

Callous-unemotional Traits in Preschool Children With Attention Deficit/hyperactivity Disorder

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1 **Callous-unemotional traits in preschool children with**
2 **attention-deficit/hyperactivity disorder**

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Abstract

Background: Children with early onset of callous-unemotional (CU) traits are at risk for long-term, persistent psychosocial problems. The current study aimed to explore the characteristics of CU in preschool children with Attention Deficit Hyperactivity Disorder (ADHD) and the diagnostic significance of CU traits in ADHD.

Method: A total of 227 preschool children (89 with ADHD, 51 with Autism Spectrum Disorder [ASD], and 87 Typically Developing Children [TDC]) aged 4-5 years old were recruited. The participants were diagnosed using the Diagnostic Infant and Preschool Assessment (DIPA), and assessed using the Swanson, Nolan, and Pelham Rating Scale-IV, The Inventory of Callous-Unemotional Traits (ICU), the Behavior Rating Scale of Executive Function-Preschool Version (BRIEF-P), and the parent-rated Strengths and Difficulties Questionnaire (SDQ).

Results: The results showed that there was a significant difference between ICU subscale scores and total scores among the ADHD, ASD, and TDC groups ($F=59.87, P < 0.001$); with the ASD groups scoring the highest (37.16 ± 10.19) and the TDC scoring the lowest (20.39 ± 7.40). The callousness scores in the ADHD+ODD group showed the highest level of significance, and the ADHD only group was significantly higher than the TDC ($F=20.42, P < 0.001$). The ICU subscales showed low to moderate positive correlations with the SDQ subscales ($\gamma = 0.21 \sim 0.68, P < 0.01$) except the unemotional subscale. The ICU subscales were also negatively associated with the prosocial behaviour subscale ($\gamma = -0.45 \sim -0.68, P < 0.05$). The total ICU score was moderately and positively related to the BRIEF-P subscales ($\gamma = 0.47 \sim 0.67, P < 0.01$).

1 The CU traits were also used to predict oppositional defiant symptoms ($\beta = 0.32$, $R^2 =$
2 0.11, $P < 0.001$). The callousness and uncaring subscale scores and the total ICU score
3 were significantly correlated with ADHD symptoms and explained a significant
4 proportion of the variance (15-24%).

5 **Conclusions:** The current study indicated that having high CU scores was associated
6 with increased odds of having ADHD. Screening for CU traits could be used to
7 predict ADHD diagnosis in preschool children.

8 **Key words:** callous-unemotional traits; Attention-Deficit/Hyperactivity Disorder;
9 conduct problems; Chinese preschool children

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1. Introduction

Callous-unemotional (CU) traits refer to low levels of guilt, empathy, and caring for others and is considered to be an early life developmental precursor to later adulthood psychopathy [1]. It is well-documented that CU traits can increase the risk of antisocial behaviour and other psychopathy, such as Conduct Disorder (CD) (Barry et al., 2000; Frick et al., 2003a; Frick et al., 2014; Frick and White, 2008; Tye et al., 2017). Cleckley, (1976) considered CU traits to be part of the conceptualization of psychopathy and as a personality disorder. CU traits are early-emerging characteristics that may be a risk factor for later externalized psychopathology. An increasing number of studies on CU traits have focused on late childhood and adolescences (Colins and Andershed, 2015; Fanti, 2013; Fanti et al., 2017b; Fanti et al., 2013), with little attention paid to early childhood, especially preschool years where early interventions can be more effective (Klingzell et al., 2016). Research has indicated that without intervention people with CU traits will have poor outcomes throughout their life course (Herpers et al., 2012; 2018).

Attention-Deficit/Hyperactivity Disorder (ADHD) is defined as one of the most common psychiatric disorders, affecting approximately 5% of children and adolescents around the world (Polanczyk et al., 2007). Oppositional Defiant Disorder (ODD) and CD frequently occur in comorbidity with ADHD (Bendiksen et al., 2017), with a prevalence of 20% among preschool children (Association, 2013). In addition, there is a consensus that aggressive and disruptive behaviour, CD, and criminal and antisocial behaviour are particularly prevalent in children with ADHD (Stadler et al.,

2011). This suggests that the pathological mechanism of ODD/CD is highly correlated with ADHD. A growing number of studies in this area have found that adolescents who have CD with co-occurring CU traits display elevated levels of emotional and behavioural dysregulation(Frick et al., 2003b). CU traits are one of the common psychopathic traits in children with ADHD and ODD/CD. However, research on CU traits in early childhood is scarce(Colins et al., 2014; Willoughby et al., 2011).

The measurement of psychopathy has high clinical value in evaluating whether a child is normal, has ADHD, or has ADHD + ODD/CD. Children with CU traits tend to have more severe and persistent behavioural problems and higher levels of aggression. CU traits have shown a certain stability from early childhood to adolescence (Frick et al., 2014; Obradović et al., 2007), and they have predictive value for the occurrence of Conduct Problems (CPs) and emotional problems, as well as predicting juvenile delinquency (Moran et al., 2009). CU traits can appear very early in childhood (Kimonis et al., 2004) and are regarded as a sign of the severity of CPs in early life (Longman et al., 2016). Although there is some debate about the pathogenesis of CD and ODD, CU traits are always recognized in preschool children with ODD (Ezpeleta et al., 2015). Using the Antisocial Process Screening Device (APSD), the results of our previous study showed that both the CU trait scores and occurrences in Chinese school children with ADHD, ODD/CD, and ADHD+ODD/CD were significantly higher when compared to those children in the typical development control group (Zhang et al., 2014).

We propose that CU traits are an important internal factor in the development of

1 ADHD and ODD/CD in childhood. Due to the early presence of ADHD and the high
2 co-morbidity of ODD/CD, CU traits should be considered one of the dimensions
3 when evaluating preschool children with ADHD. Children with ADHD often exhibit
4 external and internal behavioural problems, CPs, and executive function deficits.
5 Empirical data support these notions, as children who experience higher levels of CU
6 traits increase their CPs over time and are more likely to develop ODD or CD
7 (Herpers et al., 2016). Thus, it is necessary to assess characteristics of CU in early life
8 using reliable and valid measures (Dadds et al., 2005) as an indicator for non-drug
9 interventions in early childhood. Although the comorbidity of ADHD with ODD/CD is
10 high and common amongst ODD children with high CU, it is not clear, especially in
11 preschool children, about the relationship between solely ADHD symptoms
12 (inattention and hyperactive-impulsive) and CU traits or to what extent the CU traits
13 add the risk of ODD in ADHD children. This study therefore begins to explore the
14 correlations between CU traits, ADHD symptoms, behavioural problems, and
15 executive function.

16 In sum, the aims of the present study are, (1) To determine whether CU traits can
17 be used to discriminate children with ADHD from children with Autism Spectrum
18 Disorder (ASD) and Typically Developing Children (TDC); (2) To identify any
19 differences in the characteristics of CU traits between ADHD and ADHD+ODD; (3)
20 To examine the reciprocal association between CU traits, symptoms of ADHD, CPs,
21 and executive function in preschool children. We hypothesized that preschool children
22 with ADHD would have higher levels of CU traits than the typical development

controls, and we expected ICU to achieve incremental validity in the prediction of cross-sectional ADHD after adjusting for covariates.

2. Methods

Participants

A total of 89 participants with ADHD, 51 participants with ASD, and 87 TDCs were included in this study. The clinical interviews and diagnoses were made by psychiatrists based on the DSM-5 criteria (Association, 2013). All children met the following inclusion criteria: (1) the child's age range was in the preschool stage from 4 to 5 years and 11 months; (2) the children in ADHD group and TDC group had a full intelligence quotient (FIQ) measured by the Wechsler Primary and Preschool Scale of Intelligence (WPPSI) of ≥ 80 ; (3) both the child and his or her parents volunteered to take part in the study; and (4) the child had taken no medication(s) or underwent other behavioural interventions at least one week before the tests. Children were excluded from the study if they suffered other severe psychiatric disorders, such as anxiety disorders and mood disorders, or physical health problem, such as epilepsy and traumatic brain injury, that might interfere with the assessment and results.

The current study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Xinhua Hospital affiliated with Shanghai Jiao Tong University (approval number: XHEC-C-2014-082). Parental written informed consent, child assent, and school agreement was obtained before children could participate in the study. All preschool participants' parents and the school provided written informed consent and the children provided verbal assent.

1 Similarly a written information sheet was provided to parents and the school and
2 verbal information using language that 4-5 year olds could understand was provided
3 to the children before consent was obtained.

4 The three groups, ADHD, ASD, and TDC participated in the study from October
5 2016 to May 2018 and had different approaches to recruitment. With the ADHD
6 group the participating preschool children and their parents were recruited from the
7 outpatient clinic in the Department of Clinical Psychology, Xinhua Hospital affiliated
8 with Shanghai Jiao Tong University. Children included in the ADHD group met the
9 criteria for ADHD based on both the DIPA interview and clinical diagnosis with the
10 DSM-5. For the ASD group, fifty-one children from special education schools in
11 Shanghai were included in this group. These children had been diagnosed with typical
12 ASD by an experienced senior child psychiatrist or paediatrician who speacialized in
13 developmental behaviour. The TDC group consisted of 87 healthy control children
14 within the same age range. They were recruited from two kindergartens in the urban
15 areas of Shanghai. The children in this group were excluded if they met the diagnostic
16 criteria for ADHD or other psychiatric disorders.

17 *Measurements*

18 *Diagnostic interview*

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22 *Diagnostic Infant and Preschool Assessment (DIPA)*. The DIPA (version 2/28/14)
23 was developed by Scheeringa in 2004 and updated inthe DSM-5 in 2014(Scheeringa
24 and Haslett, 2010). The DIPA is a semi-structured instrument has been adapted for13

1 psychiatric disorders, one of them being ADHD. The DIPA also assesses psychiatric
2 symptoms, including frequency, intensity, age of onset, and presence in different
3 settings as relevant for preschool children. It is intended as an interview for caregivers
4 of children 6 years and younger. The parents in this study were interviewed using the
5 Diagnostic Infant and Preschool Assessment (DIPA). The DIPA interviews were
6 performed by early career psychiatrists or trained postgraduate students specializing
7 in children's mental health under the supervision of an experienced child psychiatrist.
8 The DIPA assesses three subtypes of ADHD: predominantly inattentive (ADHD-I,
9 $n=9$), predominantly hyperactive/impulsive (ADHD-HI, $n=16$), and combined
10 (ADHD-C, $n=64$). According to the DSM-5 diagnostic criteria (Association, 2013), a
11 diagnosis of ADHD requires for Criterion A that at least six out of nine inattentive
12 symptoms (ADHD-I), or six out of nine hyperactive-impulsive symptoms (ADHD-HI)
13 be met. If both subtypes are present, the criteria for the combined subtype (ADHD-C)
14 are met. In addition, symptoms must be maladaptive and inconsistent with
15 developmental level as well as cause impairment. The DSM-5 diagnostic criteria for
16 ODD requires four or more, out of eight, oppositional symptoms.

17

18 *Rating scales*

19

20 *Swanson, Nolan, and Pelham Rating Scale-IV (SNAP-IV)* (Bussing et al.,
21 2008) was used to measure the severity of ADHD symptoms according to inattention
22 symptoms, hyperactive/impulsive symptoms, and oppositional defiant symptoms.
23 The total score is summed from the three subscale, the higher the score, the more
24 severe the symptoms. The relatively good reliability and validity of the SNAP-IV in

Chinese preschool children is well accepted and was reported in our previous study (Zhang et al., 2016).

Inventory of Callous-Unemotional Traits (ICU) (Frick, 2004) includes 24 items, and each item is answered on a 4-point Likert scale from 0 (not at all true) to 3 (definitely true), for a total score of 0-72. The inventory assesses CU traits using the parent report version. The ICU has three subscales: Callousness (10 items), Uncaring (9 items), and Unemotional (5 items) and a total score is calculated. Ezpeleta and colleagues' study (2013) showed that the ICU is a promising questionnaire to identify CU traits early in the preschool years.

Behavior Rating Scale of Executive Function-Preschool Version (BRIEF-P) (Gioia et al., 1996) parent form is a 63 item questionnaire for parents to assess the components of executive function in preschool children aged 2 to 5 years. Each item is rated as 1 (never), 2 (sometimes), or 3 (often). The measure includes five empirically derived clinical scales: inhibition, shifting, working memory, emotional control, and planning/organization. These subscales were developed to form three broader indices; the Flexibility Index (FI), the Inhibitory Self-Control Index, and the Emergent Metacognition Index (EMI), and a composite score, the Global Executive Composite (GEC). The higher the score is, the lower the executive function. The BRIEF-P has been shown to have adequate concurrent and discriminant validity and high reliability in Chinese children (Zhang et al., 2018).

The parent-rated *Strengths and Difficulties Questionnaire (SDQ)* (Goodman et al., 2000) was used to measure psychiatric symptoms in children four to seventeen years

old. The SDQ comprises three psychiatric subscales, namely, hyperactivity, conduct and emotional problems, along with additional subscales of peer-relationship problems and prosocial behaviour. The scores for emotional symptoms, CPs, hyperactivity, and peer problems contribute to the total difficulties score. The higher the score is, the higher the difficulty is; except for the prosocial behaviour subscale. The SDQ Chinese version has been widely used in Chinese children (Kou and Du, 2005).

Study Procedure

The medical histories of the TDC children were briefly reported by their teachers and parents to exclude children with obvious medical and developmental problems. The children in the case groups and their parents were interviewed in the clinic, and primary diagnoses were made by psychiatrists according to a comprehensive medical history evaluation and psychiatric examination. Informed consent/assent was obtained before conducting any of the assessments. Parents completed questionnaires and participated in DIPA interviews. The final diagnosis was made according to the DSM-5.

Statistical analyses

The data was analysed using SPSS Statistics version 22 (IBM; Armonk, New York, USA) and EpiData3.1 (The EpiData Association, Odense, Denmark). The continuous variables were described using the mean \pm standard deviation (SD). Post hoc multiple comparisons were used to compare the significant differences among the ADHD group, ASD group, and TDC groups. After controlling for covariates, child's age, and

1 child's sex, the significant difference in means were compared among groups using
2 multivariate analysis of covariance (MANCOVA). We examined sex distribution and
3 sexsignificant differences for theADHD only and the ADHD and comorbid ODD
4 (ADHD+ODD) groups. Statistical differences in thevariables were examined by
5 independent-sample *t* tests for continuous variables and Pearson's chi-square tests for
6 categorical measures. We calculated the odds ratios (ORs) of children with ADHD
7 diagnoses also having CU traitsusingbinary logistic regression and adjusted for
8 possible covariates by child's sex, age, and oppositional defiant symptoms. Before
9 that, possible covariates were selected based on the previous studies and a correlation
10 analysis was conducted. To explore the association between CU traits and ADHD
11 symptoms, we constructed multivariable linear regression models in which the ADHD
12 symptom scores were taken as continuous variables. Furthermore, to explore the
13 associations between diagnoses and the presence of CU traits logistic regression
14 analyses were performed entering the diagnosis as the dependent dichotomous
15 variable and ICU scores as the independent continuous variable. Finally, the
16 specificity and sensitivity analyses of the ICU wereperformed using a receiver
17 operating characteristic (ROC) curve. Non-parametric estimates of the area under the
18 curve (AUC) from the ROC curve analyses quantified the diagnostic efficiency of the
19 ICU scale scores. All tests were two-tailed.

20

21 **3. Results**

22

23 *Comparisons of Age and Sex among the ADHD, ASD and TDC Groups*

24

25 A total of 227 four- to five-year-old preschool children (89 with ADHD, 51 with

1 ASD, and 87 TDCs) were enrolled in this study. There were no significant differences
 2 in age and gender among the three groups($P>0.05$), as shown in Table 1.

3 **Table 1**

Comparisons of Age and Sex among the ADHD, ASD and TDC Groups

| | ADHD (<i>n</i> =89) | ASD (<i>n</i> =51) | TDC (<i>n</i> =87) | F/χ^2 | <i>p</i> |
|-----------------------------|-------------------------|------------------------|------------------------|------------|----------|
| Age (months, mean \pm SD) | 56.88 \pm 7.96 | 55.16 \pm 11.40 | 55.16 \pm 7.29 | 0.10 | 0.906 |
| Sex(male/female) | 77/12 | 45/6 | 67/19 | 3.39 | 0.184 |

4 SD: standard deviation; ADHD: attention-deficit/hyperactivity disorder; ASD: autism spectrum
 5 disorder; TDC: typically developing child

6
 7 *Comparisons of CU Traits among the ADHD, ASD and TDC Groups*

8
 9 Table 2 shows the differences in the ICU subscale scores between the ADHD,
 10 ASD, and TDC groups. Post-hoc tests with analysis of variance (ANOVA) was used to
 11 compare the differences among groups. The results showed that the callousness
 12 scores($P < 0.001$), uncaring scores($P < 0.001$), and ICU total scores($P < 0.001$) were
 13 higher in the ASD group than in the other two groups. They were also higher in the
 14 ADHD group than in the TDC group.

15 **Table 2**

Comparisons of CU traits among the ADHD, ASD and TDC groups (mean \pm SD)

| | ADHD ^a (<i>n</i> =89) | ASD ^b (<i>n</i> =51) | TDC ^c (<i>n</i> =85) | <i>F</i> | Posthoc test |
|-------------|--------------------------------------|-------------------------------------|-------------------------------------|----------|--------------|
| Callousness | 9.49 \pm 5.20 | 12.08 \pm 6.46 | 5.45 \pm 3.58 | 30.24*** | b>a>c |
| Uncaring | 16.24 \pm 3.93 | 17.82 \pm 5.04 | 10.79 \pm 4.07 | 54.58*** | b>a>c |

| | | | | | |
|-----------------|------------|-------------|------------|----------|-------|
| Unemotional | 4.58±2.43 | 7.26±1.79 | 4.23±2.33 | 31.19*** | b>a=c |
| Total ICU score | 30.21±9.35 | 37.16±10.19 | 20.39±7.40 | 59.87*** | b>a>c |

1 *** $P < 0.001$

2 CU: callous-unemotional; ADHD: attention-deficit/hyperactivity disorder; ASD: autism spectrum
3 disorder; TDC: typically developing child; ICU: Inventory of Callous-Emotional Traits

4 Of the 89 children with ADHD, 10.1% ($n = 9$) met the criteria for ADHD-I, 18.0%
5 ($n = 16$) met the criteria for ADHD-HI, and 71.9% ($n = 64$) met the criteria for
6 ADHD-C. The preschool children with comorbid ADHD and ODD accounted for 38.2%
7 of the total with ADHD. There were no sex differences in the numbers of children
8 with inattentive, hyperactive/impulsive, and combined symptoms ($\chi^2 = 1.32$, $P = 0.52$)
9 and differences were not found in children with ADHD only and co-occurring
10 ADHD+ODD ($\chi^2 = 0.02$, $P = 0.89$).

11 The comparison results of the ICU subscale scores among the ADHD,
12 ADHD+ODD, and TDC groups analysed by one-way ANOVA and post hoc tests are
13 presented in Table 3. The callousness scores in the ADHD+ODD group were
14 significantly higher than those in the ADHD group ($P < 0.001$) and were statistically
15 significant after controlling for child's age and sex. However, there were no
16 significant differences between children with ADHD+ODD and children with ADHD
17 only in the uncaring and unemotional scores or for the total ICU score among ADHD
18 subtypes.

Table 3

Comparison of CU traits between the ADHD only, ADHD+ODD and TDC groups (mean \pm SD)

| Subscales | ADHD only ^a | ADHD+ODD ^b | TDC ^c | <i>F</i> | Post hoc test |
|-----------|------------------------|-----------------------|------------------|----------|---------------|
| | ($n = 55$) | ($n = 34$) | ($n = 87$) | | |

| | | | | | |
|-------------|--------------|--------------|--------------|----------|-----------|
| Callousness | 8.67 ± 5.29 | 10.82 ± 4.83 | 5.45 ± 3.58 | 20.42*** | b > a > c |
| Uncaring | 15.87 ± 4.03 | 16.82 ± 3.75 | 10.79 ± 4.07 | 40.60*** | a= b > c |
| Unemotional | 4.83 ± 2.45 | 4.18 ± 2.39 | 4.23 ± 2.34 | 1.27 | ns |
| TotalICU | 29.70 ± 10.4 | 32.04 ± 8.30 | 21.39 ± 7.40 | 30.12*** | a= b > c |

*** $P < 0.001$

CU: callous-unemotional; ADHD: attention-deficit/hyperactivity disorder; ODD: oppositional defiant disorder; ADHD + ODD: ADHD and comorbid ODD; TDC: typically developing child; ICU: Inventory of Callous-Emotional Traits

Correlations of CU Traits with Behavioural Problems and Executive Function

As shown in Table 4, Pearson's correlation analyses showed that there was a significant correlation between the ICU subscales (except the unemotional subscale), behavioural problems, and executive function. The original ICU subscales (except the unemotional subscale) showed low to moderate positive correlations with the SDQ subscales ($\gamma = 0.21 \sim 0.68$, $P < 0.01$), while the ICU subscales were negatively associated with the prosocial behaviour subscale ($\gamma = -0.45 \sim -0.68$, $P < 0.05$). In the correlation of the ICU with the BRIEF-P, the unemotional subscale ($\gamma = 0.23 \sim 0.32$, $P < 0.01$) showed alow positive correlations with the BRIEF-P subscales, and the other ICU ($\gamma = 0.41 \sim 0.68$, $P < 0.01$) subscales were moderately positively related to the BRIEF-P subscales.

Table 4

Pearson's Correlations Coefficients Between the ICU Subscalesand Behavioural Problems and Executive Function

| Subscales | Callousness | Uncaring | Unemotional | Total ICU |
|--------------------|-------------|----------|-------------|-----------|
| SDQ | | | | |
| Emotional symptoms | 0.25** | 0.24** | 0.21** | 0.29** |

| | | | | |
|----------------------|---------|---------|--------|---------|
| Conduct problems | 0.33** | 0.42** | 0.06 | 0.38** |
| Hyperactivity | 0.47** | 0.58** | 0.10 | 0.54** |
| Peer problems | 0.52** | 0.50** | 0.45** | 0.61** |
| Total difficulties | 0.59** | 0.65** | 0.30** | 0.68** |
| Prosocial behaviours | -0.51** | -0.69** | -0.45* | -0.68** |
| BRIEF-P | | | | |
| Inhibition | 0.54** | 0.68** | 0.25** | 0.66** |
| Shift | 0.41** | 0.41** | 0.32** | 0.49** |
| Emotional control | 0.40** | 0.44** | 0.23** | 0.47** |
| Working memory | 0.53** | 0.60** | 0.27** | 0.63** |
| Plan/organize | 0.49** | 0.51** | 0.23** | 0.55** |
| ISC | 0.53** | 0.64** | 0.26** | 0.64** |
| FI | 0.45** | 0.47** | 0.30** | 0.53** |
| EMI | 0.54** | 0.59** | 0.27** | 0.63** |
| GEC | 0.56** | 0.64** | 0.30** | 0.67** |

* $P < 0.05$, ** $P < 0.01$

ICU: Inventory of Callous-Unemotional Traits;SDQ: Strengths and Difficulties Questionnaire; BRIEF-P: BehaviorRatingScale of Executive Function-Preschool Version; ISC: Inhibition Self-control Index; FI: Flexibility Index; EMI: Emergent Metacognition Index; GER: Global Executive Composite.

Correlation of CU Traits with the Symptoms of ADHD

As shown in Table 5, the ICU callousness and uncaring subscales had low to modest correlations with ADHD symptoms and oppositional defiant symptoms ($\gamma = 0.31 \sim 0.58$, $P < 0.01$). Linear regressions were performed to assess the likelihood of CU traits to predict oppositional defiant and ADHD symptoms. In the linear regressions, the correlations were all significant, with attention symptoms having higher beta values ($\beta = 0.55$, $R^2 = 0.20$, $P < 0.001$) than hyperactivity symptoms ($\beta =$

0.39, $R^2 = 0.15$, $P < 0.001$). The CU traits were also used to predict oppositional defiant symptoms ($\beta = 0.32$, $R^2 = 0.11$, $P < 0.001$). The callousness and uncaring subscale scores and the total ICU score were significantly correlated with ADHD symptoms and explained a significant proportion (15-24%) of the variance, as shown in Table 6.

Table 5

Pearson's Correlations Between CU Traits (subscale scores and total CU scores) and ADHD Symptoms (subscale scores and total scores)

| Subscale | Callousness | Uncaring | Unemotional | Total ICU |
|----------------------|-------------|----------|-------------|-----------|
| Inattention | 0.40** | 0.54** | -0.05 | 0.47** |
| Hyperactivity | 0.32** | 0.54** | -0.09 | 0.42** |
| Oppositional defiant | 0.31** | 0.44** | -0.12 | 0.34** |
| Total ADHD symptoms | 0.39** | 0.58** | -0.07 | 0.48** |

** $P < 0.01$

ICU: Inventory of Callous-Unemotional Traits; ADHD: attention-deficit/hyperactivity disorder

Table 6

Linear Regression Analysis for the Effect of CU Traits on the Symptoms of ADHD

| Variable | β | R^2 | t | p |
|----------------------|---------|-------|-------|--------|
| Attention | 0.55 | 0.20 | 8.704 | <0.001 |
| Hyperactivity | 0.39 | 0.15 | 5.224 | <0.001 |
| Oppositional defiant | 0.32 | 0.11 | 4.264 | <0.001 |
| Total ADHD symptoms | 0.49 | 0.24 | 7.023 | <0.001 |

β = standardized regression coefficient; R^2 = determination coefficient; CU: callous-unemotional traits; ADHD: attention-deficit/hyperactivity disorder

Covariates

1 Taking age, sex, CPs, and oppositional defiant symptoms as independent variables
2 and CU traits and ADHD symptoms as dependent variables, the results of the single
3 linear regression modelsshowed that sex, CPs and oppositional defiant symptoms
4 were significantly related to CU traits($\beta = -0.16, 0.50, 0.34$, respectively, $P < 0.05$)and
5 ADHD symptoms ($\beta = -0.22, 0.34, 0.65$,respectively, $P < 0.01$) , as shown in Table 7.
6 The covariates included child sex, CPs and oppositional defiant symptoms due to their
7 correlations with CU traits and ADHD symptoms.

Table 7

Identification of potential covariates

| Variable | TotalICUtotalscore | | TotalADHD symptoms | |
|----------|--------------------|------|--------------------|------|
| | β | p | β | p |
| Age | 0.06 | 0.47 | -0.05 | 0.54 |
| Sex | -0.16 | 0.04 | -0.22 | 0.00 |
| CPs | 0.50 | 0.00 | 0.34 | 0.00 |
| OD | 0.34 | 0.00 | 0.65 | 0.00 |

9 β = standardized regression coefficient;ICU: Inventory of Callous-Unemotional Traits; ADHD:
10 attention-deficit/hyperactivity disorder; CPs: conduct problems; OD: oppositional defiant

12 *Incremental validity of the ICU scale for predicting ADHD symptoms and diagnosis of* 13 *ADHD*

15 Multiple linear regression analysis and binary logistic regression analysis were
16 performed to assess the incremental validity of the ICU, as shown in Table 8. Logistic
17 regression was used to model the binary outcome of ADHD. The results indicated that
18 CU traits (OR = 1.13, 95%CI = 1.13 ~ 1.42, $P < 0.05$)significantly predicted an
19 increased risk for ADHD diagnosis after controlling for the oppositional defiant
20 covariate. Sex($\beta= -0.13$, $P < 0.05$), oppositional defiant symptoms($\beta= 0.55$, $P <$
21 0.001), and CU traits ($\beta= 0.27$, $P < 0.001$)predicted the presence of ADHD

1 symptoms. When the influence of sex and oppositional defiant symptoms were
 2 controlled, the analysis results showed that ICU could be used to explain 13% of the
 3 incremental validity in ADHD diagnoses and 6% in ADHD symptoms.

Table 8

Incremental validity of the ICU Scale for predicting ADHD symptoms and diagnosis of ADHD

| | ADHD symptoms | | ADHD diagnosis | |
|--------------|---------------|-------|--------------------|------|
| | β | p | OR (95% CI) | p |
| Model 1 | | | | |
| Sex | -0.16 | 0.005 | 0.74 (0.29 ~ 1.87) | 0.52 |
| OD | 0.64 | 0.00 | 1.32 (1.19 ~ 1.47) | 0.00 |
| RI^2 | 0.45 | | 0.22 | |
| Model 2 | | | | |
| Sex | -0.13 | 0.02 | 0.89 (0.32 ~ 2.52) | 0.83 |
| OD | 0.55 | 0.00 | 1.27 (1.13 ~ 1.42) | 0.00 |
| CU | 0.27 | 0.00 | 1.13 (1.07 ~ 1.18) | 0.00 |
| $R2^2$ | 0.51 | | 0.35 | |
| ΔR^2 | 0.06 | | 0.13 | |

4 β = standardized regression coefficient; CI= confidence interval; OR = odds ratio; OD:
 5 oppositional defiant; CU: Callous-unemotional; ADHD: attention-deficit/hyperactivity disorder

6 The standardized regression coefficients (β) were calculated by converting all predictors and
 7 outcomes to z-scores before the analysis.

8 Model 1 predictive variable: sex, OD

9 Model 2 predictive variable: sex, OD, CU

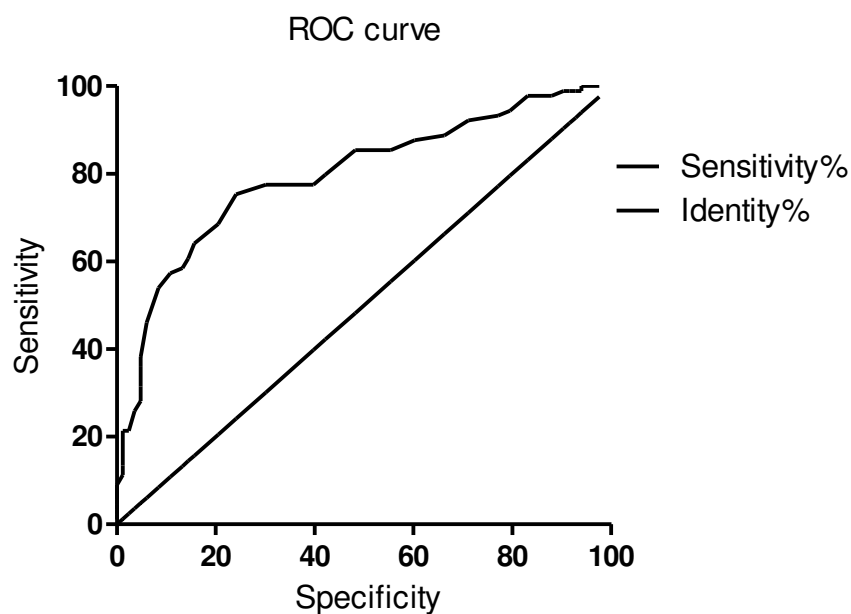
10

11 *Specificity and sensitivity of the ICU scale*

12

13 The ROC was calculated to analyse the specificity and sensitivity of the ICU scale
 14 in the diagnosis of ADHD, and to differentiate the ADHD group from the TDC group.

1 According to the ROC curve like that shown in Figure 1, the tangent point with the
 2 largest Youden index nearest to the upper left, was selected as the best critical point;
 3 that is, when the ICU total score was 24.5, the sensitivity of the diagnosis of ADHD
 4 was 0.753, and the specificity was 0.759 (AUC = 0.795, 95% CI = 0.67 ~ 0.84, $P <$
 5 0.001).



6
 7 **Fig. 1.** ROC curve of the ICU questionnaire
 8 ACU: area under the curve; CI: confidence interval

10 **4. Discussion**

12 This study included a large clinic-based sample of 227 preschool children (89 with
 13 ADHD, 51 with ASD, and 87 TDC). The results of the research confirmed that the
 14 ICU subscales had discriminationability among the three groups. We found that
 15 children with ASD had the highest levels of CU traits among the threegroups.
 16 Compared with TDC, children with ADHD had higher ICU subscale scores; except
 17 for unemotional subscalescores. The current findings are in line with those of previous
 18 studies, such as that of Brammer and Lee(2012), which suggests that children with

1 ADHD had a high level of CU traits. Previous findings have also revealed that
2 children with ASD display elevated aggressive and antisocial behaviour(Bauminger et
3 al., 2010). A longitudinal study of children with ADHD demonstrated that
4 approximately 21% developed antisocial personality disorder (ASPD) in
5 adulthood(Fischer et al., 2002; Lahey et al., 2005; Loeber et al., 2002; Mannuzza et al.,
6 1993; Storebø and Simonsen, 2016). At present, most studies have indicated that CU
7 traits are related to social cognitive deficits observed in ASD(Jones et al., 2010;
8 Lockwood et al., 2013; O'Nions et al., 2014; Schwenck et al., 2012; Wallace et al.,
9 2012).The findings suggest that CU traits provide relative cognitive strength in
10 conflict monitoring in ASD.

11 In contrast to the previous study, a new and important finding from this study is
12 that children with ADHD and ASD both had high levels of CU traits. In addition, due
13 to abnormal brain development, children with ASD were much more callous, uncaring,
14 and unemotional than children with ADHD. Based on a symptom assessment, CU
15 traits can help distinguish children with ADHD from children with ASD and TCD.

16 Detecting differences in CU traits in children with ADHD is particularly important
17 to identify possible populations with co-occurring ODD. In this study the comorbidity
18 of ADHD with ODD was consistent with previous studies, demonstrating that high
19 scores for CU characteristics increase the odds of ODD(Herpers et al., 2016).
20 Furthermore, the current study indicated that children with a co-comorbidity of
21 ADHD+ODD present much higher callousness symptoms than children with ADHD
22 only, however, the difference was not enough to clearly discriminate children with

1 ADHD and ADHD+ODD in this study. The children in this study may have been too
2 young to fully present CU traits and ODD symptoms.

3 Our results further revealed that higher levels of CU traits were related to lower
4 levels of prosocial behaviours, such as less consideration of others, sharing with
5 others, and providing help to people in difficulty. Meanwhile, children with high
6 levels of CU traits had more difficulties with behavioural problems including
7 emotional problems, CPs, peer problems, and hyperactivity problems. This finding
8 supports previous evidence indicating that CU traits are correlated with the severity of
9 behavioural disturbances (Blader et al., 2013). Children with high levels of CU traits
10 tend to exhibit high and persistent levels of CPs, inattention and hyperactivity
11 symptoms, impulsivity, and narcissism(Fanti et al., 2017a).Mounting evidence has
12 demonstrated that CPs early in life are associated with a CU personality(Edens et al.,
13 2001; Frick and Marsee, 2006; Kotler and McMahon, 2005) and a high risk for
14 psychosocial problems(Frick et al., 2003a; Kim-Cohen et al., 2003; Rutter et al.,
15 2006). Peer problems usually present as bullying. Previous research has shown that
16 CU traits are viewed as a risk factor for bullying victimization in preschool
17 children(O'Brien, 2012) and that bullying is related to peer difficulties(Kimonis et al.,
18 2004). Based on the above findings, we might conclude that children with ADHD,
19 especially ADHD+ODD,have higher levels of CU traits during the preschool period.
20 The co-occurrence of ADHD and high levels of CU traits might be the main reasons
21 and indicators of having ahigh risk of developing CPs, which are more likely to
22 develop into antisocial personality.

1 Our research also confirmed that CU traits were significantly correlated with
2 executive function. These findings are supported by previous studies, which suggest
3 that executive functioning deficits in children with ADHD are conditional upon the
4 level of CU traits, as well as high levels of CU traits being associated with an altered
5 neurophysiological profile among children with ASD (Tye et al., 2017). However,
6 studies concerning the relationship between executive function and CU traits are still
7 scarce (O'Brien, 2012). Across follow-up studies, CU traits have predicted behavioural
8 problems presented in late childhood and adolescence (Frick et al., 2014). Therefore,
9 more longitudinal studies on CU traits, in early childhood, with later behavioural
10 disorders, need to be carried out in the future.

11 The results of the current study demonstrate that the ICU could be used in
12 preschool children to identify the level of CU traits. CU traits are associated with
13 ADHD symptoms, and the influence of the total ICU scores on ADHD symptoms was
14 present in 15-24% of children. High levels of CU traits emerged as a strong predictor
15 for the risk of ADHD in young children when controlling for other possible
16 covariates. The incremental predictive utility of CU traits showed that the ICU could be
17 used to explain 13% of the variance in ADHD diagnosis and 6% of the variance in
18 ADHD symptoms.

19 Although this research revealed that CU traits are a risk factor for ADHD, their effects
20 were relatively weak.

21 There are still some limitations with this study. Other cross-sectional and
22 longitudinal studies with large samples of preschool children have suggested that

1 when sex, temperament, executive function and other covariates are controlled,
2 preschool children's CU traits are effective in predicting the occurrence of CD and
3 ODD(Ezpeleta et al., 2013). However, due to the low prevalence rate of ODD/CD and
4 the co-occurring rate of CD with ADHD in preschool children, this study did not
5 establish an ODD or CD group to explore the relationship between CU traits, CD, and
6 ODD in preschool children. Therefore, this study only used cross-sectional methods
7 and conducted analyses to explore the effects of CU traits on ADHD symptoms.
8 Based on the findings, it is necessary to follow up and explore the trajectories of CU
9 trait development in children with ADHD from preschool to school-age, and up to
10 adulthood. In future research, different methodologies and analyses could be used to
11 explore developmental heterogeneity in CU traits and the association of these traits
12 with possible protective factors and risk variables.

13

14 *Conclusion*

15 There is growing interest in investigating CU traits in ADHD children. This study
16 was the first to measure the characteristics of CU in a clinical sample of Chinese
17 preschool children who had ADHD comorbid with ODD. Furthermore, previous
18 studies of children with ADHD have not measured the correlations between CU traits,
19 behavioural problems, executive function, and the effect of CU traits on the symptoms
20 and diagnosis of ADHD. The incremental validity of the ICU was measured to
21 investigate whether the use of the ICU scale was associated with increasing diagnostic
22 efficacy of ADHD. Perhaps the most important insight from our study is that the
23 increase in ICU scores during early childhood tended to significantly predict the

1 likelihood of ADHD. These findings provide evidence for the importance of taking
2 ICU into account as an auxiliary diagnosis tool of ADHD. Identification of early CU
3 traits may help us better understand symptoms and behavioural problems in children
4 with ADHD. Furthermore, identifying preschool children who potentially have high
5 levels of CU traits is helpful to determine which children might be at risk of
6 developing ODD or CD. Early detection may help to implement timely intervention
7 strategies to prevent psychopathy and antisocial personality disorder developing.
8 However, it remains unclear whether high levels of CU traits predict the
9 aforementioned disorders as children with ADHD are more likely to develop ODD or
10 CD in the future.

11

12 **Declarations**

13

14 **Ethics approval and consent to participate**

15 The current study was conducted in accordance with the Declaration of Helsinki
16 and was approved by the Ethics Committee of Xinhua Hospital affiliated with
17 Shanghai Jiao Tong University (approval number: XHEC-C-2014-082).

18 Parental written informed consent, child assent, and school agreement was
19 obtained before children could participate in the study. All preschool participants'
20 parents and the school provided written informed consent and the children provided
21 verbal assent.

22 **Consent for publication**

23 All authors agree to publish the article.

24 **Availability of data and materials**

The datasets used and analysed during the current study available from the corresponding author on reasonable request.

Competing interests

The authors declared that there were no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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Authors' contributions

Jinsong Zhang conceived and designed experiments; Huifeng Zhang, Weiping Xia, Zhouye Wang and Meihui Qiu distributed the questionnaires together, and Huifeng Zhang input them; Wei Li and Lan Shuai analyzed experimental results. Jinsong Zhang and Wei Li and Yuanyuan Wang and Amanda Wilson participated in the analysis and discussion of experimental data. Both Jinsong Zhang and Wei Li contributed to the first version of the manuscript. All authors discussed the results and contributed to the final manuscript.

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Conflicts of interest

The authors declared that there were no potential conflicts of interest with respect to the research, authorship, and publication of this article.

References

Association, A.P., 2013. Diagnostic and statistical manual of mental disorders (DSM-5®). American Psychiatric Pub.

Barry, C.T., Frick, P.J., DeShazo, T.M., McCoy, M., Ellis, M., Loney, B.R., 2000. The importance of callous-unemotional traits for extending the concept of psychopathy to children. *Journal of abnormal psychology* 109 (2), 335.

Bauminger, N., Solomon, M., Rogers, S.J., 2010. Externalizing and internalizing behaviors in ASD. *Autism Research* 3 (3), 101-112.

Bendiksen, B., Svensson, E., Aase, H., Reichborn-Kjennerud, T., Friis, S., Myhre, A.M., Zeiner, P., 2017. Co-occurrence of ODD and CD in preschool children with symptoms of ADHD. *Journal of attention disorders* 21 (9), 741-752.

Blader, J.C., Pliszka, S.R., Kafantaris, V., Foley, C.A., Crowell, J.A., Carlson, G.A., Sauder, C.L., Margulies, D.M., Sinha, C., Sverd, J., 2013. Callous-unemotional traits, proactive aggression, and treatment outcomes of aggressive children with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry* 52 (12), 1281-1293.

Brammer, W.A., Lee, S.S., 2012. Impairment in children with and without ADHD: contributions from oppositional defiant disorder and callous-unemotional traits. *Journal of attention disorders* 16 (7), 535-543.

1 Bussing, R., Fernandez, M., Harwood, M., Hou, W., Garvan, C.W., Eyberg, S.M.,
2 Swanson, J.M., 2008. Parent and teacher SNAP-IV ratings of attention deficit
3 hyperactivity disorder symptoms: psychometric properties and normative
4 ratings from a school district sample. *Assessment* 15 (3), 317-328.

5 Caspi, A., Moffitt, T.E., Newman, D.L., Silva, P.A., 1996. Behavioral observations at
6 age 3 years predict adult psychiatric disorders: Longitudinal evidence from a
7 birth cohort. *Archives of general psychiatry* 53 (11), 1033-1039.

8 Cleckley, H., 1976. *The mask of sanity*, Mosby, St. Louis, Mo.

9 Colins, O.F., Andershed, H., 2015. The DSM-5 with limited prosocial emotions
10 specifier for conduct disorder among detained girls. *Law and human behavior*
11 39 (2), 198.

12 Colins, O.F., Andershed, H., Frogner, L., Lopez-Romero, L., Veen, V., Andershed,
13 A.-K., 2014. A new measure to assess psychopathic personality in children:
14 The Child Problematic Traits Inventory. *Journal of psychopathology and*
15 *behavioral assessment* 36 (1), 4-21.

16 Dadds, M.R., Fraser, J., Frost, A., Hawes, D.J., 2005. Disentangling the underlying
17 dimensions of psychopathy and conduct problems in childhood: a community
18 study. *Journal of consulting and clinical psychology* 73 (3), 400.

19 Edens, J.F., Skeem, J.L., Cruise, K.R., Cauffman, E., 2001. Assessment of “juvenile
20 psychopathy” and its association with violence: A critical review. *Behavioral*
21 *Sciences & the Law* 19 (1), 53-80.

22 Ezpeleta, L., Granero, R., De, I.O.N., Domènech, J.M., 2015. Clinical Characteristics

1 of Preschool Children with Oppositional Defiant Disorder and
2 Callous-Unemotional Traits. PloS one 10 (9), e0139346.

3 Ezpeleta, L., Osa, N.d.l., Granero, R., Penelo, E., Domènech, J.M., 2013. Inventory of
4 callous-unemotional traits in a community sample of preschoolers. Journal of
5 Clinical Child & Adolescent Psychology 42 (1), 91-105.

6 Fanti, K.A., 2013. Individual, social, and behavioral factors associated with
7 co-occurring conduct problems and callous-unemotional traits. Journal of
8 Abnormal Child Psychology 41 (5), 811-824.

9 Fanti, K.A., Colins, O.F., Andershed, H., Sikki, M., 2017a. Stability and change in
10 callous-unemotional traits: Longitudinal associations with potential individual
11 and contextual risk and protective factors. Am J Orthopsychiatry 87 (1), 62-75.

12 Fanti, K.A., Colins, O.F., Andershed, H., Sikki, M., 2017b. Stability and change in
13 callous-unemotional traits: Longitudinal associations with potential individual
14 and contextual risk and protective factors. American Journal of
15 Orthopsychiatry 87 (1), 62.

16 Fanti, K.A., Demetriou, C.A., Kimonis, E.R., 2013. Variants of callous-unemotional
17 conduct problems in a community sample of adolescents. Journal of Youth and
18 Adolescence 42 (7), 964-979.

19 Fischer, M., Barkley, R.A., Smallish, L., Fletcher, K., 2002. Young adult follow-up of
20 hyperactive children: self-reported psychiatric disorders, comorbidity, and the
21 role of childhood conduct problems and teen CD. Journal of Abnormal Child
22 Psychology 30 (5), 463-475.

- 1 Frick, P.J., 2004. The inventory of callous-unemotional traits. Unpublished rating
2 scale.
- 3 Frick, P.J., Cornell, A.H., Barry, C.T., Bodin, S.D., Dane, H.E., 2003a.
4 Callous-unemotional traits and conduct problems in the prediction of conduct
5 problem severity, aggression, and self-report of delinquency. *Journal of*
6 *Abnormal Child Psychology* 31 (4), 457-470.
- 7 Frick, P.J., Cornell, A.H., Bodin, S.D., Dane, H.E., Barry, C.T., Loney, B.R., 2003b.
8 Callous-unemotional traits and developmental pathways to severe conduct
9 problems. *Developmental psychology* 39 (2), 246.
- 10 Frick, P.J., Marsee, M.A., 2006. Psychopathy and developmental pathways to
11 antisocial behavior in youth. *Handbook of psychopathy*, 353-374.
- 12 Frick, P.J., Ray, J.V., Thornton, L.C., Kahn, R.E., 2014. Can callous-unemotional
13 traits enhance the understanding, diagnosis, and treatment of serious conduct
14 problems in children and adolescents? A comprehensive review. *Psychological*
15 *bulletin* 140 (1), 1.
- 16 Frick, P.J., White, S.F., 2008. Research review: The importance of callous-
17 unemotional traits for developmental models of aggressive and antisocial
18 behavior. *Journal of Child Psychology and Psychiatry* 49 (4), 359-375.
- 19 Gioia, G.A., Andrus, K., Isquith, P.K., 1996. Behavior rating inventory of executive
20 function-preschool version (BRIEF-P). *Psychological Assessment Resources*
21 Odessa, FL.
- 22 Goodman, R., Ford, T., Simmons, H., Gatward, R., Meltzer, H., 2000. Using the

1 Strengths and Difficulties Questionnaire (SDQ) to screen for child psychiatric
2 disorders in a community sample. *Br J Psychiatry* 177 (6), 534-539.

3 Herpers, P.C., Klip, H., Rommelse, N.N., Greven, C.U., Buitelaar, J.K., 2016.
4 Associations between high callous-unemotional traits and quality of life across
5 youths with non-conduct disorder diagnoses. *Eur Child Adolesc Psychiatry* 25
6 (5), 547-555.

7 Herpers, P.C., Rommelse, N.N., Bons, D.M., Buitelaar, J.K., Scheepers, F.E., 2012.
8 Callous–unemotional traits as a cross-disorders construct. *Social psychiatry*
9 and *psychiatric epidemiology* 47 (12), 2045-2064.

10 Jones, A.P., Happé, F.G., Gilbert, F., Burnett, S., Viding, E., 2010. Feeling, caring,
11 knowing: different types of empathy deficit in boys with psychopathic
12 tendencies and autism spectrum disorder. *Journal of Child Psychology and*
13 *Psychiatry* 51 (11), 1188-1197.

14 Kim-Cohen, J., Caspi, A., Moffitt, T.E., Harrington, H., Milne, B.J., Poulton, R., 2003.
15 Prior juvenile diagnoses in adults with mental disorder: developmental
16 follow-back of a prospective-longitudinal cohort. *Archives of general*
17 *psychiatry* 60 (7), 709-717.

18 Kimonis, E.R., Frick, P.J., Barry, C.T., 2004. Callous-unemotional traits and
19 delinquent peer affiliation. *Journal of consulting and clinical psychology* 72
20 (6), 956.

21 Klingzell, I., Fanti, K.A., Colins, O.F., Frogner, L., Andershed, A.-K., Andershed, H.,
22 2016. Early childhood trajectories of conduct problems and

- 1 callous-unemotional traits: The role of fearlessness and psychopathic
2 personality dimensions. *Child Psychiatry & Human Development* 47 (2),
3 236-247.
- 4 Kotler, J.S., McMahon, R.J., 2005. Child psychopathy: Theories, measurement, and
5 relations with the development and persistence of conduct problems. *Clinical*
6 *child and family psychology review* 8 (4), 291-325.
- 7 Kou, J., Du, Y., 2005. Reliability and validity of "children strengths and difficulties
8 questionnaire" in Shanghai norm. *Shanghai Archives of Psychiatry* 17 (1),
9 25-28.
- 10 Lahey, B.B., Loeber, R., Burke, J.D., Applegate, B., 2005. Predicting future antisocial
11 personality disorder in males from a clinical assessment in childhood. *Journal*
12 *of consulting and clinical psychology* 73 (3), 389.
- 13 Lockwood, P.L., Bird, G., Bridge, M., Viding, E., 2013. Dissecting empathy: high
14 levels of psychopathic and autistic traits are characterized by difficulties in
15 different social information processing domains. *Frontiers in human*
16 *neuroscience* 7, 760.
- 17 Loeber, R., Burke, J.D., Lahey, B.B., 2002. What are adolescent antecedents to
18 antisocial personality disorder? *Criminal Behaviour and Mental Health* 12 (1),
19 24-36.
- 20 Longman, T., Hawes, D.J., Kohlhoff, J., 2016. Callous-Unemotional Traits as Markers
21 for Conduct Problem Severity in Early Childhood: A Meta-analysis. *Child*
22 *Psychiatry & Human Development* 47 (2), 326-334.

- 1 Mannuzza, S., Klein, R.G., Bessler, A., Malloy, P., LaPadula, M., 1993. Adult
2 outcome of hyperactive boys: Educational achievement, occupational rank,
3 and psychiatric status. *Archives of general psychiatry* 50 (7), 565-576.
- 4 Moran, P., Rowe, R., Flach, C., Briskman, J., Ford, T., Maughan, B., Scott, S.,
5 Goodman, R., 2009. Predictive value of callous-unemotional traits in a large
6 community sample. *Journal of the American Academy of Child & Adolescent*
7 *Psychiatry* 48 (11), 1079-1084.
- 8 O'Brien, C., 2012. Examining the association between callous-unemotional traits,
9 bullying and victimization in preschoolers. University of Alabama Libraries.
- 10 O'Nions, E., Sebastian, C.L., McCrory, E., Chantiluke, K., Happe, F., Viding, E., 2014.
11 Neural bases of Theory of Mind in children with autism spectrum disorders
12 and children with conduct problems and callous-unemotional traits.
13 *Developmental science* 17 (5), 786-796.
- 14 Obradović, J., Pardini, D.A., Long, J.D., Loeber, R., 2007. Measuring Interpersonal
15 Callousness in Boys From Childhood to Adolescence: An Examination of
16 Longitudinal Invariance and Temporal Stability. *Journal of Clinical Child*
17 *& Adolescent Psychology* 36 (3), 276-292.
- 18 Polanczyk, G., De Lima, M.S., Horta, B.L., Biederman, J., Rohde, L.A., 2007. The
19 worldwide prevalence of ADHD: a systematic review and metaregression
20 analysis. *American Journal of Psychiatry* 164 (6), 942-948.
- 21 Rutter, M., Kim-Cohen, J., Maughan, B., 2006. Continuities and discontinuities in
22 psychopathology between childhood and adult life. *Journal of Child*

1 Psychology and Psychiatry 47 (3-4), 276-295.

2 Scheeringa, M.S., Haslett, N., 2010. The reliability and criterion validity of the

3 Diagnostic Infant and Preschool Assessment: a new diagnostic instrument for

4 young children. *Child Psychiatry & Human Development* 41 (3), 299-312.

5 Schwenck, C., Mergenthaler, J., Keller, K., Zech, J., Salehi, S., Taurines, R., Romanos,

6 M., Schecklmann, M., Schneider, W., Warnke, A., 2012. Empathy in children

7 with autism and conduct disorder: Group-specific profiles and developmental

8 aspects. *Journal of Child Psychology and Psychiatry* 53 (6), 651-659.

9 Stadler, C., Kroeger, A., Weyers, P., Grasmann, D., Horschinek, M., Freitag, C.,

10 Clement, H.-W., 2011. Cortisol reactivity in boys with

11 attention-deficit/hyperactivity disorder and disruptive behavior problems: the

12 impact of callous unemotional traits. *Psychiatry research* 187 (1-2), 204-209.

13 Storebø, O.J., Simonsen, E., 2016. The association between ADHD and antisocial

14 personality disorder (ASPD) a review. *Journal of attention disorders* 20 (10),

15 815-824.

16 Tye, C., Bedford, R., Asherson, P., Ashwood, K., Azadi, B., Bolton, P., McLoughlin,

17 G., 2017. Callous-unemotional traits moderate executive function in children

18 with ASD and ADHD: a pilot event-related potential study. *Developmental*

19 *cognitive neuroscience* 26, 84-90.

20 Wallace, G.L., Shaw, P., Lee, N.R., Clasen, L.S., Raznahan, A., Lenroot, R.K., Martin,

21 A., Giedd, J.N., 2012. Distinct cortical correlates of autistic versus antisocial

22 traits in a longitudinal sample of typically developing youth. *Journal of*

1 Neuroscience 32 (14), 4856-4860.

2 Willoughby, M.T., Waschbusch, D.A., Moore, G.A., Propper, C.B., 2011. Using the

3 ASEBA to screen for callous unemotional traits in early childhood: Factor

4 structure, temporal stability, and utility. Journal of psychopathology and

5 behavioral assessment 33 (1), 19-30.

6 Zhang, H.-F., Shuai, L., Zhang, J.-S., Wang, Y.-F., Lu, T.-F., Tan, X., Pan, J.-X., Shen,

7 L.-X., 2018. Neuropsychological Profile Related with Executive Function of

8 Chinese Preschoolers with Attention-Deficit/Hyperactivity Disorder:

9 Neuropsychological Measures and Behavior Rating Scale of Executive

10 Function-Preschool Version. Chinese medical journal 131 (6), 648.

11 Zhang, H.-F., Zhang, J.-S., Shuai, L., Lu, T.-F., 2016. Reliability and validity of the

12 Chinese version of the Swanson, Nolan, and Pelham, version IV scale-parent

13 form. Chinese Journal of Child Health Care 24 (12), 1253-1256.

14 Zhang, J., Wang, P., Han, J., Xiaomeng, L.I., Tan, X., 2014. Analysis of psychopathy

15 in children with oppositional defiant disorder, conduct disorder, and

16 attention-deficit hyperactivity disorder. Journal of Bio-education2(1):16-20.

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Figures

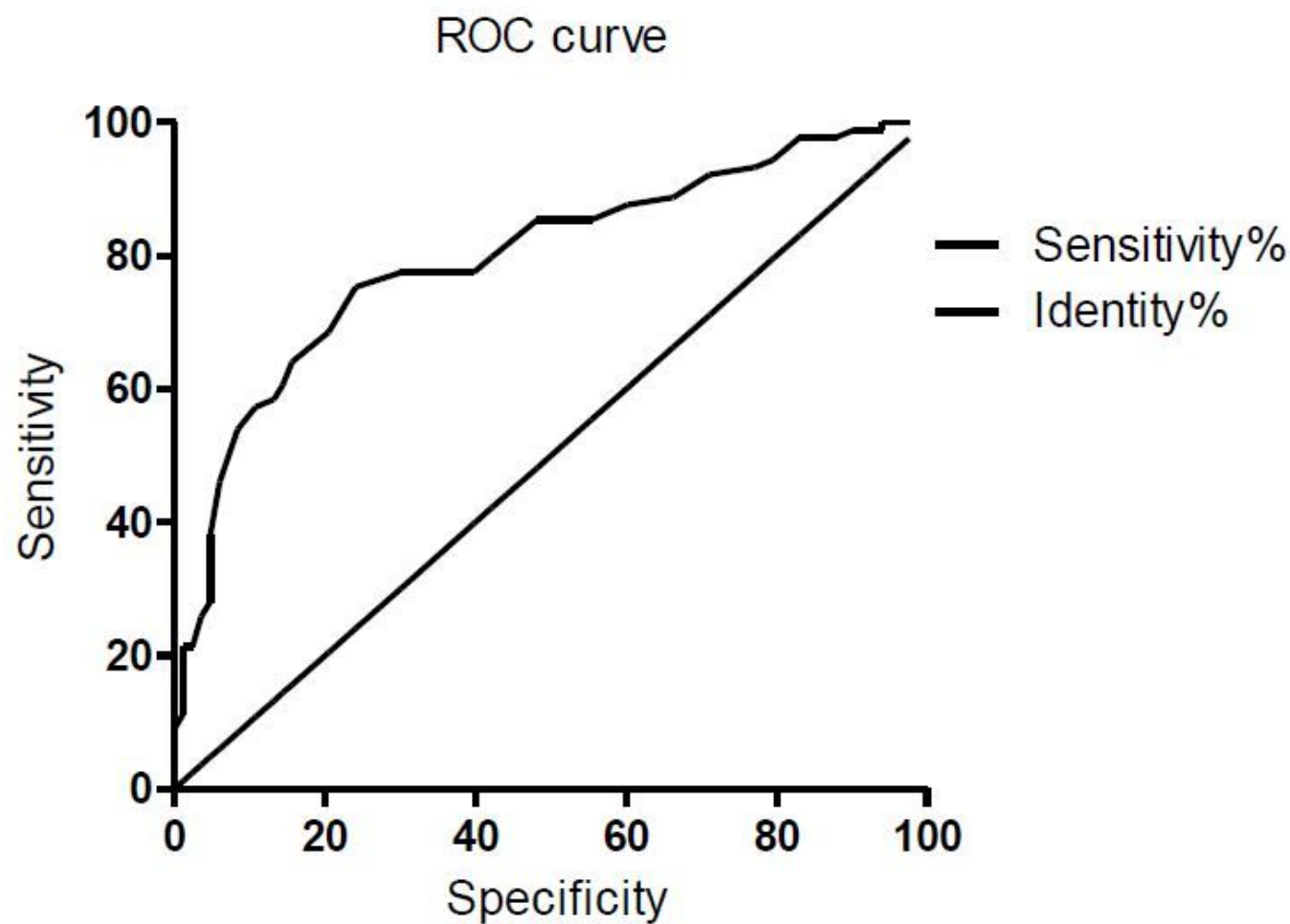


Figure 1

ROC curve of the ICU questionnaire ACU: area under the curve; CI: confidence interval

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