The Cognitive Function of Deception in Children with Autism Spectrum Disorder

Susumu Yokota* and Mari Tanaka

Faculty of Arts and Science, Kyushu University, Fukuoka, Japan

Successful deception involves understanding and manipulating other people's mental states. Previous studies have revealed difficulty and developmental delay in the ability to deceive and cognitive dysfunction in children with autism spectrum disorder (ASD). However, little is known about the cognitive functions related to deception, especially in children with ASD. Therefore, this study investigated the relationship between deception and cognitive functions in children with ASD. Participants performed an animated deception task and completed a standardized test of cognitive function. Children with ASD showed the same levels of accuracy but significantly longer reaction times than typically developing children regarding successful deception. Children with ASD showed significantly lower scores than typically developing children regarding cognitive functions. Planning score, which requires cognitive flexibility, and age in months were negatively correlated with reaction time in ASD. These results indicate that the difficulties experienced by children with ASD regarding deceiving are related to executive dysfunction.

Key Words: autism spectrum disorder, deception, cognitive function, reaction time

Introduction

Autism spectrum disorder (ASD) is characterized by social disorder, deficits in social communication and social interactions across multiple contexts, and restricted and repetitive patterns of behavior or activity (Diagnostic and Statistical Manual of mental disorders 5th edition, DSM-5; American Psychiatric Association, 2013). Previous studies have strongly indicated that children with ASD have an impaired ability to deceive (Baron-Cohen, 1992; Russell, Mauthner, Sharpe, & Tidswell, 1991; Sodian & Frith, 1992; Yi, Fan, Li, Huang, Wang, Tan, Zou, & Lee, 2014; Yirmiya, Solomonica-Levi, & Shulman, 1996). Deception is related to creating false beliefs in the mind of another person for some ulterior purpose (Carlson, Moses, & Hix, 1998). The results of previous studies on typically developing (TD) children have shown that to deceive successfully, children need to attain certain abilities, such as inferring the other person's knowledge about a fact and anticipating how that person's future behavior will be affected by the deception. Therefore, one must understand the other person's mental state and manipulate it to deceive (Yi et al., 2014; Yirmiya et al., 1996). Little is known about cognitive functions related to these behaviors in children with ASD, although these abilities are crucial in social communications, such as irony or joking.

Compared with TD children, previous studies on deception in children with ASD have typically shown difficulties and delayed or different developmental processes (Baron-Cohen, 1992; Li, Kelley, Evans, & Lee, 2011; Sodian & Frith, 1992; Talwar, Zwaigenbaum, Goulden, Manji, Loomes, & Rasmussen, 2012; Yirmiya et al., 1996; Yokota & Tanaka, 2013; Yang, Tian, Fang, Lu, Wei, & Yi, 2017). These studies frequently used the temptation resistance and game context paradigms (Evans, Xu, & Lee, 2011; Lewis, Stanger, & Sullivan, 1989; Peskin, 1992; Polak & Harris, 1999; Sodian & Frith, 1992; Sodian, Taylor, Harris, & Perner, 1991; Talwar, Gordon, & Lee, 2007; Talwar & Lee, 2008; Yirmiya et al., 1996). Children are required to conceal about peeking an answer of quizzes or touching toys while the experi-
menter is out of a room in the temptation resistance paradigm. The experimenter does not explicitly ask the subject to engage in deception in this paradigm (Evans et al., 2011; Lewis et al., 1989; Polak & Harris, 1999; Talwar et al., 2007; Talwar & Lee, 2008). When deciding whether to deceive, the subject must spontaneously infer the experimenter's intention or behavior. Therefore, this paradigm allows researchers to observe children in a natural situation in which deception may occur (Evans et al., 2011). Li et al. (2011), who investigated 5- to 12-year-old children with ASD and TD children, indicated that both groups of children were capable of denying their transgression; however, the children with ASD were less able than TD children to maintain consistency between their initial denial and subsequent statements.

In the game context paradigm, the children take part in a game (e.g., hiding an object) and then practice deception in order to beat the experimenter. Hence, the children are instructed by the experimenter to deceive in this paradigm (Baron-Cohen, 1992; Chandler, Fritz, & Hala, 1989; Hala, Chandler, & Fritz, 1991; Peskin, 1992; Sodian & Frith, 1992; Sodian et al., 1991; Yirmiya et al., 1996; Yang et al., 2017). Therefore, the situation cannot be considered natural. However, this paradigm does allow us to collect more elaborate data, such as accuracy or reaction time, than does the temptation resistance paradigm because there are multiple trials. For example, Sodian and Frith (1992), who matched ASD children's verbal mental age with TD children's chronological age, suggested that children with ASD whose verbal mental age was above that of a 7-year-old could deceive more effectively than younger children with ASD. Moreover, Russell et al. (1991) showed that children with ASD and TD 3-year-old children repeatedly pointed to the true location of a reward rather than an empty location, thus allowing a competitor to gain the rewards.

Previous studies have shown that children with ASD face greater difficulty in deceiving other people than TD children. Previous studies with TD children have indicated a relationship between some aspects of cognitive function and deceptive behavior despite having only one study that investigated the relationship between these difficulties and cognitive function in children with ASD (Yi et al., 2014). Previous studies that used the game context paradigm suggested a relationship between deceptive behavior and ability of inhibit prepotent response (Hughes, 1998) and cognitive flexibility in preschool children (Hughes, 1998; Russell et al., 1991). Evans et al. (2011) investigated the effects of multiple aspects of executive function (e.g., working memory, inhibition, and planning) on the decisions and sophistication of deceptive behavior in 8- to 16-year-old TD children using the temptation resistance paradigm. They found a significant effect of inhibition on the decision to engage in deceptive behavior, but the effect on the sophistication of the deception was not significant. As for children with ASD, Yi et al. (2014) examined whether ASD group's tendency to deceive correlated with their executive function and false belief understanding. They found positive correlations between the performance in the cognitive flexibility task, not in the false belief understanding and deception. They concluded that cognitive flexibility played a key role to make deceptions among children with ASD.

Many previous studies have illustrated the difficulty that children with ASD experience regarding executive functions, including inhibition (Hughes, Russell, & Robbins, 1994; Luna, Doll, Hegedus, Minshew, & Sweeney, 2007; Ozonoff & Jensen, 1999), working memory (Bennetto, Pennington, & Rogers, 1996; Schuh & Eigsti, 2012; Steele, Minshew, Luna, & Sweeney, 2007), and cognitive flexibility (Kalaid, Smith, & Mortensen, 2008; Shu, Tien, & Chen, 2001). We can hypothesize that the difficulties and developmental delays experienced by children with ASD in implementing deception are caused by cognitive dysfunction by considering both these previous findings and the relationship between deception and cognitive function in TD children.

Das Naglieri Cognitive Assessment System (DN-CAS) is one of standardized test battery measuring these cognitive abilities related with deceptive behavior. The Japanese version of the DN-CAS has been normalized using Japanese populations of children aged 5 to 17 years and 11 months (Maekawa, Nakayama, & Okazaki, 2007). This test is based on the CAS (Naglieri & Das, 1997), which is used to measure cognitive functions in children and adolescents (Chan, Shum, Touloupoulou, & Chen, 2008). The CAS has been applied to various populations, such as individuals with attention deficit/hyperactivity disorder (Goldstein & Naglieri, 2008; Naglieri, Salter, & Edwards, 2004) and developmental disor-
Cognitive Function of Deception

The Cognitive Function of Deception was developed according to the PASS (planning, attention, simultaneous, successive) theory of intelligence (Das, Naglieri, & Kirby, 1994) and can be used to obtain a cognitive profile of a subject and to analyze his or her cognitive strength and weakness in the PASS. PASS theory is modeled by Luria’s cognitive functional units (Luria, 1966, 1976). Attention is located in the first functional unit, which provides the brain with the appropriate level of arousal or cortical tone for focused attention and resistance to distraction. The second functional unit is related to information coding, which is responsible for the acquisition, storage, and retrieval of knowledge through simultaneous and successive processes. The third functional unit, which is related to planning, provides the individual with a mechanism for regulation and verification of activity, generation of plans of action, inspection of actions so that the aims of the plans may be attained, and the development of new plans, if necessary. Planning entails the aptitude for asking new questions, solving problems, and self-monitoring (Naglieri, Prewett, & Bardos, 1989).

There is no uniform agreement about the specific cognitive processes that comprise executive function. However, the vast amount of empirical studies has been indicated that core components of executive function include inhibition, task shifting, and updating of working memory (Miyake, Friedman, Emerson, Witzki, Howert, & Wager, 2000). According to this conceptualization of executive function, planning and attention in PASS theory mainly related to task shifting (flexibility) and inhibition could conceptualize a part of executive function. A previous study investigating cognitive performance of children with ASD using the CAS system indicated that their attention and planning abilities were significantly lower than those of TD children (Taddei & Contena, 2013).

This study aims to investigate the cognitive abilities related to deception in children with ASD in comparison with TD children using the game context paradigm. Based on the previous findings regarding deception and executive function, the following two hypotheses were generated: (a) Children with ASD have a deficit in deceptive abilities when compared with TD children; (b) This deficit is associated with their difficulties in executive functions, especially planning. We applied the game context paradigm to measure participants’ capacity for deception (determined by accuracy score) and fluency of deception (determined by reaction time) to achieve this purpose.

Methods

Participants
Twenty-one children with ASD, aged 6 to 12 years, participated in this study. They were recruited by advertising through a local support center and an organization for parents of children with developmental disorders. All the children had been diagnosed by pediatricians as having autism or Asperger’s syndrome based on clinical interviews using DSM-IV-TR criteria and as not having intellectual disabilities using standardized IQ test. For the control group, an age-matched set of 29 TD children was recruited by advertising through a local elementary school. ASD traits were assessed using the children’s version of the Autism Quotient (AQ; Wakabayashi, Baron-Cohen, Uchiyama, Yoshida, Tojo, Kuroda, & Wheelwright, 2007) for all participants.

All the participants were Japanese. Informed consent was obtained from all participants and their parents before the start of the experiment. This study was approved by the Ethics Review Board of Tohoku University. A summary of the participants’ characteristics is shown in Table 1.

Materials
Deception task. We modified the animation used by Yokota, Taki, Hashizume, Sassa, Thyeau, Tanaka, and Kawashima (2013) (Fig. 1). The characters in the animation were a witch and a girl, and we used blue and pink boxes with a window facing the participants to decrease memory load. Two kinds of fruit (cho-

Table 1 Chronological Age in Months and AQ Score of Children with Autism Spectrum Disorder and Typically Developing Children

|                 | ASD | Typically developing | t   | p   |
|-----------------|-----|----------------------|-----|-----|
| N               | 21  | 29                   |     |     |
| Age in months (SD) | 114.24 (17.68) | 119.17 (20.19) | −0.90 | n.s. |
| AQ (SD)         | 27.71 (7.96)    | 15.31 (5.85)      | 6.35 | <.001|

Note. ASD=autism spectrum disorder; AQ=autism spectrum quotient.
For receipt randomly from apples, bananas, and oranges) appeared on a table. In the first scene of the animation, a character sat in front of the table on which the boxes and fruits were placed. Next, the character looked at one fruit with a smile or with an expression reflecting disgust. She then looked at the other fruit with a facial expression opposite to the first one (e.g., if she smiled at the first fruit, she expressed disgust toward the second). These procedures allowed the participants to judge which fruit the character liked and which one she disliked. Next, the fruit jumped into the boxes after a curtain was drawn. Because the characters were behind the curtain, they were unable to see which box contained which fruit. However, the participants were able to view this sequence of events. The curtain opened in the last scene, and the character asked the participants which box contained which fruit. Under both the deception and truth conditions, the character asked the participants about the position of their liked or disliked fruit: "Is my favorite/disliked fruit in the pink/blue box?"

The animations were presented by presentation software (Neurobehavioral Systems, USA) running on a mobile PC (VAIO; Sony, Japan). Both deception and truth conditions contain 12 trials (contained six "favorite" and six "dislike" trials). The trials were self-paced, and each animation lasted 8 s. We simply summed correct trials in each condition for accuracy score. Reaction time was measured as the time from the presentation of the question until the participant pressed the button.

Cognitive function test. We used the Japanese DN-CAS. This test comprises 12 subtests in the standard version and eight subtests in the abbreviated version. We used the abbreviated version to reduce the risk of participant fatigue. Each PASS scale is measured by two subtests in the abbreviated version.

From each subtest, we obtained raw scores. Then, taking each child's age into account, the scores were translated into four standardized process scores (one for each of the PASS components) and one complete score (M=100, SD=15 for all five scores).

Design and Procedure
The deception task and cognitive function test were conducted by an experimenter with each participant individually. Four persons, including the first author, served as the experimenters. The participants were asked to watch the short animated film and answer the characters’ questions. The girl was introduced as a good character who should be helped to obtain the desired fruit. The witch was introduced as an evil character who should be prevented from obtaining the fruit. The participants were told, "In the animation, there are two characters: a witch and a girl. They looked for some fruit, but they did not know where it was. So, if the girl asks you about the position of the fruit, you should always tell her. But whenever the witch asks you about the position of the fruit, you should prevent her from getting it.” The participants completed short practice tasks consisting of four trials under each condition before they completed the experimental trials. The trials were self-paced to maximize task comprehension. If a participant failed to answer the question correctly, we presented the rules and explained the situation again. In this way, we confirmed that all participants could correctly answer all the practice questions. The order of the trials was randomized across participants. Accuracy and response time for all trials were...
recorded by the presentation software. Only reaction times from the correct trials were used for the data analyses reported below.

**Data Analysis**

Deception task and cognitive function test. The group differences in accuracy and reaction time on the deception condition, along with the complete scores and those for each of the four PASS processes from the DN-CAS, were examined using unpaired t-tests. Cohen's $d$ standardized effect size was calculated to evaluate effect size.

Relationship between deception and cognitive function. We conducted multiple regression analysis for each group (ASD/TD) because the complete score of DN-CAS in ASD group was significantly lower than that of TD group. Accuracy and reaction time were treated as dependent variable respectively. The age (in months) of the participant, AQ score, and the four process scores were treated as independent variables. The statistical threshold was set at $p<.05$. These data were analyzed using SPSS Version 21 (IBM Inc., Tokyo, Japan).

**Results**

**Traits of the Participants**

The group differences between the ASD and TD children were analyzed using unpaired t-tests. The difference in age was not significant, $t(48)=-.90$, $p=.37$, and the AQ score was significantly higher for the ASD group than for the TD group, $t(48)=6.35$, $p<.001$, $d=1.3$. These results are shown in Table 1.

**The Deception Task**

In Table 2, accuracy and reaction time for the deception condition are summarized. In the deception condition, the difference in accuracy between the children with ASD and the TD children was not significant, $t(26.9)=-1.83$, $p=.07$. However, the difference in reaction time between the two groups was significant, $t(24.4)=3.37$, $p<.01$, $d=.71$. Thus, the children with ASD had a significantly longer reaction time in the deception condition.

**The Cognitive Function Test**

Children with ASD scored significantly lower than TD children on three process scores and the complete score: planning, $t(48)=-3.47$, $p<.05$, $d=.70$; simultaneous processing, $t(48)=-1.74$, $p=.09$; attention, $t(48)=-6.83$, $p<.001$, $d=1.5$; successive processing, $t(48)=-3.52$, $p<.05$, $d=.72$; complete score, $t(48)=-5.62$, $p<.001$, $d=1.1$. These results are shown in Table 3.

**Relationship between Deception and Cognitive Function**

Multiple regression analyses were performed on the accuracy and reaction time data from the deception condition for each group. As for the ASD group, age and score of planning had a significantly negative correlation with reaction time ($R^2=.38$; age, $β=-.54$, $p<.05$; planning, $β=-.68$, $p<.05$). Only age showed a significantly negative correlation with reaction time in the TD group ($R^2=.40$; age, $β=-.64$, $p<.01$). The scatter plots of these results were shown in Fig. 2. There was no significant correlation between accuracy and independent variables in both groups.

**Discussion**

In this study, we found that children with ASD demonstrated a significantly longer reaction time in carrying out deception than TD children. From this result, we can conclude that children with ASD have
difficulty in performing deception, consistent with the results of previous studies. Moreover, in ASD group, we found that scores for planning and age in months were negatively correlated with reaction time in deception. In TD group, only age in months showed a significant negative correlation with reaction time.

One novel contribution of this study is that we measured the reaction time in performing deception. To the best of our knowledge, no previous study has measured this variable in children with or without ASD. The between-group analysis revealed a significant difference in reaction time to deceive. Children with ASD responded significantly more slowly than TD children. We believe that reaction time reflects fluency of deception. In other words, the shorter reaction time in the deception task among TD children indicates that they understand and can manipulate the other person’s mental state more fluently because deception is associated with inferences about the character’s knowledge and anticipation of the consequences of behavior (Sodian & Frith, 1992; Yirmiya et al., 1996). The finding of a significant difference in reaction time but not in accuracy suggests that reaction time is a better indicator of difficulty in implementing deception among children with ASD than is accuracy.

A longer reaction time indicates more cognitive processes related to performing deception (Walczyk, Roper, Seemann, & Humphrey, 2003). Regarding cognitive processes for deceiving, reaction time reflects fluency in making a deceptive reply, and we found that planning negatively correlated with reaction time in ASD group. In our task, participants were required to alternate between being truthful and lying, depending on who the character was (i.e., the girl or the witch, respectively). According to PASS theory, planning is responsible for programming, regulation, and verification of activity and is related to asking new questions and solving problems (Luria, 1976; Naglieri & Das, 1997). Thus, cognitive flexibility appears necessary to correctly answer the question. We conclude that executive functions related to switching mental sets play a key role in the fluency of deception, which is related with understanding other’s mental state effectively, among children with ASD. Moreover, these results indicate that the difficulties in deception are influenced by difficulties with executive functions.

We found negative correlations in both groups regarding the relationship between age and reaction time of deception. Because our task was related to the concealment of the truth, children simply make counterfactual statements to deceive. From the results of this study, children in both groups could deceive correctly (accuracy rates of both groups were higher than 80%), and older children could deceive more fluently. Using the temptation resistance paradigm,
previous studies on deception suggested that older children could make more sophisticated deception that depends on one’s “semantic leakage control” (Talwar et al., 2007; Evans & Lee, 2011). Taken together, the development of sophisticated deception needs to make lower-order deception such as simply concealing the truth fluently. However, the results also showed that it is not clear what kind of abilities will change along with the growth. Previous studies suggested that sophisticated deception is related to the ability to remain consistent with one’s previous statements and also to executive functions in 8- to 16-year-old TD children (Evans & Lee, 2011; Talwar et al., 2007). To investigate more closely the ability of children with ASD in understanding or manipulating another person’s mental state, developmental changes in the relationship between deception and executive function need to be clarified, especially within the game context paradigm.

**Limitations of the Study**

This study has some limitations. First, because our task was presented verbally to the participants, the possibility that their verbal mental age affected their performance cannot be completely denied. We could not conduct a standardized IQ test for ASD children as clinical reasons. Therefore, it is possible that the level of cognitive abilities differed between groups, and this discrepancy might have been affected the results of the tasks. To elucidate the relationship between verbal mental age and deceptive behavior in children with ASD, further research would be needed. Second, because we focused on the game context paradigm, the cognitive functions related to deception in the temptation resistance paradigm remain unclear. Considering the inconsistent results of previous studies on deception, depending on whether the game context or temptation resistance paradigm was used, it seems that there may be different relationships between deception and cognitive functions in the temptation resistance paradigm. Clarifying these relationships will lead to a better understanding of the daily difficulties in social cognition experienced by children with ASD.

**Conclusion**

In this study, children with ASD demonstrated the same accuracy level as TD children but a longer reaction time when asked to engage in deception. We also found that children with ASD scored lower than TD children in three components and on total scores on the cognitive function test. As for the relationship between performance of deception task and cognitive functions, reaction time in deception was negatively correlated with planning score and age in ASD group. We conclude that the difficulties in implementing deception among children with ASD are caused by difficulties in planning which is related with cognitive flexibility.

**Acknowledgment**

This study was supported by a Grant-in-Aid from the Japan Society for the Promotion of Science Fellows and JSPS KAKENHI Grant Number 23330270. We thank the participants, their parents, and those who administered the cognitive tests and deception task.

**References**

American Psychiatric Association (2013) *Diagnostic and statistical manual of mental disorders: DSM-5*. American Psychiatric Publishing, Arlington.

Baron-Cohen, S. (1992) Out of sight or out of mind?: Another look at deception in autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 33, 1141–1155.

Bennetto, L., Pennington, B. F., & Rogers, S. J. (1996) Intact and impaired memory functions in autism. *Child Development*, 67, 1816–1835.

Carlson, S. M., Moses, L. J., & Hix, H. R. (1998) The role of inhibitory processes in young children’s difficulties with deception and false belief. *Child Development*, 69, 672–691.

Chan, R. C., Shum, D., Touloumpoulou, T., & Chen, E. Y. (2008) Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology*, 23, 201–216.

Chandler, M., Fritz, A. S., & Hala, S. (1989) Small-scale deceit: Deception as a marker of two-, three-, and four-year-olds’ early theories of mind. *Child Development*, 60, 1263–1277.

Das, J. P., Naglieri, J. A., & Kirby, J. R. (1994) *Assessment of cognitive processes: The PASS theory of intelligence*. Allyn & Bacon, Boston.

Evans, A. D. & Lee, K. (2011) Verbal deception from late childhood to middle adolescence and its relation to executive functioning skills. *Developmental Psychology*, 47, 1108–1116.

Evans, A. D., Xu, F., & Lee, K. (2011) When all signs point to you: Lies told in the face of evidence. *Developmental Psychology*, 47,
Goldstein, S. & Naglieri, J. A. (2008) The school neuropsychology of ADHD: Theory, assessment, and intervention. *Psychology in the Schools*, 45, 859–874.

Hala, S., Chandler, M., & Fritz, A. S. (1991) Fledgling theories of mind: Deception as a marker of three-year-olds’ understanding of false belief. *Child Development*, 62, 83–97.

Hughes, C. (1998) Executive function in preschoolers: Links with theory of mind and verbal ability. *British Journal of Developmental Psychology*, 16, 233–253.

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

Kaland, N., Smith, L., & Mortensen, E. L. (2008) Brief report: Cognitive flexibility and focused attention in children with Asperger syndrome or high-functioning autism as measured on the computerized version of the Wisconsin Card Sorting Test. *Journal of Autism and Developmental Disorders*, 38, 1161–1165.

Kroeger, T. L., Rojahn, J., & Naglieri, J. A. (2001) Role of planning, attention, and simultaneous and successive cognitive processing in facial recognition in adults with mental retardation. *American Journal of Mental Retardation*, 106, 151–161.

Lewis, M., Stanger, C., & Sullivan, M. W. (1989) Deception in 3-year-olds. *Developmental Psychology*, 25, 439–443.

Li, A. S., Kelley, E. A., Evans, A. D., & Lee, K. (2011) Exploring the ability to deceive in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 41, 185–195.

Luna, B., Doll, S. K., Hegedus, S. J., Minshew, N. J., & Sweeney, J. A. (2007) Maturation of executive function in autism. *Biological Psychiatry*, 61, 474–481.

Luria, A. R. (1966) *Higher cortical functions in man*. Basic Book Inc., New York.

Luria, A. R. (1976) *The working brain: An introduction to neuropsychology*. Basic Books, New York.

Maekawa, H., Nakayama, K., & Okazaki, S. (2007) DN-CAS Cognitive assessment system. Nihon Bunka KagakuSha, Tokyo.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howser, A., & Wager, T. D. (2000) The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41, 49–100.

Naglieri, J. A. & Das, J. (1997) *Cognitive Assessment System*. Riverside Publishing, Illinois.

Naglieri, J. A., Prewett, P. N., & Bardos, A. N. (1989) An exploratory study of planning, attention, simultaneous, and successive cognitive processes. *Journal of School Psychology*, 27, 347–364.

Naglieri, J. A., Salter, C. J., & Edwards, G. H. (2004) Assessment of children of attention and reading difficulties using the PASS theory and Cognitive Assessment System. *Journal of Psychoeducational Assessment*, 22, 93–105.

Ozonoﬀ, S. & Jensen, J. (1999) Brief report: Speciﬁc executive function proﬁles in three neurodevelopmental disorders. *Journal of Autism and Developmental Disorders*, 29, 171–177.

Ozonoﬀ, S., Pennington, B. F., & Rogers, S. J. (1991) Executive function deﬁcits in high-functioning autistic individuals: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 32, 1081–1105.

Peskin, J. (1992) Ruse and representations: On children's ability to conceal information. *Developmental Psychology*, 28, 84–89.

Polak, A. & Harris, P. L. (1999) Deception by young children following noncompliance. *Developmental Psychology*, 35, 561–568.

Russell, J., Mauthner, N., Sharpe, S., & Tidswell, T. (1991) The ‘windows task’ as a measure of strategic deception in preschoolers and autistic subjects. *British Journal of Developmental Psychology*, 9, 331–349.

Schuh, J. M. & Eigsti, I.-M. (2012) Working memory, language skills, and autism symptomatology. *Behavioral Sciences (Basel, Switzerland)*, 2, 207–218.

Shu, B.-C., Tien, A. Y., & Chen, B.-C. (2001) Executive function deﬁcits in non-retarded autistic children. *Autism*, 5, 165–174.

Sodian, B. & Frith, U. (1992) Deception and sabotage in autistic, retarded and normal children. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 33, 591–605.

Sodian, B., Taylor, C., Harris, P. L., & Perner, J. (1991) Early deception and child's theory of mind: False trails and genuine markers. *Child Development*, 62, 468–483.

Steele, S. D., Minshew, N. J., Luna, B., & Sweeney, J. A. (2007) Spatial working memory deficits in autism. *Journal of Autism and Developmental Disorders*, 37, 605–612.

Taddei, S. & Contena, B. (2013) Brief report: Cognitive performance in autism and asperger's syndrome: What are the differences? *Journal of Autism and Developmental Disorders*, 43, 1–7.

Talwar, V., Gordon, H. M., & Lee, K. (2007) Lying in the elementary school years: Verbal deception and its relation to second-order belief understanding. *Developmental Psychology*, 43, 804–810.

Talwar, V. & Lee, K. (2008) Social and cognitive correlates of children's lying behavior. *Child Development*, 79, 866–881.

Talwar, V., Zwagenbaum, L., Goulden, K. J., Manji, S., Loomes, C., & Rasmussen, C. (2012) Lie-telling behavior in children with autism and its relation to false-belief understanding. *Focus on Autism and Other Developmental Disabilities*, 27, 122–129.

Wakabayashi, A., Baron-Cohen, S., Uchiyama, T., Yoshida, Y.
Cognitive Function of Deception

Tojo, Y., Kuroda, M., & Wheelwright, S. (2007) The autism-spectrum quotient (AQ) children’s version in Japan: A cross-cultural comparison. *Journal of Autism and Developmental Disorders*, 37, 491–500.

Walczyk, J. J., Roper, K. S., Seemann, E., & Humphrey, A. M. (2003) Cognitive mechanisms underlying lying to questions: Response time as a cue to deception. *Applied Cognitive Psychology*, 17, 755–774.

Yang, Y., Tian, Y., Fang, J., Lu, H., Wei, K., & Yi, L. (2017) Trust and deception in children with autism spectrum disorders: A social learning perspective. *Journal of Autism and Developmental Disorders*, 47, 615–625.

Yi, L., Fan, Y., Li, J., Huang, D., Wang, X., Tan, W., Zou, X., & Lee, K. (2014) Distrust and retaliatory deception in children with Autism Spectrum Disorder. *Research in Autism Spectrum Disorders*, 8, 1741–1755.

Yirmiya, N., Solomonica-Levi, D., & Shulman, C. (1996) The ability to manipulate behavior and to understand manipulation of beliefs: A comparison of individuals with autism, mental retardation, and normal development. *Developmental Psychology*, 32, 62–69.

Yokota, S., Taki, Y., Hashizume, H., Sassa, Y., Thyreau, B., Tanaka, M., & Kawashima, R. (2013) Neural correlates of deception in social contexts in normally developing children. *Frontiers in Human Neuroscience*, 7, 206.

Yokota, S. & Tanaka, M. (2013) Development of deceptive behavior in children with autism spectrum disorder. *Journal of Special Education Research*, 2, 1–9.