engagement, less negative engagement, and

395 more parent-child interactions. Third, for the ASD group, more parenting stress was
396 associated with negative child engagement and parent negative engagement. Child negative
397 engagement was associated with externalizing problems and parent negative engagement.
398 Positive child engagement was associated with parent-child interactions. Both child
399 externalizing and internalizing behaviours were associated with parent negative engagement.
400 Fourth, parenting stress was uniquely associated with decreased externalizing problems in
401 infants at high risk for ASD.

402

403 ***Link to the Intervention***

404 In this longitudinal intervention, behavioural observations were performed at baseline and at
405 12 weeks postintervention to assess the participation status and problem behaviours of
406 children aged 8-30 months at high for risk ASD. The results indicate that the PCBI
407 significantly ameliorated internalizing behaviours, encouraged active participation and
408 improved child object exploration behaviours. Moreover, parent-child interactions increased
409 significantly. The increase in active participation indicates the children's socialization and
410 interactions with their parents increased after training. The behavioural parental interventions
411 referenced in some studies are well recognized as effective interventions to treat behavioural
412 problems among neurotypical individuals and other clinical patients [52]. A recent meta-
413 analysis examined the efficacy of parental interventions on destructive and hyperactive
414 behaviours among children with ASD and evidence of parenting efficacy and stress; the
415 interventions were effective in improving externalizing behaviours and parental happiness
416 [28, 53]. The results of our study are consistent with those reported by Barlow et al. [52] and

417 Fabiano et al. [54], verifying the efficacy of interventions on behavioural problems. However,
418 our study was different in the following ways. First, early childhood was selected to explore
419 children's problem behaviours and provide early guidance. Second, the PCBI performed in
420 this study consisted of behaviour management, behaviour training and play-based social skills
421 training. In addition, the PCBI involves the use of critical techniques that are suitable for
422 ASD children and can be effectively mastered by parents or other caregivers after training.
423 Existing studies have suggested that various games contribute to children's self-esteem,
424 behavioural regulation, emotional expression, cognitive and motor skills, adaptability and
425 mental health. Playing games is considered a right for children [55]. ASD diagnoses are
426 provided between the ages of 2 and 7 years old, whereas autism symptoms can be identified as
427 early as the first 6 months of life [56, 57]. Early intervention may help improve variations in
428 the volume of brain area (e.g., the amygdala of ASD children), which in turn improves
429 sociability and alleviates the excessive growth of the amygdala at an early stage [54].
430 Moreover, early intervention for children and training for parents can effectively improve
431 interactions and enhance parents' ability to intervene. The integration of parental intervention
432 strengthens the diversity and efficacy of interventions. Theoretical and empirical evidence
433 suggests that externalizing behaviours and internalizing symptoms have similar
434 developmental antecedents and may respond to similar interventions.

435

436 ***Link to Parent-Child Interactions***

437 This study suggests that a critical factor of externalizing behaviours is passive participation,
438 indicating that an increase in passive participation among children may lead to externalizing

439 behaviours, thereby increasing the risk of future comorbidities. Existing studies have
440 suggested that common irritability among children is associated with a threefold greater risk
441 of disruptive behaviours throughout middle childhood. Some ASD children with negative
442 emotionality show destructive behaviours (tantrums or physical attacks in anger), while
443 others may interact in a way that interferes with their target behaviours (excessive agitation or
444 depression). Interventions for excessive negative emotionality in early childhood can mitigate
445 possible behavioural problems. Passive participation among children at high risk for ASD
446 (e.g., frowning, refusing free play and crying in free play) may be initially attributed to their
447 increasing emotional response and poor emotional control. Poor emotional regulation can be
448 inherent in ASD children [55], leading to externalizing behaviours (e.g., throwing objects,
449 crying and stomping). Second, negative emotionality is also considered to be associated with
450 ASD children's "alexithymia", which is "the difficulty in identifying, describing and
451 distinguishing emotionality". Research by Costa suggests that teaching ASD children how to
452 identify and distinguish their emotionality from that of others by improving their
453 "alexithymia" may be useful for regulating their emotionality [58]. The critical factor of
454 internalizing behaviours is child object exploration. Internalizing behaviours predict more
455 emotional problems (e.g., anxiety and depression) in the future. Children's object exploration
456 affects internalizing behaviours because children at high risk for ASD engage in less active
457 socialization and prefer to be immersed in their own worlds. ASD is an early-onset complex
458 neurodevelopmental disorder that affects two aspects of children's emotional lives: their
459 emotionality is primarily negative [59], and their ability to express emotionality is weak.
460 Notably, ASD children also have less positive emotionality than do TD children. Children's

461 fear is a self-protective characteristic that is attributed to their responses to threatening or
462 unfamiliar stimuli, and an increase in fear among infants predicts subsequent behavioural
463 inhibition and anxiety [60]. In contrast, anger reflects a child's tendency to express negative
464 emotionality in response to constraints or target blocking, thereby serving a protective
465 function [61, 62]. The rise of anger in preschool predicts subsequent externalizing
466 behaviours. Furthermore, some studies demonstrate that parents can help regulate stress
467 hormones and brain activity in children, but not adolescents. Synchronous interaction through
468 child feeding can buffer the impact of adverse environments on child outcomes, making
469 sensitive care an important target for interventions with high-risk families. Caregivers often
470 vigorously adjust young children's behaviour and physiology (by reducing the stress response
471 attributed to the amygdala and the involvement of the frontal lobes) but allow behavioural
472 and physiological development to unfold naturally during puberty. It has been proposed that
473 there are sensitive periods before puberty. Early in the life of a child, behavioural
474 interventions can be used to regulate the child's mind and physiology, thereby offering early
475 life programming of the most optimized brain structure, which is vital to lifelong
476 emotionality. Thus, children's development can be supported to gradually reduce subsequent
477 developmental complications.

478

479 *Links to Parenting Stress*

480 Pressure in a family is more likely to make parents become sensitive caregivers, and it
481 mediates many adverse child outcomes associated with emotional regulation and behavioural
482 problems [63-65]. Parenting-related stress was higher in parents of toddlers with ASD than in

483 the TD group. This finding is consistent with prior research with mothers of preschool-aged
484 children with ASD and with a study of parents of children with ASD of a different age group
485 [66]. In the hierarchical regression analysis, consistent with previous literature, children's
486 behavioural problems, particularly externalizing behaviours, were found to appropriately
487 contribute to the parenting stress of parents of children with ASD [26]. Parenting-related
488 stress is directly tied to the parenting role, but parent engagement state was measured in this
489 study. Parenting-related stress was shown to be higher in parents of children with ASD. One
490 source of increased parenting demands demonstrated in this study and prior studies is
491 behavioural problems [26, 67]. This finding suggests that children's behavioural problems are
492 an important target of early autism intervention. However, we did not assess parenting stress
493 at the end of the intervention. Importantly, though, we found a significant improvement in
494 parents' engagement states during free play. Improving behavioural problems has a positive
495 impact on children with ASD and can also improve parenting-related stress in caregivers.
496 This finding is consistent with previous studies of parents of preschool children with ASD,
497 but few studies have examined children aged approximately 8-30 months. Early intervention
498 approaches that focus on parenting strengths may be able to build upon and reinforce parents'
499 positive coping strategies, which also decrease parenting stress. Future studies are required to
500 better understand how emotional and societal factors contribute to parenting stress in families
501 of children with ASD. Parenting demands change as children develop, so further research
502 examining the developmental trajectory of the relationships between parenting stress and
503 problem behaviours throughout the lifespan is necessary.

504 Such future studies will improve our understanding of the role of infant behaviours,

505 parent-infant interactions, and temperament in behavioural development and emotional
506 regulation in the first years of life. Our results indicate that early intervention helps prevent
507 the development of these EBPs in infants. Looking toward the future, our results suggest the
508 potential of early childhood interventions on individual and parent variables. Researchers
509 might consider focusing such interventions on not the individual child, but rather, the family
510 unit, with the goal of promoting more effective parenting styles and creating environments
511 more conducive to healthy development among autistic children.

512

513 ***Limitations***

514 The limitations of this study are as follows. 1. No other parent variables, such as education,
515 were explored. 2. The behavioural changes cannot be completely attributed to treatment and
516 may have been affected by factors such as the passage of time. 3. In this study, only baseline
517 and 12-week assessments were conducted. Our research group evaluated and predicted
518 children's emotions and behaviours after 2 years, which will be reflected in the following
519 articles. Children participating in long-term interventions should be followed up multiple
520 times to increase the reliability of the results and to explore the impact of the interventions on
521 long-term development.

522

523 **Conclusions**

524 The present study discussed more behavioural problems in groups at high risk for ASD than
525 for TD peers. The results emphasized that reductions in parent negative engagement and
526 parenting stress are important for mitigating child behavioural problems. The results

527 underline that early intervention for infants and parents is important for emotional and
528 behavioural regulation and reducing possible comorbidity problems in the future.

529

530 **List of Abbreviations**

531 Autism spectrum disorder (ASD)

532 Emotional and Behavioural Problems (EBPs)

533 Typically Developing (TD)

534 Play-based Communication and Behaviour Intervention (PCBI)

535 Autism Diagnostic Observational Schedule (ADOS)

536 Autism Diagnostic Interview-Revised (ADI-R)

537 Childhood Autism Rating Scale (CARS)

538 Developmental Assessment (DQ)

539 Autism Behaviour Checklist (ABC)

540 The Broad Autism Phenotype Questionnaire (BAPQ)

541 Parenting Stress Index Short Form (PSI-SF)

542 National Institute of Child Health and Human Development – Early Childcare and Youth

543 Development (NICHD-ECCRN)

544

545 **Declarations**

546 All methods were carried out in accordance with relevant guidelines and regulations.

547

548 ***Ethics Approval and Consent to Participate***

549 All parents signed an informed consent form. Ethical approval for the study was granted by

550 the China Clinical Trial Registration Center (Name of the Ethic Committee: Nanjing Brain

551 Hospital Ethics Committee), ChiCTR-OPC-1701 1995. The study was approved the Nanjing

552 Brain Hospital Ethics Committee (Approval certificate number: 2017-KY098-01).

553

554 ***Consent for Publication***

555 Not applicable.

556

557 ***Availability of Data and Materials***

558 The datasets used or analysed during the current study available from the corresponding
559 author (Ning Ding) on reasonable request.

560

561 ***Competing Interests***

562 The authors declare that they have no competing interests.

563

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569

570 ***Authors' Information and Contributions***

571 Xiaoyan Ke, Ning Ding, Yanling Ren designed the study and performed the experiments;
572 Ning Ding, Jiying Jiang, Huan Shao, Mengyao Zhai, Linyan Fu, Yu Li, Nana Qiu performed
573 the experiments, Ning Ding analysed the data and wrote the manuscript.

574

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578

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