Journal of Autism and Developmental Disorders (2020) 50:2007–2018
https://doi.org/10.1007/s10803-019-03957-7

ORIGINALPAPER

Identifying the Cognitive Correlates of Reciprocity in Children with Autism Spectrum Disorder

Szu-Shen Lai[1,2] · Ching-Hong Tsai[3] · Chin-Chin Wu[4,5] · Cheng-Te Chen[6] · Hsing-Jung Li[3] · Kuan-Lin Chen[1,7]

Published online: 7 March 2019

Abstract
This study examined the cognitive correlates of reciprocity in children with autism spectrum disorder (ASD). A total of 59 children with ASD were assessed with the Interactive Drawing Task, Theory of Mind Task Battery, Children's Card Change Sort Task, and Children's Gambling Task respectively for their reciprocity, theory of mind, cool executive function (EF), and hot EF. The correlational findings revealed that cool EF ($r = .482$ and $-.501$, $p < .01$) and hot EF ($r = .396$, $p < .05$) were significantly correlated with children's total reciprocity. The regression models also showed that cool and hot EF abilities were significant predictors. Conclusively, cool and hot EF abilities are the correlates of reciprocity rather than of ToM in children with ASD.

Keywords Autism spectrum disorder · Reciprocity · Theory of mind · Executive function

Introduction

Reciprocal behaviors, one of the most important social interaction skills, are defined as mutual and symmetrical exchanges between individuals (Gernsbacher 2006). Reciprocal behaviors are pivotal to the minute process of collaborative behaviors between individuals who perform activities to reach shared goals, such as when children are talking, working, or playing together (Cole and Teboul 2004). The ability to execute reciprocal behaviors develops with age, depending on the development of cognitive skills and emotional functioning (Perez and Gauvain 2005). At around 2 years of age, typically developing children play in proximity with each other and do the same type of activity but without mutual exchange, called parallel activity. Gradually, children begin to interact with other children and develop basic reciprocal behaviors, such as equal turn taking and object sharing (Eckerman et al. 1989; Warneken and Tomasello 2006). At 3 years of age, children start to share themes among playmates (e.g., building a sandcastle together) (Howes 1988). During middle childhood, collaborative reciprocal behaviors emerge when the children understand others' goals and intentions; therefore, children can share their psychological states with others (Tomasello

✉ Kuan-Lin Chen
klchen@mail.ncku.edu.tw

1 Department of Occupational Therapy, College of Medicine, National Cheng Kung University, No. 1, University Rd., Tainan City 701, Taiwan, R.O.C.

2 Occupational Therapy, Department of Rehabilitation, Taoyuan Chang Gung Memorial Hospital, No. 123, Dinghu Rd., Guishan Dist., Taoyuan City, Taiwan, R.O.C.

3 Department of Child & Adolescent Psychiatry, Kaohsiung Municipal Kai-Syuan Psychiatric Hospital, No. 130, Kaisyuan 2nd. Rd., Lingya Dist., Kaohsiung City 802, Taiwan, R.O.C.

4 Department of Psychology, Kaohsiung Medical University, No. 100, Shiquan 1st Rd., Sanmin Dist., Kaohsiung City, Taiwan, R.O.C.

5 Department of Medical Research, Kaohsiung Medical University Hospital, No. 100, Ziyou 1st Rd., Sanmin Dist., Kaohsiung City, Taiwan, R.O.C.

6 Department of Educational Psychology and Counseling, National Tsing Hua University, No. 101, Section 2, Kuang-Fu Rd., Hsinchu, Taiwan, R.O.C.

7 Department of Physical Medicine and Rehabilitation, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, No. 1, University Rd., Tainan City 701, Taiwan, R.O.C.

et al. 2005). This sharing behavior is composed of basic to complex reciprocal behaviors and enables children to play with a full variety of such behaviors to achieve a common goal, such as building a small play house together or making a joint drawing (van Ommeren et al. 2012). Therefore, reciprocal behaviors play a decisive role in child development in interactive play and social interaction.

Social interaction deficit is an obvious symptom in children with autism spectrum disorder (ASD), manifested by the lower frequency and complexity of reciprocity in their social development (Spence et al. 2004; van Ommeren et al. 2012). Children with ASD have been found to be unable to show appropriate reciprocal behaviors with peers and adults, including the failure to develop peer relationships, the lack of spontaneous seeking to share enjoyment, interests, or achievements with other people, and the lack of social or emotional reciprocity (Sally and Hill 2006). Several studies have also shown that children with ASD have lower social network centrality and less friendship reciprocity than do typically developing children (Chamberlain et al. 2007; Kasari et al. 2011; Rotheram-Fuller et al. 2010).

The neural correlates of human reciprocity have been investigated as possible intervention targets (Caceda et al. 2017; Kuss et al. 2015; Sakaiya et al. 2013; van den Bos et al. 2009). These neuroimaging results have indicated that the right middle dorsolateral prefrontal cortex (DLPFC), dorsal caudate, ventromedial prefrontal cortex (VMPFC), and precuneus are activated when individuals perform reciprocal actions (Sakaiya et al. 2013). The region of the DLPFC is known to be associated with human executive function, and the VMPFC and precuneus are known as the theory of mind (ToM) regions. Therefore, reciprocity performance may be affected by ToM and EF, which are respectively controlled by the ToM regions and the DLPFC. However, so far, no behavioral research has been conducted to directly examine the correlates of reciprocity in children with ASD.

ToM and EF have also been examined for impaired reciprocity in children with ASD. Children with ASD have been found to have impaired ToM (Adibsereshki et al. 2015; Baron-Cohen et al. 1985; Schuwerk et al. 2016), which may lead to impairment in social interaction, such as collaboration and reciprocity (Sally and Hill 2006). ToM is a cognitive ability (Adolphs 2001) with which a person understands and infers the mental states (e.g., belief, desires and intensions) of others and uses such information to explain and predict behaviors and actions (Premacka 1978). Therefore, ToM is essential for a person to develop reciprocal conversation and social interactions (Mastrangelo 2009). In Sally and Hill's (2006) study, three types of strategy games were used to investigate the relationship between ToM and reciprocity in children with ASD. However, the results showed that children with ASD had impaired ToM ability in both first and second-order false belief tasks, but not in the reciprocity game. Their results also showed that the reciprocity of children with ASD was similar to that of typically developing children, even though social reciprocity deficit is an obvious limitation in the daily lives of children with ASD. It may be that children with ASD perform better on a structured computer reciprocity game and worse in unstructured daily life situations.

In addition to ToM, EF is another neural correlate of reciprocity. EF is a collection of interrelated cognitive and behavioral skills that are responsible for purposeful, goal-directed activity, include the highest levels of human functioning (Lezak 1995). EF allows us to access information, think about solutions, and implement those solutions. Currently, EF can be divided into cool and hot EF. Cool EF is defined as goal-directed and future-oriented skills that are manifested within abstract, decontextualized, nonemotional and analytical conditions, which is a more pure cognitive aspect of EF associated with the DLPFC (Metcalfe and Mischel 1999). Hot EF is goal-directed and future-oriented cognitive processes manifested within the contexts of endangering emotion and motivation (Zelazo and Carlson 2012; Zelazo and Mu¨ller 2002; Zelazo et al. 2005). Hot EF is the affective aspect of EF and associated with the orbitofrontal cortex (OFC), an area of the VMPFC, and other medial regions (Happaney et al. 2004) for reappraisal of the affective or motivational significance of stimuli (Rolls 2004). Traditionally, the cool aspect of EF has been predominately investigated in children with ASD, but the results have been inconsistent (Craig et al. 2016; Geurts et al. 2009; Hill 2004). Some have suggested that children with ASD have cool EF deficits (Hughes et al. 1994; Lai et al. 2017; Szatmari et al. 1989), while others have argued to the contrary (Dawson et al. 1998; McEvoy et al. 1993; Yerys et al. 2007). This inconsistency may cause difficulty in recognizing the relationship between EF and social interaction (Zimmerman et al. 2016). As regards hot EF, although children with ASD have hot EF deficit (Zimmerman et al. 2016), so far, no studies have investigated the relationship between social interaction and hot EF in children with ASD.

In summary, children with ASD have obvious deficits in reciprocity in their daily living contexts. The regions controlling ToM and EF have been found to be the neural correlates of reciprocity, but to the best of our knowledge, no clinical behavioral studies to date have examined the relationships of ToM and EF simultaneously with reciprocity in children with ASD to confirm the neuroimaging evidence. In addition, the structured computer game used in past studies might not reflect the reciprocal performances of children with ASD in real-life reciprocal contexts (Sally and Hill 2006). Therefore, to resolve the above two issues, this study aimed to investigate the correlates of reciprocity in children with ASD by considering cool EF, hot EF, and ToM with a more unstructured assessment in reciprocity. If clinicians are informed of these evidenced cognitive correlates of reciprocity, assessment and intervention plans could be better targeted to better improve the children's reciprocity in their interactive play and social interaction.

Methods

Participants

Children with ASD were recruited from January 2015 to September 2015 from teaching hospitals, clinics, and developmental centers of Taiwan. The inclusion criteria were: (a) formal diagnosis of autistic disorder or Asperger's syndrome according to the DSM-IV or DSM-IV-TR by a trained psychiatrist or pediatrician; (b) age of 4–12 years; (c) basic verbal ability, indicated by a score of 60 on the WISC-IV or WPPSI-IV (determined by a pilot study); (d) ability to follow orders and complete all procedures; (e) absence of symptoms associated with organic brain dysfunction (e.g., seizures), and (f) absence of uncorrectable visual or hearing impairments.

Measures

Reciprocity: Interactive Drawing Test (IDT)

The IDT was developed by Dr. Tineke Backer van Ommeren and Dr. Sander Begeer (van Ommeren et al. 2012). The IDT was designed to examine reciprocity in a joint, unstructured situation similar to unpredictable aspects of real-life social interactions. No drawing skill is needed in this test. The test elicits spontaneous interaction with the experimenter to achieve a mutual goal, which takes approximately 10 min. For administering the IDT, a table, drawing paper of size A3, four colored markers (red, blue, black, green), and a video camera are needed. The experimenter starts the test by saying, "We are going to draw together. You may choose a marker." This is the only instruction for the children. The desired goal of the IDT is equal participation of the participants. The experimenter is instructed to be reciprocal with increasing dynamics (i.e., initiating his or her own objects and contributing to the child's objects) and to elicit reciprocal behaviors by drawing incomplete objects and by giving examples of reciprocal responses (i.e., adding elements to the incomplete drawing of the child). Then the experimenter begins turn-taking by turning the paper to the child; this is repeated throughout the administration. The experimenter starts the test by drawing a line. The first thing the experimenter draws is a house. The experimenter has to finish it in five turns of only one line per turn. The experimenter also has to draw things that are not finished (e.g., a part of a window or part of a car) so that the child is always able to add meaningful elements to the objects drawn by the experimenter. In addition, the experimenter can partly color an object to join in the creation of the objects drawn by the child without contributing new elements. After a few turns, the experimenter makes a specific and new contribution; i.e., an interfering input. In later objects drawn by the child, the experimenter adds absurd and damaging input.

Three types of reciprocal behaviors are measured in this assessment. The first is the proportion of reciprocal drawing (i.e., joining in by adding meaningful elements) of total turns, which is also called total reciprocity. Reciprocal drawing (total reciprocity) can be divided into the proportion of reciprocity in the other's initiative and reciprocity in the child's own initiative, which refers to the amount of reciprocity in the objects drawn by the experimenter and the amount of reciprocity in the objects drawn by the child, respectively.

Theory of Mind: Theory of Mind Task Battery (ToMTB)

The ToMTB (Hutchins et al. 2012) was designed to assess the ToM understanding of younger and older children, who vary widely in their cognitive and linguistic profiles. The ToMTB consists of 15 test questions within 9 tasks. Tasks are presented as short vignettes arranged in ascending difficulty, including identifying emotions associated with facial expressions, understanding the visual perspective of the experimenter, inferring desire-based emotion, perception-based belief, perception-based action, and first- and second-order false beliefs. The tasks are presented in a storybook format. Each page has color illustrations and accompanying text. Memory control questions are included, and the control questions must be passed in order for credit to be given on the test questions. Appropriate for verbal and nonverbal children with ASD, the test is constructed such that children can respond by answering verbally or by pointing to a picture that shows the correct answer. Each ToM question is scored as pass (1) or fail (0), and no credit is awarded for a ToM target question unless the associated control questions are passed. The ToMTB has been shown to have good test–retest reliability and internal consistency (Hutchins et al. 2008).

Cool Executive Function: Computerized Dimensional Card Change Sort Task (DCCS)

The computerized DCCS (Diamond and Kirkham 2005; Dichter et al. 2010) was administered and scored for cool EF in this study. The picture files consist of two response icons (a red truck and a blue star) and two stimuli (a blue truck and a red star). No stimulus matches a model picture in both color and shape. Therefore, the correct response for sorting by color is always the wrong response for sorting by shape, and vice versa. During a trial, the word "color" or "shape" indicates the relevant sorting criterion for that trial.

In this study, each participant first completed 15 practice trials with performance feedback (i.e., "correct" or "incorrect") prior to the test blocks. After the practice trials, they completed seven blocks of test trials without feedback. Each block used one of the two sorting criteria, either color or shape. Blocks 1, 3 and 6 used the "color" criterion, blocks 2, 5 and 7 used the "shape" criterion, and block 4 was a mixed task consisting of color and shape sorting rules (pseudorandomly intermixed color and shape trials with 13 nonswitch trials and 7 switch trials). Each block comprised 10 trials, except for the mixed block, with 20 trials. Reaction time (RT) from stimulus onset to key press was measured in milliseconds. As soon as a key was pressed, the stimulus and cue word disappeared, leaving only the model pictures. Consistent with the criteria of Diamond and Kirkham (2005), only correct responses were included in the RT analyses. Additionally, trials in which an RT was more than 2.5 standard deviations above the mean and those in which RT was < 200 ms were dropped. Shifting cost was calculated as the difference between the last two trials in the first block and the first two trials in the second block.

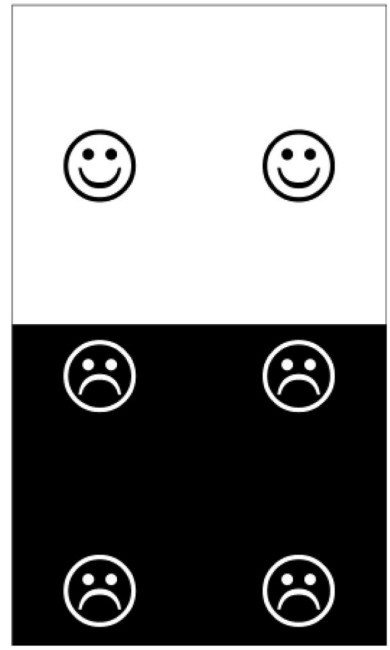

Fig. 1 Sample card face from the disadvantageous deck (gain = + 2, Loss = − 4)

Hot Executive Function: Children's Gambling Task (CGT)

The children's hot executive function was measured with the Children's Gambling Task (CGT) (Kerr and Zelazo 2004). The Children's Gambling Task, a simplified version of the Iowa Gambling Task (Bechara et al. 1994), involves two decks of 50 cards. The cards are divided into two parts, a white top and a black bottom. Black happy faces appear on the top half and white sad faces appear on the bottom half (Fig. 1). The number of happy faces on each card refers to the number of rewards that the participant gains, and the number of sad faces refers to the number of rewards that the participant loses. Rewards are represented by candies or toys determined by the child. A plastic box is positioned between the two decks of cards. When children gain or lose rewards, candies are moved into/out of the plastic box from/to a plastic container kept by the experimenter.

The two decks of cards are different. One is advantageous, and the other is disadvantageous. A child who chooses from the advantageous deck consistently earns a net gain in rewards, and a child who chooses from the disadvantageous deck consistently experiences a net loss of rewards. The number of gains is the same across the cards, but the number of losses is not. In the advantageous deck, cards always provide a gain of one reward (i.e., they show one happy face) together with zero or one loss (for an average of five candies gained per block of ten cards). In the disadvantageous deck, cards always provide a gain of two rewards (i.e., they show two happy faces) together with losses of 0, 4, 5, or 6 candies (for an average of five candies lost per block of ten cards). The order of cards in each is fixed, and the gain/loss contingencies associated with each card in each deck are proportional to those used in the Iowa Gambling Task (Table 1). The CGT score is calculated by subtracting the number of disadvantageous deck choices from the number of advantageous deck choices.

Severity of the Symptoms of Autism: Childhood Autism Rating Scale (CARS)

The children's autistic symptom severity was measured with the CARS (Schopler et al. 1980, 1988), which is a 15-item behavioral rating scale. Each item ranges from 1 (no abnormality) to 4 (severe abnormality), so the total score of the CARS ranges from 15 to 60. The rating of the CARS is based not only on clinical observation and classroom observation but also on a caregiver interview (Matson et al. 2010; Schopler et al. 1988). The cutoff point of a diagnosis of autism is 30 points. The score range from 30 to 36 represents mild to moderate symptoms of autism, and a score higher than 37 suggests severe symptoms of autism. The psychometric properties of the CARS have been well established. The CARS has good internal consistency ($r = .896$) and good inter-rater reliability ($r = .796$) (Breidbord and Croudace 2013).

Table 1 Outcomes of each card in the advantageous and disadvantageous decks

Card No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
−Deck (losses)	0	0	−4	0	−6	0	−4	0	−5	−6	0	−6	0	−5	−4	0	−6	−4	0	0	0	−6	0	−6	0
+Deck (losses)	0	0	−1	0	−1	0	−1	0	−1	−1	0	−1	−1	0	0	0	−1	−1	0	−1	0	0	0	−1	−1
Card No.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
−Deck (losses)	−4	−5	−4	0	0	−6	−4	−5	0	0	0	−4	−6	0	0	0	0	−4	0	−6	0	−4	0	−5	−6
+Deck (losses)	−1	0	0	−1	−1	0	0	0	−1	−1	0	−1	0	−1	−1	0	0	−1	0	−1	0	−1	0	−1	−1

− Deck (disadvantageous deck): provides a gain of two rewards

+ Deck (advantageous deck): provides a gain of one reward

Verbal Ability: Wechsler Intelligence Scale for Children®-Fourth Edition (WISC®-IV) or Wechsler Preschool and Primary Scale of Intelligence™-Fourth Edition (WPPSI™-IV)

Children's verbal ability was measured with the Verbal Comprehension Index (VCI) of the Chinese version of the Wechsler Intelligence Scale for Children®-Fourth Edition (WISC®-IV) (Chen and Chen 2007/2003) or the Wechsler Preschool and Primary Scale of Intelligence™-Fourth Edition (WPPSI™-IV) (Chen and Chen 2013/2012). In the current study, the verbal abilities of the children aged from 4 to 6 years old were measured with the WPPSI-IV, and the verbal abilities of children older than 6 years old were measured with the WISC-IV.

The WISC-IV is an intelligence test for children aged from 6 years old to 16 years old 11 months consisting of ten core subtests and five additional subtests. The VCI contains the Vocabulary, Similarities, and Comprehension subtests. The standard mean score of the VCI is 100, and the standard deviation is 15. The Chinese Version of the WISC-IV, published in 2007, has good reliability and validity (Chen et al. 2009). The WPPSI-IV is an assessment for measuring children's cognitive development from age 2 years 6 months to age 7 years 7 months. It consists of 14 subtests. The VCI for children aged from 4 to 7 years 7 months contains the Information and Similarities subtests. The Chinese Version WPPSI-IV, published in 2013, is for children aged from 2 years 6 months to 7 years 11 months and also has good reliability and validity (Chen and Chen 2013).

Procedures

The protocol of this study was approved by the Institutional Review Board of two teaching hospitals. After recruitment, participants' caregivers were informed of relevant details of this study, and informed consent forms were signed by those willing to participate in the study.

Children's data were collected in two visits to avoid fatigue and prolonged assessment. Each visit took about 1 hour, or the time to complete the assessments. At the first visit, the child was assessed with the WISC-IV or WPPSI-IV, and children who did not achieve a score of 60 (e.g., based on the norm for 8-year-old children) on the VCI of the WISC-IV or WPPSI-IV were excluded. The criterion of basic verbal ability was decided based on the results of a previous pilot study for a child to understand and follow the instructions for the present study. Children with sufficient verbal ability were then assessed with the ToMTB. Their caregivers filled out the basic information sheet and were interviewed with the CARS. At the second visit, children were assessed with the DCCS, the CGT, and the IDT by a trained administrator.

All the data of the IDT were collected by the first author. Her training on the IDT was specifically provided by the developer of the IDT, Tineke Backer van Ommeren (van Ommeren et al. 2012) from May 2014 to September 2015. The training process included: (1) developing familiarity with the manual, instructions, scoring criteria, and drawing inputs of the IDT; (2) standardizing the procedures and scoring criteria of the IDT; (3) practicing evaluation with the IDT; (4) assessing a child with ASD with the IDT, recording the evaluation process, rating the child's reciprocal behaviors, and sending the drawing and scoring form to Dr. van Ommeren; and (5) correcting the scoring based on suggestions by Dr. van Ommeren. Steps (4) and (5) were repeated until Dr. van Ommeren approved the assessment skills, such as giving special input accurately and coding behaviors appropriately.

Statistical Analysis

The collected data were analyzed in SPSS 17.0 for Windows (SPSS Inc., USA) for the descriptive analysis and hypothesis testing. For descriptive purposes, means and standard deviations were computed for the demographic data of the children. Pearson's correlation analyses (two-tailed) were computed among cool EF, hot EF, ToM, reciprocity, age, and verbal ability. The cut off points for the Pearson correlation coefficients were 0.25, 0.5, and 0.75, indicating mild, moderate, and good levels of correlation (Portney and Watkins 2007). Three hierarchical regression models were used to identify the significant predictors of reciprocity in children with ASD while controlling for age, verbal ability, and severity of the symptoms of autism. The dependent variables were the three IDT variables: reciprocal drawing (total reciprocity), reciprocity in own initiative, and reciprocity in other's initiative. Independent variables were introduced to the regression models in two steps. In the first step, all of the controlled-for variables, including the age, VCI from the WISC-IV or WPPSI-IV, and CARS total score were entered and denoted as the baseline. In the second step, the variables of interest, including ToMTB total score, DCCS, and CGT variables, were added to the baseline model, the combination of which was denoted as the augmented model. Comparing the augmented and baseline models allowed us to examine the additional contributions from the variables of interest while controlling for the effects of age, VCI, and CARS total score. The *F*-test of overall significance and model comparison, the coefficient of determination (R^2) and R^2 change (ΔR^2), and the regression coefficients were provided to determine the significance of ToM, cool and hot EF. To finalize the model, non-significant variables of interest were removed from the augmented model. The significance level was set at alpha < 0.05.

Results

A total of 59 children diagnosed with ASD (50 boys, 9 girls) were included in the present study, including 12 children with Asperger's syndrome and 47 diagnosed with autistic disorder. Participants were recruited from nine clinics, six hospitals, and one developmental center in Tainan, Kaohsiung, and Taipei. Originally, a total of 75 children with autistic disorder or Asperger's syndrome were recruited in this study. In the end, 16 children were excluded because they could not finish the whole process (n = 1) or pass the verbal ability criterion (n = 14), or some data were missing. The mean age of the 59 participants was 88.8 months. The children's mean VCI on the WISC-IV or WPPSI-IV was 104.9, indicating that our participants had moderate verbal comprehension ability. The mean score of autistic symptom severity on the CARS is 30.2, indicating that the included participants had mild autistic traits. The mean score of socioeconomic status (SES) was 39.4, indicating the medium level of the socioeconomic level of the participants' families (Hollingshead 1957).

The results of descriptive analysis of ToM, cool EF, hot EF, and social interaction are shown in Table 2. The children's ToMTB scores indicated that the children in our sample had basic ToM development on average and could understand the first order false belief task. As for the DCCS, the means of the children's accuracy in the single block,

Table 2 Sample characteristics of children with autism spectrum disorder (N = 59)

	Mean/frequency	SD	Range
Chronological age (months)	88.8	25.1	57–143
Gender (boys; girls), n	50; 9		
Childhood autism rating scale (CARS)	30.2	3.4	21–38
Verbal comprehension index of the WISC/WPPSI	104.9	18.4	58–154
Socioeconomic status	39.4	6.8	23–48
Theory of mind task battery	9.2	2.4	3–15
Dimensional card change sort task			
Single block			
Accuracy (%)	85.0	12.8	35–100
Reaction time (ms)	1714.5	633.5	671.7–3533.6
Mixed block			
Accuracy (%)	79.3	13.6	45–100
Reaction time (ms)	1990.0	745.0	699–5328.3
Shifting cost (ms)	− 1517.9	2412.2	− 11,506–2426
Children's gambling task	6.7	18.9	− 40 to 50
Interactive drawing test			
Reciprocal drawing (%)	67.3	22.1	0–100
Reciprocity in own initiative (%)	36.1	21.9	0–83.3
Reciprocity in other's initiative (%)	31.5	20.2	0–78.9

WISC Wechsler Intelligence Scale for Children-Fourth Edition, *WPPSI* Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition accuracy in the mixed block, reaction time in the single block, reaction time in the mixed block, and shifting cost are listed in Table 2. The mixed block in the DCCS was more difficult than the single block for the children due to the lower accuracy and longer reaction time. The children's CGT mean score indicated that the children chose more cards from the advantage deck than from the disadvantage deck. In the IDT, the mean percentage of the children's reciprocal drawing was 67.3%, including the mean percentage of the children's reciprocity in their own initiative, 36.1%, and the mean percentage of children's reciprocity in the other's initiative, 31.5%. The IDT results indicate that most of the children could participate in the joint drawing activity to add meaningful elements, but it was more difficult for them to add elements to the other's initiative.

The results of the Pearson correlation coefficients among the ToM, cool EF and hot EF with reciprocity are shown in Table 3. DCCS-single block accuracy ($r = .482$, $p < .01$), DCCS-mixed block accuracy ($r = .501$, $p < .01$), and CGT ($r = .396$, $p < .05$) were significantly correlated with the reciprocal drawing with mild to moderate positive correlation coefficients. The significant correlates of reciprocity in the child's own initiative were the variables of the DCCS-single block accuracy ($r = .342$, $p < .01$) and DCCS-mixed block accuracy ($r = .441$, $p < .01$). However, none of the variables were found to be significantly correlated with reciprocity in the other's initiative. Furthermore, the VCI ($r = .380$, $p < .01$) was found to be significantly correlated with reciprocity in the child's own initiative.

The results of the hierarchical regression analyses are summarized in Table 4. For the model of reciprocal drawing, the results showed that in addition to age, VCI, and CARS, the DCCS-mixed block accuracy and CGT made significant additional contributions to predict reciprocal drawing (total reciprocity) with an F-value of 10.473, accounting for an additional 26.1% of the total variance. For reciprocity in the child's own initiative, in addition to age, VCI, and CARS, only the DCCS-mixed block accuracy was significant with an F-value of 13.498, which additionally explained 17.2% of the variance in reciprocity in the child's own initiative. For the last dependent variable, no variables of interest were significant in explaining reciprocity in the other's initiative while controlling for age, VCI, and CARS.

Discussion

The present study examined the relationships among ToM, cool EF, hot EF, and reciprocity in children with autistic disorder and Asperger's syndrome while considering their verbal ability and autistic symptom severity. The results suggest that cool EF and hot EF are both significantly correlated with total reciprocity, and that only verbal ability is significantly correlated with reciprocity in the child's own initiative. The present study fills important gaps in previous research to provide better understanding of the correlates in reciprocity in children with autistic disorder and Asperger's syndrome by conducting a behavioral study of reciprocity, considering hot EF as a correlate, and using a reciprocity task similar to unstructured and unpredictable aspects of real-life social interactions.

In this study, total turns of reciprocal drawing (i.e., joining in by adding meaningful elements) is referred to as total reciprocity. Reciprocal drawing (total reciprocity) can be divided into the proportion of reciprocity in the other's initiative and reciprocity in the child's own initiative, which refers to the amount of reciprocity in the objects drawn by the experimenter and children, respectively. According to the correlational results, for reciprocal drawing, both cool EF and hot EF were found to be significant correlates. Children with better cool EF and hot EF ability may perform more reciprocal behaviors. In addition, cool EF and verbal comprehension ability were the significant correlates of reciprocity in the child's own initiative. That is, children with better cool EF and verbal ability may have better reciprocity in their own initiatives. However, the correlate of reciprocity in the other's initiative was not identified in the present study, so further investigation is warranted to discover other correlates of children's reciprocity in others' initiatives, such as social interaction style.

Regarding the significant correlation between cool EF and reciprocal drawing, the cool EF task, the DCCS, focuses on children's abilities of shifting attention, impulse control and sustained attention. Therefore, children who are able to correctly shift their attention based on the sorting rule, inhibit the impulse to follow the rules, and sustain attention in the task may perform more reciprocal drawing behaviors because it is easier for them to inhibit their own impulses and then shift and sustain their attention to the collaborative theme. The result is consistent with previous neural process research reporting that the DLPFC, the neural region for cool EF, is the neural correlate of reciprocal behaviors (Sakaiya et al. 2013).

On the other hand, hot EF, a goal-directed and future-oriented cognitive process, is manifested within the contexts of endangering emotion and motivation (Zelazo and Carlson 2012; Zelazo and Mu¨ller 2002; Zelazo et al. 2005). Hot EF was found to be significantly associated with the capacity for reciprocal drawing behavior. It could be that the IDT is a task that requires maintained motivation, so the importance of the drawing themes may require reappraisal. Therefore, children with better hot EF ability can maintain their attention and motivation on the reciprocal themes and contribute meaningful elements toward the collaborative goals.

Two possible reasons may explain the non-significant relationship between ToM and reciprocal drawing. First,

Table 3 Correlations on measurements of interest in children with autism spectrum disorder (N = 59)

		1	2	3	4	5	6	7	8	9	10	11
1	Age											
2	WISC/WPPSI VCI	−.385**										
3	CARS	.265*	−.600**									
4	SRS-2	.109	−.212	.449**								
5	ToMTB	.286*	.438**	−.253	−.091							
6	DCCS single-accuracy	.142	.164	−.350**	−.172	.211						
7	DCCS mixed-accuracy	.130	.038	−.384**	−.147	.029	.713**					
8	DCCS single-reaction time	−.196	−.194	.223	.036	−.365**	−.497**	−.432**				
9	DCCS mixed-reaction time	−.148	−.188	.060	−.050	−.241	−.135	−.097	.764**			
10	DCCS shifting cost	.176	.122	.008	.043	.295*	−.015	−.036	−.444**	−.527**		
11	CGT	.258*	.099	.004	.057	.193	.128	.100	−.119	−.177	.218	
12	IDT reciprocal drawing (total reciprocity)	.108	.173	−.190	−.088	−.073	.482**	.501**	−.106	−.066	−.129	.396*
13	IDT reciprocity in own initiative	.062	.310*	−.242	−.039	.143	.342**	.441**	−.246	−.147	.002	.151
14	IDT reciprocity in other's initiative	.044	−.157	.063	−.063	−.252	.157	.071	.160	.098	−.105	.135

WISC Wechsler Intelligence Scale for Children-Fourth Edition, *WPPSI* Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition, *CARS* Childhood Autism Rating Scale, *SRS* Social Responsiveness Scale, *ToMTB* Theory of Mind Task Battery, *DCCS* Dimensional Card Change Sort Task, *CGT* Children's Gambling Task, *IDT* Interactive Drawing Test

*$p < .05$; **$p < .01$

Table 4 The hierarchical regression models of reciprocity in children with autism spectrum disorder ($N = 59$)

Model	Predictors	B	Standard error (B)	R^2 or ΔR^2	F (p)
Models for interactive drawing task—reciprocal drawing (total reciprocity)					
Baseline	Constant	.586	.500	.079	1.578 (.205)
	Age	.002	.001		
	VCI	.002	.002		
	CARS	− .010	.011		
Augmented	Constant	− .598	.554	.340	5.462 (< .001)**
	Age	.000	.001		
	VCI	.003	.002		
	CARS	.009	.010		
	DCCS-mixed block accuracy	.842**	.208		
	CGT	.002*	.001		
Model comparison				.261	10.473 (< .001)**
Models for interactive drawing task—reciprocity in own initiative					
Baseline	Constant	− .030	.478	.141	3.013 (.038)*
	Age	.002	.001		
	VCI	.004*	.002		
	CARS	− .006	.010		
Augmented	Constant	− 1.241*	.543	.313	6.147 (< .001)**
	Age	.001	.001		
	VCI	.005**	.002		
	CARS	.011	.010		
	DCCS-mixed block accuracy	.764**	.208		
Model comparison				.172	13.498 (.001)**
Models for interactive drawing task—reciprocity in other's initiative					
Baseline	Constant	.638	.469	.027	.501 (.683)
	Age	.001	.001		
	VCI	− .002	.002		
	CARS	− .003	.010		

VCI Verbal Comprehension Index, *CARS* Childhood Autism Rating Score, *DCCS* Dimensional Card Change Sort Task, *CGT* Children's Gambling Task

$^{*}p < .05$; $^{**}p < .01$

the drawing theme of the experimenter was obvious, so the children may have used their cognitive ability more than ToM, social cognition, to speculate on the experimenter's behaviors. Second, the IDT is an unstructured and unpredictable task, so it is hard for children with autistic disorder and Asperger's syndrome to generalize their ToM ability to this unstructured situation. As a result, they are unable to give proper responses. Despite being able to perform well on the ToM task, they cannot perform well on a reciprocity task in an unstructured context. The findings of the present study are consistent with those of previous studies, in which children with ASD were found to have difficulties in using their ToM in an unstructured context (Begeer et al. 2010; Dahlgren and Trillingsgaard 1996; Tomasello et al. 2005). High functioning adolescents and adults with ASD are able to pass the ToM task at various levels of complexity (Dahlgren and Trillingsgaard 1996). They can give proper responses in structured situations (Begeer et al. 2010), but they cannot respond properly in unstructured and unpredictable situations. However, Tomasello et al. (2005) have found that children with ASD have fewer reciprocal behaviors, possibly due to difficulties in understanding others' intentions, which is inconsistent with the non-significant correlation between ToM and reciprocity found in the present study. In summary, further study is still warranted to better elucidate the relationship between ToM and reciprocity with consideration of the task characteristics, such as the collaborative themes and unstructured or structured tasks used in measuring children's reciprocal behaviors.

One possible explanation is that the reciprocity in their own initiatives of children with ASD was greater than the reciprocity in the other's initiative in our study. The less reciprocity in the other's initiative may be due to their restricted and repetitive behavioral characteristics, which cause them difficulty in shifting their attention to another's drawing theme. For instance, many of the children in this study would only focus on their own drawing themes of dinosaurs, cars, and busses, so it was difficult for them to follow the experimenter's initiative. A previous study by van Ommeren et al. (2012) also suggested that children with ASD would perform more reciprocity on their own initiatives because children want to avoid the confrontation of unexpected situations and prefer to lead the drawing themes.

As for the positive correlation of verbal ability and cool EF to reciprocity in the child's own initiative, a possible explanation may be that better verbal comprehension ability and better accuracy in the cool EF task revealed that children having better cognitive ability can better execute reciprocal behaviors based on their own initiatives. On the other hand, children with better cognitive ability still cannot perform more reciprocity in others' initiative behaviors. This may be influenced by their characteristic of restricted behaviors, which led to focusing on their own theme in the IDT test. As seen in the correlational results, the relationship between cool EF-shifting and reciprocity in the child's own initiative was negative ($r = -.246$, $p = .061$), which is close to statistical significance. A larger sample size may be needed to better examine the relationship between reciprocity in the child's own initiative and cool EF.

In this study, based on our observation, children's reciprocity performance on the IDT could be divided into three types: active, passive, and proper reciprocity. Children of the active type presented much reciprocity in their own initiatives, and the drawing themes usually focused on typical objects for the child, such as cars and busses. The child responded less to the experimenter's initiatives, a tendency common in younger children diagnosed with Asperger's syndrome. Children of the passive type exhibited much reciprocity in the experimenter's initiative, and the children responded properly to the experimenter's drawing theme. However, the experimenter had to lead the drawing theme, and these children tended not to initiate their own drawing themes. Children of the proper type exhibited balanced reciprocity in their own initiatives and in the experimenter's initiative. The child and the experimenter would take turns leading the drawing theme, which would increase the dynamic between the experimenter and the child. These types of reciprocal behaviors on the IDT in the current study are similar to the four types of social interaction styles: typical, active-but-odd, passive, and aloof (Castelloe and Dawson 1993; O'Brien 1996; Scheeren et al. 2012). Active-but-odd children actively seek social interaction, but they do so in an unusual way (e.g., holding a monologue about a particular interest), which is similar to the active type of IDT performance (e.g., children focus on their own specific drawing themes and cannot properly respond to the experimenter's theme). Passive children do not initiate social interaction, but they do respond suitably to another's initiative, resembling the passive type of IDT performance (e.g., seldom initiating their own drawing themes but being able to add proper and meaningful elements to the experimenter's drawing theme). Typical children act properly in social interactions, similarly to the proper type in IDT performance (e.g., the children both initiate their own themes and participate in the experimenter's drawing theme). Aloof children seek no social interaction and do not respond to another's initiative. These children usually have less verbal ability and are low-functioning; thus, this type may not be a factor in the present study because of the verbal ability inclusion criterion. Regarding the similarities between the types of IDT performance and social interaction style, children's social interaction styles might be an important correlate of reciprocity in the child's own or the other's initiative.

The present study has two main limitations. First, the findings cannot be generalized to lower-functioning and non-verbal children with ASD or to children diagnosed with PDD-NOS because the present study included only children with better functioning, verbal ability, and diagnosis of autistic disorder or Asperger's syndrome. Second, children's reciprocity may be correlated with their social interaction styles, but the present study did not assess social interaction styles. Therefore, further study is warranted to (1) recruit children with lower-functioning and less verbal ability and a diagnosis with PDD-NOS if the corresponding measurements adjusted for these children are available; (2) apply a ToM measurement that is less verbally demanding; and (3) add a measurement for evaluating social interaction styles.

Conclusion

The present study examined the relationships of ToM, cool EF, and hot EF to reciprocity in children with ASD. This study, which used a relatively unstructured reciprocity task to better reflect the children's daily reciprocity performance, provides the first step in considering hot EF in reciprocity. The results showed that children with autistic disorder and Asperger's syndrome who have better cool EF and hot EF may have a better capacity for reciprocity. For clinicians, on the basis of this research, assessment plans could be developed to evaluate children's ToM, cool EF, hot EF, and reciprocity as the foundation of intervention. With consideration of the children's cognitive correlates, targeted interventions could be accordingly developed to improve the children's basic and collaborative reciprocal behaviors in their interactive play and social interaction, such as equal turn taking, object sharing, theme sharing, and understanding of psychological states. For researchers, it is recommended that future studies include more low-functioning and non-verbal children with autistic disorder and Asperger's syndrome, apply a ToM measure that is less verbally demanding, and assess social interaction styles to better illustrate the cognitive correlates in reciprocity.

Acknowledgments We especially thank the children and caregivers who participated in our study. Additionally, we are very grateful for the help of Dr. Tineke Backer van Ommeren, who kindly shared the manual of the Interactive Drawing Test (IDT) and provided training in the administration and scoring of the IDT. Last but not least, we would like to give thanks to the occupational therapists and psychiatrists of Country Hospital, Chi Mei Medical Center, De Shang Clinic, National Cheng Kung University Hospital, Xing Cheng Rehabilitation Clinic, Yong Cheng Rehabilitation Clinic, and Kaohsiung Municipal Kai-Syuan Psychiatric Hospital for their assistance with recruiting participants. This study was supported by grants awarded to the corresponding author by the Ministry of Science and Technology, R.O.C. (MOST 103-2410-H-006-060 and MOST 104-2410-H-006-065). No party having a direct interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which they are associated

Author Contributions SL and KC originated and executed this study; CW participated in the research design and data interpretation; CC analyzed and interpreted the data; CT and HL participated in the research design and data collection. All authors read and approved the final manuscript.

Compliance with Ethical Standards

Informed Consent Participant consent forms have been collected.

References

Adibsereshki, N., Nesayan, A., Asadi Gandomani, R., & Karimlou, M. (2015). The effectiveness of theory of mind training on the social skills of children with high functioning autism spectrum disorders. *Iranian Journal of Child Neurology, 9*(3), 40–49.

Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology, 11*(2), 231–239.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37–46.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*(1–3), 7–15.

Begeer, S., Malle, B. F., Nieuwland, M., & Keysar, B. (2010). Using theory of mind to represent and take part in social interactions: Comparing individuals with high-functioning autism and typically developing controls. *European Journal of Child Development, 7*, 104–122.

Breidbord, J., & Croudace, T. J. (2013). Reliability generalization for Childhood Autism Rating Scale. *Journal of Autism and Developmental Disorders, 43*(12), 2855–2865.

Caceda, R., Prendes-Alvarez, S., Hsu, J. J., Tripathi, S. P., Kilts, C. D., & James, G. A. (2017). The neural correlates of reciprocity are sensitive to prior experience of reciprocity. *Behavioural Brain Research, 14*(332), 136–144.

Castelloe, P., & Dawson, G. (1993). Subclassification of children with autism and pervasive developmental disorder: A questionnaire based on Wing's subgrouping scheme. *Journal of Autism and Developmental Disorders, 23*(2), 229–241.

Chamberlain, B., Kasari, C., & Rotheram-Fuller, E. (2007). Involvement or isolation? The social networks of children with autism in regular classrooms. *Journal of Autism and Developmental Disorders, 37*(2), 230–242.

Chen, Y. H., & Chen, H. Y. (2007). *Wechsler Intelligence Scale for children-Fourth Edition: Chinese version manual* (Wechsler, D.). Taipei: The Chinese Behavioral Science Corporation. (**Original work published 2003**).

Chen, Y. H., & Chen, H. Y. (2013). *Wechsler Preschool and Primary Scale of Intelligence - Fourth Edition: Chinese version manual* (Wechsler, D.). Taipei: Chinese Behavioral Science Corporation. (**Original work published 2012**).

Chen, H. Y., Chen, Y. H., Keith, T. Z., & Chang, B. S. (2009). What does the WISC-IV measure? Validation of the scoring and CHC-based interpretative approaches. *Journal of Research in Education Sciences, 54*(3), 85–108.

Cole, T., & Teboul, J. C. B. (2004). Non-zero-sum collaboration, reciprocity, and the preference for similarity: Developing an adaptive model of close relational functioning. *Personal Relationships, 11*, 135–160.

Craig, F., Margari, F., Legrottaglie, A. R., Palumbi, R., De Giambattista, C., & Margari, L. (2016). A review of executive function deficits in autism spectrum disorder and attention-deficit/hyperactivity disorder. *Neuropsychiatric Disease and Treatment, 12*, 1191–1202.

Dahlgren, S. O., & Trillingsgaard, A. (1996). Theory of mind in non-retarded children with autism and Asperger's syndrome. A research note. *Jouranal of Child Psychology and Psychiatry, 37*(6), 759–763.

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28*(6), 479–485.

Diamond, A., & Kirkham, N. (2005). Not quite as grown-up as we like to think: Parallels between cognition in childhood and adulthood. *Psychological Science, 16*(4), 291–297.

Dichter, G. S., Radonovich, K. J., Turner-Brown, L. M., Lam, K. S., Holtzclaw, T. N., & Bodfish, J. W. (2010). Performance of children with autism spectrum disorders on the dimension-change card sort task. *Journal of Autism and Developmental Disorders, 40*(4), 448–456.

Eckerman, C. O., Davis, C. C., & Didow, S. M. (1989). Toddlers' emerging ways of achieving social coordinations with a peer. *Child Development, 60*(2), 440–453.

Gernsbacher, M. A. (2006). Toward a behavior of reciprocity. *Journal of Developmental Processes, 1*, 139–152.

Geurts, H. M., Corbett, B., & Solomon, M. (2009). The paradox of cognitive flexibility in autism. *Trends in Cognitive Science, 13*(2), 74–82.

Happaney, K., Zelazo, P. D., & Stuss, D. T. (2004). Development of orbitofrontal function: current themes and future directions. *Brain Cognition, 55*(1), 1–10.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Science, 8*(1), 26–32.

Hollingshead, A. B. (1957). *Two factor index of social position*. New Haven, CT: Privately published.

Howes, C. (1988). Peer interaction of young children. *Monographs of the Society for Research in Child Development, 53*, 1–78.

Hughes, C., Russell, J., & Robbins, T. W. (1994). Evidence for executive dysfunction in autism. *Neuropsychologia, 32*(4), 477–492.

Hutchins, T. L., Bonazinga, L. A., Prelock, P. A., & Taylor, R. S. (2008). Beyond false beliefs: The development and psychometric evaluation of the perceptions of children's theory of mind measure-experimental version (PCToMM-E). *Journal of Autism and Developmental Disorders, 38*(1), 143–155.

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2012). Psychometric evaluation of the Theory of Mind Inventory (ToMI): A study of typically developing children and children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*(3), 327–341.

Kasari, C., Locke, J., Gulsrud, A., & Rotheram-Fuller, E. (2011). Social networks and friendships at school: Comparing children with and without ASD. *Journal of Autism and Developmental Disorders, 41*(5), 533–544.

Kerr, A., & Zelazo, P. D. (2004). Development of "hot" executive function: the children's gambling task. *Brain Cognition, 55*(1), 148–157.

Kuss, K., Falk, A., Trautner, P., Montag, C., Weber, B., & Fliessbach, K. (2015). Neuronal correlates of social decision making are influenced by social value orientation—An fMRI study. *Frontiers in Behavioral Neuroscience, 9*, 40.

Lai, C. L. E., Lau, Z., Lui, S. S., Lok, E., Tam, V., Chan, Q., … Cheung, E. F. (2017). Meta-analysis of neuropsychological measures of executive functioning in children and adolescents with high-functioning autism spectrum disorder. *Autism Research, 10*(5), 911–939.

Lezak, M. D. (1995). *Neuropsychological assessment* (3rd ed.). New York: Oxford University Press.

Mastrangelo, S. (2009). Play and the child with autism spectrum disorder: From possibilities to practice. *International Journal of Play Therapy, 18*(1), 13–30.

Matson, J. L., Hess, J. A., Mahan, S., & Fodstad, J. C. (2010). Convergent validity of the Autism Spectrum Disorder Diagnostic for Children (ASD-DC) and Autism Diagnostic Interview-Revised (ADI-R). *Research in Autism Spectrum Disorders, 4*, 741–745.

McEvoy, R. E., Rogers, S. J., & Pennington, B. F. (1993). Executive function and social communication deficits in young autistic children. *Journal of Child Psychology and Psychiatry, 34*(4), 563–578.

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review, 106*(1), 3–19.

O'Brien, S. K. (1996). The validity and reliability of the Wing Subgroups Questionnaire. *Journal of Autism and Developmental Disorders, 26*(3), 321–335.

Perez, S. M., & Gauvain, M. (2005). The role of child emotionality in child behaviour and maternal instruction on planning taks. *Social Development, 14*, 250–272.

Portney, L. G., & Watkins, M. P. (2007). *Foundations of clinical research applications to practice* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences, 1*(4), 515–526.

Rolls, E. T. (2004). The functions of the orbitofrontal cortex. *Brain Cognition, 55*(1), 11–29.

Rotheram-Fuller, E., Kasari, C., Chamberlain, B., & Locke, J. (2010). Social involvement of children with autism spectrum disorders in elementary school classrooms. *Journal of Child Psychology and Psychiatry, 51*(11), 1227–1234.

Sakaiya, S., Shiraito, Y., Kato, J., Ide, H., Okada, K., Takano, K., & Kansaku, K. (2013). Neural correlate of human reciprocity in social interactions. *Frontiers in Neuroscience, 7*(239), 1–12.

Sally, D., & Hill, E. (2006). The development of interpersonal strategy: Autism, theory-of-mind, cooperation and fairness. *Journal of Economic Psychology, 27*(1), 73–97.

Scheeren, A. M., Koot, H. M., & Begeer, S. (2012). Social interaction style of children and adolescents with high-functioning autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*(10), 2046–2055.

Schopler, E., Reichler, R., DeVellis, R., & Daly, K. (1980). Toward objective classification of childhood autism: Childhood autism rating scale (CARS). *Journal of Autism and Developmental Disorders, 10*, 91–103.

Schopler, E., Reichler, R., & Rochen Renner, B. (1988). *The childhood autism rating scale*. Los Angeles: Western Psychological Services.

Schuwerk, T., Jarvers, I., Vuori, M., & Sodian, B. (2016). Implicit mentalizing persists beyond early childhood and is profoundly impaired in children with autism spectrum condition. *Frontiers in Psychoogyl, 7*, 1696.

Spence, S. J., Sharifi, P., & Wiznitzer, M. (2004). Autism spectrum disorder: screening, diagnosis, and medical evaluation. *Seminars in Pediatric Neurology, 11*(3), 186–195.

Szatmari, P., Bartolucci, G., Bremner, R., Bond, S., & Rich, S. (1989). A follow-up study of high-functioning autistic children. *Journal of Autism and Developmental Disorders, 19*(2), 213–225.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *The Behavioral Brain Sciences, 28*(5), 675–691 (**discussion 691–735**).

van den Bos, W., van Dijk, E., Westenberg, M., Rombouts, S., & Crone, E. A. (2009). What motivates repayment? Neural correlates of reciprocity in the Trust Game. *Social Cognitive and Affective Neuroscience, 4*(3), 294–304.

van Ommeren, T. B., Begeer, S., Scheeren, A. M., & Koot, H. M. (2012). Measuring reciprocity in high functioning children and adolescents with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*(6), 1001–1010.

Warneken, F., & Tomasello, M. (2006). Altruistic helping in human infants and young chimpanzees. *Science, 311*(5765), 1301–1303.

Yerys, B. E., Hepburn, S. L., Pennington, B. F., & Rogers, S. J. (2007). Executive function in preschoolers with autism: Evidence consistent with a secondary deficit. *Journal of Autism and Developmental Disorders, 37*(6), 1068–1079.

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool xxecutive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives, 6*(4), 354–360.

Zelazo, P. D., & Müller, U. (2002). Executive functions in typical and atypical development. In U. Goswami (Ed.), *Blackwell handbook of childhood cognitive development* (pp. 445–469). Malden: Blackwell.

Zelazo, P. D., Qu, L., & Müller, U. (2005). Hot and cool aspects of executive function: Relations in early development. In W. Schneider, R. Schumann-Hengsteler & B. Sodian (Eds.), *Young children's cognitive development: Interrelationships among executive functioning, working memory, verbal ability, and theory of mind* (pp. 71–93). Mahwah: Lawrence Erlbaum.

Zimmerman, D. L., Ownsworth, T., O'Donovan, A., Roberts, J., & Gullo, M. J. (2016). Independence of hot and cold executive function deficits in high-functioning adults with autism spectrum disorder. *Frontiers in Human Neuroscience, 5*, 10–24.