Theory of mind development: A comparison of children with autism spectrum disorders and typically developing South African children

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ABSTRACT

Theory of mind (ToM) is the ability to recognize other people's mental states, and to understand that people's behaviour is influenced by their emotions, beliefs and desires. Children with autism spectrum disorders (ASD) show severe deficits in ToM ability; these deficits can account for the social, communicative and imaginative deficits seen in ASD. Previous studies have found that individuals with ASD have a specific deficits and delays in ToM development. However, it is still unclear whether, or to what extent, ToM development takes place in children with ASD, and how age and verbal IQ impact on ToM ability. Using a novel and developmentally sequenced ToM battery, the aims of this study were to (a) compare the developmental trajectory of ToM in typically developing South African children, aged 3-13 years, with that of children from other countries (reported in previous studies), and (b) compare ToM ability in South African typically developing and ASD children. As expected, children with ASD performed consistently more poorly on the ToM tasks than typically developing children. Furthermore, ToM ability in the current typically developing sample was roughly on par with similarly-aged children from other countries. Interestingly, South African children performed worse than children from other countries on the more advanced ToM tasks, which may be due to cultural insensitivity of those tasks.

Keywords: autism spectrum disorder, child development, cross-sectional comparison, delay and deviance, false belief reasoning, theory of mind

Autism is characterized by Wing and Gould's (1979) triad of impairments: impairment in communication, imagination, and socialization. A lack of theory of mind (ToM; that is, the ability to recognize the mental states of others) has been proposed to explain these deficits in autism. However, ToM deficits are not specific to autism; for instance, deficits are also found in individuals with schizophrenia and traumatic brain injuries, and in late-signing deaf individuals (Brüne & Brüne-Cohrs, 2006). Autistic individuals also differ in level of ToM ability, with some individuals passing first- and second-order false belief tests, while others do not. This study was a pilot for a larger study to be conducted next year, which will examine the normal development of ToM in typically developing children and children with ASD. Firstly, ToM abilities in typically developing South Africa children were compared across age groups and with developmental norms from other countries. ToM in autistic children, age 7 to 11 years, was then compared with ToM in similarly-aged typically developing children.

LITERATURE REVIEW

Autism spectrum disorders

Autism is defined in the text revision of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000) as a developmental disorder whose onset must be prior to 3 years of age and which is characterized by (1) deficits in social interactions, (2) impaired verbal and non-verbal communication, and (3) repetitive, restricted or stereotyped behaviour interests and activities (see Appendix A).

Autistic individuals can furthermore be divided into high-functioning and low-functioning groups. Low-functioning autistic (LFA) individuals make up roughly 75 percent of the autistic population, and have an IQ of below 70. High-functioning autistic (HFA) individuals have an IQ higher than 70. Individuals with Asperger's syndrome are similar to HFA individuals, but do not show a delay in the onset of language abilities. Because of these overlaps, the broader DSM-IV category autism spectrum disorders (ASD) includes autism and Asperger's syndrome, as well as pervasive developmental disorder-not otherwise specified (PDD-NOS; American Psychiatric Association, 2000).

What is theory of mind and how does it develop?

ToM refers to the ability to recognize other people's mental states, and the realization that other people can "want, feel and believe things" (Baron-Cohen, Leslie, & Frith, 1985, p. 38). The false belief test has traditionally been the predominant test of ToM (Fodor, 1992). The classic false belief test used by Baron-Cohen and colleagues (1985), the "Sally-Anne test", shows Sally placing a marble in a basket and leaving the room. While she is away, Anne removes the marble from the basket and hides it in a box. Participants are then asked, "When Sally returns, where will she look for the marble?" The question is answered correctly (i.e., "in the basket") if the participant understands that Sally's belief does not represent the reality of the situation. This understanding of other people's beliefs is called first-order belief attribution.

Critics of the false belief test argue that its high executive function and linguistic demands may contribute to children failing the test, even though these children may be able to attribute belief to others (Bloom & German, 2000; Wellman, Cross, & Watson, 2001). Less demanding false belief tests where visual cues are provided, mental states are stated explicitly, a deceptive motive is employed, or non-verbal tasks are used, show increased success rates for typically developing children of all ages compared to 'standard' false belief tests (e.g., Chasiotis, Kiessling, Hofer, & Campos, 2006; Colle, Baron-Cohen, & Hill, 2007). These task variations may be more sensitive tests of ToM, or may simply display increased false positives (Wellman et al., 2001). Another criticism of the false belief task is that while 3-year-olds and autistic individuals both fail the false belief task, autistic children are very unlike normal 3-year-olds who display joint attention, pretend play and basic belief-desire reasoning (Bloom & German, 2000). Thus, a gap in the literature that has only recently begun to be addressed is assessment of ToM in typically developing and ASD children using multiple ToM measures, including some tasks that are easier and some that are more difficult than false belief tasks, in order to get a more accurate measure of ToM ability.

A normal developmental trajectory of theory of mind

ToM develops from a very young age. From 14 to 24 months of age, normally developing children start to engage in pretend play, show joint attention (looking at an object a parent is looking at) and show a dramatic increase in language learning (Duchan, 2000; U. Frith & C. D. Frith, 2003). Pretend play and joint attention are thought to be precursors to ToM (Charman et al., 2000), and linguistic ability has been correlated with ToM test performance (Harris, De Rosnay, & Pons, 2005; Tager-Flusberg, 2007). At around age 2 years, children

spontaneously begin to talk about their own mental states, express desires and also show an understanding of other people's desires (Wellman & Woolley, 1990). Between 3 and 5 years old, children begin to understand others' false beliefs, appearance-reality differences, and their own previous false beliefs (Bibby & McDonald, 2005; Naito, Komatsu, & Fuke, 1994). Between 5 and 7 years old, children are able to understand second-order beliefs: In other words, they grasp that a person can have beliefs about other people's beliefs. An example is a thief who thinks that he has been caught when a policeman stops him, and surrenders. However, the policeman simply wanted to tell him that he dropped something (Gallagher et al., 2000). The difference between jokes and lies begins to be appreciated by 6-7-year-olds, as are language forms such as metaphor, sarcasm and irony (Brüne & Brüne-Cohrs, 2006). This is an important indicator of ToM ability, as these language forms require an understanding of the speaker's intent. From 9 to 11 years old, children are able to recognize social faux pas, for example saying to a parent, "You have a lovely daughter", when it is in fact a boy (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999). Although ToM is clearly a complex set of skills, which is likely to continue to develop throughout the lifespan, ToM development after this point has not been studied.

Is theory of mind development consistent across cultures?

 In order to compare ToM development across cultures, most studies have looked at the age at which children from different countries pass first-order false belief tests (e.g. Callaghan et al., 2005; Naito & Koyama, 2006; Yazdi, German, Defeyter, & Siegal, 2006). In a comprehensive meta-analysis, Wellman et al. (2001) concluded that while performance on false belief tests differs between countries, age of onset is universally between $2 \frac{1}{2}$ and 5 years, and that the developmental trajectory is similar across cultures. These studies point to ToM abilities resulting from biological maturation. However, it could also indicate the role of universal experiences, such as conversation, in the development of ToM.

Studies related to the age of onset and developmental trajectory for ToM have shown mixed results. For instance, Japanese children have shown a delay in false belief development compared with British children, with provincial Japanese children more delayed in their onset of ToM than their urban counterparts. Belief attribution was only fully developed in 6-7-year-olds in provincial Japanese populations (Naito & Koyama, 2006). In another study, Chasiotis et al. (2006) found that 3-5-year-old children from Germany and Costa Rica performed similarly to American children on first-order false belief tests, but that Cameroonian children of similar age showed delayed development of belief attribution. These researchers concluded

that contextual variables such as socioeconomic status, number of siblings and parenting style influence the development of ToM abilities. Specifically, they speculated that Cameroon's typically authoritarian parenting style could have led to increased inhibition and less conversation exposure in children, leading to delays in onset of ToM. Significantly, however, other researchers have suggested that increased inhibition control skills are also associated with *better* false belief test results (Wellman et al., 2001; Yazdi et al., 2006).

In other cross-cultural ToM studies, Callaghan et al. (2005) found that children from Samoa, Canada, Thailand, Peru and India did not differ significantly in time of onset of ToM. The majority of 3-year-old children from all of these countries failed false belief tasks with a deceptive motive, while the majority of 5-year-old children passed these tasks. This development of first-order false belief at around 4 years of age corresponds to what has been found in studies on belief attribution in normally developing children from the United States and United Kingdom (Wellman et al., 2001). Where onset of ToM was delayed, this delay was attributed to low socioeconomic status, rather than cultural factors.

There have been, to my knowledge, no studies on ToM development in South Africa. If ToM development is indeed universal, as is suggested by Wellman et al.'s (2001) meta-analysis, then children in South Africa should display a similar age of onset and developmental trajectory to children in other countries. Factors such as low socio-economic status or parenting style may, however, influence ToM development in South African children, consistent with results from the Cameroonian sample of Chasiotis et al. (2006), and the results of Callaghan et al. (2005) and Naito and Koyama (2006) .

Theory of mind in ASD

Individuals with ASD show delays and deficits in developing ToM (Baron-Cohen et al., 1985; Holroyd & Baron-Cohen, 1993; Ozonoff & McEvoy, 1994; Tager-Flusberg, 2007). For instance, children with ASD do not appear to understand the distinction between appearance and reality and are not good at recognizing mental state words such as "think" and "know". They also do not engage in pretend play or imitation, and do not follow the gaze of a speaker (Charman et al., 2000). Although they may understand behaviour based on desires, they do not understand complex causes of behaviour such as beliefs (Baron-Cohen & Swettenham, 1997). Furthermore, they struggle with non-literal speech such as metaphor and irony (Happé, 1993). Autistic children's ToM difficulties cannot be attributed to low IQ, as children with Down's syndrome have similar or lower IQ scores, but perform significantly better on false belief tests (Baron-Cohen et al., 1985). Thus, most autistic children show severe deficits in

ToM ability that can account for the social, communicative and imaginative deficits seen in autism (Baron-Cohen & Swettenham, 1997).

Although most ASD individuals fail false belief tasks such as the Sally-Anne test, a significant minority of autistic individuals (around 15 to 55 percent) *do* pass first-order false belief tests (Happé & Frith, 1996). These individuals are usually older and have a higher verbal mental age (VMA) than autistic individuals who fail first-order false belief tasks (Happé & Frith, 1996; Ozonoff & McEvoy, 1994). Furthermore, they require higher IQ and verbal IQ scores than normally developing individuals to be able to pass first- and second-order false belief tests.

Even those ASD individuals who pass second-order false belief tests still display marked social and communicative impairments (Happé, 1994; Kaland et al., 2002), which are reflected in their difficulty in more naturalistic tests of social situations, such as the Faux Pas test (Baron-Cohen et al., 1999).It is thus argued that ASD individuals who pass false belief reasoning tasks might solve these ToM tasks using language skills and general cognitive processes rather specific mental state processes (Bauminger & Kasari, 1999; Tager-Flusberg, 2007). This argument is supported by the fact that individuals with ASD activate different brain regions to control subjects when answering ToM questions (Baron-Cohen et al., 2008). ASD individuals also take longer to answer ToM questions than typically developing individuals, which points to reasoning out the answer rather than understanding emotions and beliefs (Kaland, Smith, & Mortensen, 2007).

The observation that some individuals with ASD pass false belief tasks, and that these individuals are usually much older than typically developing or non-autistic mentally handicapped children who pass these tasks, has led researchers to believe that individuals with ASD may have a specific developmental delay in ToM (Baron-Cohen, 1989; Baron-Cohen & Swettenham, 1997). Children and adolescents with ASD might have an early delay in ToM, so that their ability is equivalent to the ToM of a typically developing child at 1-2 years of age; in other words, before joint attention and imaginative play develops. Autistic individuals who pass first-order false belief tests have reached a ToM ability equivalent to that of a normally developing 4 year old (even though they may have a much higher chronological and verbal mental age), but usually fail second order false belief tests which are aimed at the 6-7-year-old (Holroyd & Baron-Cohen, 1993). For instance, Happé (1995) found that ASD individuals with a VMA of lower than 5 years 6 months (5:6) all failed the first-order false belief tasks given, while all the autistic individuals with a VMA higher than 11:9 passed. The mean VMA required for passing was 9:7, which is much higher than that of typically

developing and mentally handicapped children who pass false belief tests. This is supported by the findings of Tager-Flusberg and Joseph (2005, in Tager-Flusberg, 2007) that linguistic ability is related to ToM performance; and more specifically, that semantic and grammatical knowledge significantly predict false-belief performance. Thus, a relatively high verbal ability might be necessary, but not sufficient, for children with ASD to pass false belief tasks (Baron-Cohen, 1989; Sparrevohn & Howie, 1995). It is therefore possible that children with high-functioning autism, who have higher verbal IQs than low-functioning children, may show delayed ToM development, while low-functioning children never achieve false belief reasoning skills.

The delayed development hypothesis is supported by the findings of a longitudinal study by Steele, Joseph, and Tager-Flusberg (2003), in which autistic children aged 4 to 14 years showed significant improvement in ToM abilities over the course of 1 year. In contrast to these results, however, longitudinal studies by Ozonoff and McEvoy (1994) and Holroyd and Baron-Cohen (1994) found no improvement in false belief scores of individuals with ASD at, respectively, 3 and 7 years after baseline testing. One explanation for these contrasting results might be that Steele et al. (2003) used a more developmentally sensitive test battery, rather than only false belief tests: for instance, they included tests for early developing aspects of ToM, such as desire-based action tasks. Indeed, those researchers found that most of the improvement took place between early ToM and first-order ToM abilities, which could not have been measured by the false belief tests used in the other two studies.

Another longitudinal study supports the results of Steele et al. (2003). Serra, Loth, van Geert, Hurkens, and Minderaa (2002) studied ToM development in 4-6-year-old children with PDD-NOS compared with controls matched on verbal and non-verbal mental age. They found that development of ToM abilities had taken place in the PDD-NOS group 6 months after baseline testing, but that this development was markedly slower than the typically developing control group, and was not statistically significant. Furthermore, the developmental pattern between the groups differed considerably. While the typically developing group showed a relatively stable phase followed by rapid increase in ToM scores, the PDD-NOS group showed a pattern of increase, decrease, and increase again before stabilizing. Burack and Volkmar (1992) also noted that children with ASD are more likely to show developmental regressions than are typically developing children, and low-functioning autistic children are more likely to show developmental regressions than are high-functioning autistic children.

When a different developmental sequence is seen, as is the case in Serra et al. (2002), or if the same level of performance is never reached, as seen in Ozonoff and McEvoy (1994) and

Holroyd and Baron-Cohen (1994), development is seen as *deviant* rather than *delayed* (Burack, 1992). Additional support for the deviance account of ToM development in ASD comes from a study comparing the ToM developmental sequence in normally developing, deaf, and autistic children. Peterson, Wellman, and Liu (2005) found that individuals with autism, aged 6 to 14 years, showed a different ToM developmental pathway to both typically developing children and deaf children with a ToM deficit. Although all children showed the same developmental sequence for acquiring early ToM abilities, children with ASD found the false belief task more difficult than a hidden emotions task, while normally developing, late-signing deaf and native signing deaf children found the hidden emotions task the most difficult. So, although both autistic and deaf children have deficits in ToM, this study suggests that deaf children follow the same developmental pattern as typically developing children, whereas autistic children may follow a different developmental pattern, which may be unique to autism.

These studies support both a delayed and deviant hypothesis for ToM development in ASD. ToM development does seem to occur, but it is slower and possibly follows a different developmental pattern to ToM in normally developing children. The results from the longitudinal studies by Holroyd and Baron-Cohen (1994) and Ozonoff and McEvoy (1994) further point to a possible ceiling effect in ToM development in ASD.

Studies have reported a correlation between level of functioning (in other words, low-functioning or high-functioning autism) and ToM test performance, but these correlations were non-significant once mental age matching was controlled for. This does not mean that there is no difference in ToM ability between HFA and LFA individuals. However, when autistic individuals are matched with children of a similar mental age or verbal IQ, level of functioning is no longer a statistically significant moderator variable because individuals with LFA are matched with children who are younger or have a lower mental age than the children matched with individuals with HFA (Yirmiya, Solomonica-Levi, Shulman, & Pilowsky, 1996).

Rival explanations to the ToM hypothesis of autism

A limitation of the ToM account of autism is that it cannot explain the non-social aspects of the disorder. Another theory that has therefore been proposed to explain the restricted and repetitive behaviour patterns, problems in planning and organizing, and the desire for sameness seen in autism is the theory of executive dysfunction (Happé & Uta Frith, 1996; Joseph, 1999). Executive function covers a wide array of cognitive skills, such as working memory, the ability to disengage from context, inhibition of inappropriate responses, planning, verbal ability and shifting attention set (Hill, 2004a; Pellicano, 2007). Executive function is closely related to ToM ability, and performance on executive function tasks predicts performance on ToM tasks (Hill, 2004b). This may be because ToM tasks also require executive function abilities. False belief tasks require the participant to keep the false belief in their working memory and inhibit the impulse to predict the person's action based on the reality of the situation (Tager-Flusberg, 2007). Indeed, autistic and normally developing children with better planning skills and inhibitory control score higher on false belief tests (Hill, 2004b). It may also be that development in ToM is necessary for the development of executive function, or conversely, that a deficit in executive functioning may lead to impairment in theory of mind development (Pellicano, 2007a). Shortcomings of the executive dysfunction theory of autism are that there is a disagreement in the literature as to what executive function abilities are impaired in ASD, and that executive dysfunction is not unique to ASD (Hill, 2004b).

More recently, the empathizing-systemizing theory (Baron-Cohen, 2004) proposes that individuals with ASD are hypersystemizing, along with having a deficit in empathizing. Empathy involves recognising others' mental states, which requires ToM, and responding in the appropriate emotional manner. The function of systemizing is to find the laws governing systems by carefully observing data in order to predict events. The hypersystemizing theory explains the repetitive behaviour or interests seen in ASD, which are usually directed towards systems with set rules, and their attention to detail (Baron-Cohen, 2008). Social interactions are not rule-bound and easily predictable, which may be why children with ASD do not show interest in imaginative play and struggle to understand conversation and emotion.

In conclusion, ToM seems to have a universal age of onset and developmental trajectory in typically developing children. However, contextual factors such as socioeconomic status may also influence the age at which ToM abilities develop. In comparison with typically developing children, children with ASD show severe delays in ToM development and deviance in the developmental trajectory of ToM. However, previous research on ToM in

ASD has mostly focused on ability to pass false belief tasks. Very few studies have looked at ToM using a range of developmentally sequenced tests. To get a more accurate picture of ToM in ASD it is thus essential to have a broad range of ToM tasks, some easier and some harder than the false belief task.

It is also known that performance on ToM tests differs between LFA and HFA individuals. What has not been studied, however, is whether ToM development is the same in LFA and HFA individuals. Research has typically focused on only LFA or only HFA individuals, although it is not certain that LFA and HFA individuals follow the same patterns of deviance and delay.

SPECIFIC AIMS/ HYPOTHESES

No studies have been done on ToM development in South African children, and it is currently unknown whether typically developing South African children will display the same age of onset of false belief reasoning, and more advanced ToM abilities, as children from other countries. If ToM abilities are influenced by cultural and contextual factors, South Africa is the ideal place to study the effects of these factors, as South Africa is a multidimensional country, where children attending the same schools may have very different cultural and socio-economic backgrounds.

Furthermore, it is still unclear to what extent ToM development takes place in children with ASD, specifically in the different subgroups of ASD. This study compared ToM abilities in typically developing and autistic children as a pilot for a larger future study in which HFA, LFA and typically developing participants in different age ranges will be compared on ToM. The following hypotheses are examined:

(1) False belief reasoning should develop at around age 4 years in typically developing South African children, consistent with the results of previous research in other countries.

(2) Children with ASD should show deficits in ToM, particularly false belief reasoning, compared to typically developing children.

(3) Poor performance on ToM tasks in ASD is due to a specific deficit in ToM, rather than general cognitive impairment.

METHODS

Research design and setting

This study was a pilot study for a larger research project that will examine ToM development in typically developing, HFA and LFA children. The study was an existing groups-comparison. The typically developing group was divided into three age groups in order to compare ToM at different ages. I used a cross-sectional design to compare the typically developing and ASD groups. Convenience sampling was used to obtain participants for the study.

Testing took place at the schools. Participants were tested in a quiet room free of distractions.

Participants

This study followed the ethical guidelines for research with human subjects outlined by the Health Professions Council of South Africa (HPCSA) and the University of Cape Town (UCT) Codes for Research. Ethical approval for this study was obtained from the Ethics Committee of the UCT Department of Psychology and from the Western Cape Education Department. Permission was also obtained from the relevant schools to use their students in the study. Informed consent and assent was obtained from participants and their parents (see Appendix B).

Nineteen typically developing children took part in the study. These participants were recruited from schools and daycare centres in the Cape Town area. The typically developing group was subdivided into three age bands in order to compare ToM at different ages. The age groups were: 3 years 0 months to 5 year 11 months (*n*=5), 6 years 0 months to 7 years 11 months (*n*=2), and 8 years 0 months to 13 years 0 months (*n*=13).

Eleven children with ASD between the ages of 6 and 11 years took part in the study. These participants were recruited from Western Cape schools that specialize in the education of children with autism. A condition of admission to these schools is a diagnosis of autism. A qualified clinician, independent of this study, made the diagnosis of ASD according to the criteria set out in the DSM-IV-TR (American Psychiatric Association, 2000). The ASD participants were compared with 13 typically developing children who were in the same age range.

Table 1. Demographic information of the ASD and Typically Developing (TD) groups.

Demographic Information	ASD (n=11)	TD (n=19)
Age Range (Years: Months)	6:11-11:7	3:8-12:9
Age (Years)		
Mean (SD)	8.82 (1.37)	8.5 (2.65)
Sex		
Male: Female	9: 2	8: 12
Language		
English: Afrikaans: Xhosa	8: 1: 2	16: 3: 0
Ethnicity		
White: Black: Coloured: Indian	4: 2: 3: 2	10: 1: 7: 1
Socio-economic status		
High: Medium: Low	4: 1: 4	11: 4: 2

Inclusion and exclusion criteria

Exclusion criteria included a history of head injury or infantile meningitis, ASD candidates with additional neurological conditions, and control candidates with any neurological conditions. Individuals with any serious social deficits, such as conduct disorder (CD) or oppositional defiant disorder (ODD), a communication disorder, attention-deficit hyperactivity disorder (ADHD) or any pervasive developmental disorder, or a history of these disorders, were excluded from the typically developing control group. Furthermore, participants were all fluent in English. Three participants were excluded from the study: two participants were excluded from the typically developing group because of English ability, and one because of failure to complete all the tasks.

Measures

Cognitive ability

To assess general intellectual functioning, the *Wechsler Abbreviated Scale of Intelligence* (WASI; Wechsler, 1999) was used for participants aged 6 years and older, and the revised *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI-R; Wechsler, 1989) for participants younger than 6 years. The WASI has been standardized and normed for individuals between the ages of 6 and 89 years, and the WPPSI-R for children between the ages of 2 years 11 months and 7 years 3 months. All four subtests were administered to obtain VIQ and performance IQ (PIQ) scores.

Four subtests from the fourth United Kingdom (UK) edition of the *Wechsler Intelligence Scale for Children* (WISC-IV[UK]; Wechsler, 2004) were administered to obtain a

measure of working memory and processing speed. I used the Digit Span and Letter-Number Sequencing subtests to get a measure of working memory. To obtain a measure of processing speed, the Coding and Symbol Search subtests were used.

The *Delis-Kaplan Executive Function System* (D-KEFS; Delis, Kaplan, & Kramer, 2001) measures key components of executive function. The D-KEFS has been standardized and normed for populations between the age of 8 and 89 years, and has a high content validity for assessing executive function. The Verbal Fluency and Colour-Word Interference subtests were administered. Verbal Fluency measures both lexic and semantic generativity. Colour-Word Interference, based on the Stroop (1935/1992) test, measures the participant's ability to inhibit an overlearned verbal response. As the D-KEFS was administered from the age of 6 years in this study, and the ASD and typically developing groups were of similar age, raw scores rather than scaled scores were used to compare the groups.

Theory of Mind

Eleven ToM tasks were administered. The battery was adapted from that used by Steele, Joseph and Tager-Flusberg (2003), and similarly to theirs, was divided into three developmentally sequenced batteries: early, basic and advanced ToM. It differs from the Steele et al. (2003) battery in that the Perception-Knowledge task was moved from the basic to the early battery in this study, as it was judged that this ability develops somewhat earlier than false belief reasoning. The Explanation of Action task was added to the basic battery and two of the advanced tasks (namely, Traits and Moral Responsibility) were replaced with other tasks (Strange Stories and Faux Pas) that measure ToM ability directly, rather than performance on factors associated with ToM.

The early battery consisted of three tasks: Desire, Pretend/Attributing Agency, and Perception-Knowledge. The basic battery consisted of four tasks: Explanation of Action, Location-Change False Belief (Sally-Anne task), Unexpected-Contents False Belief (the Smarties task), and Sticker Hiding. The advanced battery also consisted of four tasks: Second-order False Belief, Lies and Jokes, Strange Stories (Happé, 1994), and Faux Pas (Baron-Cohen et al., 1999). The tasks included both test and control questions, with the exception of Pretend, Sticker Hiding and Strange Stories. All tasks, except those using dolls and the advanced Faux Pas task, also had accompanying pictures to minimize linguistic and memory demands.

Early Battery

The *Pretend* task was designed for this study and tests the ability to use a doll as an independent agent in a pretend situation. The original task by Kavanaugh, Eizenman and Harris (1997) and Steele et al. (2003) was judged to be inappropriately female-gender stereotyped. Stories were therefore changed to depict gender-neutral events. The task consists of four stories. Participants are asked to complete the stories by acting out the next event using the dolls (see Appendix C).

The *Desire* task (Steele et al., 2003; Wellman & Woolley, 1990) tests the ability to predict action based on a character's stated desire. The task contains two picture stories. In each of the two stories the protagonist is looking for an object that is in one of two named locations. The character fails to find the object in the first location. Participants are asked whether the protagonist will keep on searching and why.

The *Perception-Knowledge* task (Pratt & Bryant, 1990; Steele et al., 2003) tests the ability to know that a character obtains knowledge from visual access. The task contains four control questions, alternated with four test questions in which one doll looks into a box and another pushes the box. The child is asked which doll knows what is inside the box.

Basic Battery

The *Location-Change False Belief* task (Baron-Cohen et al., 1985; Steele et al., 2003; Wimmer & Perner, 1983) contains two picture stories wherein an object is moved while the main character is out of the room. The child is asked whether the character knows where the object is, where the character will look for the object, and why the character will look there.

In the *Unexpected-Contents False Belief* task (Perner, Leekam & Wimmer, 1987, in Steele et al., 2003) participants are shown four familiar containers with unexpected contents inside. The child is asked, "When you first saw the box, all closed up, what did you think was inside?" and "When X comes into the room, and sees the box all closed up, what will he/she think is inside?"

The *Explanation of Action* task (H. B. Tager-Flusberg, personal communication, March 14, 2008) contains 12 stories in which an action based on an emotion, desire, cognitive process (think, know or forget) or non-mental event is portrayed. The child is asked why the character performs the action, and what is going on in the character's head when the action is performed.

The *Sticker Hiding* task (Devries, 1970; Steele et al., 2003) is a deception task wherein the participant is required to hide a sticker from the experimenter. The task starts with six

practice trials wherein the experimenter hides a sticker in one, both or neither hand so that the child will guess the location of the sticker correctly at least once, and incorrectly at least once. The child then hides the sticker for ten trials, of which the last five are scored for ability to hide the sticker from the experimenter. Points are given for (1) taking both hands behind the back to hide the sticker, (2) bringing both hands to the front, (3) keeping both hands closed until the experimenter has made a guess, and (4) keeping the sticker completely invisible in the hand.

Advanced Battery

The *Second-order False Belief* task (Ozonoff & McEvoy, 1994; Steele et al., 2003) consists of two picture stories, and tests knowledge of a character's beliefs about a second character's beliefs. The child is asked an ignorance ("Does Mom know what you are making her for Mother's Day?"), belief (What does Mom think you are making her for Mother's Day?"), and justification question.

The *Lies and Jokes* task (Steele et al., 2003; Winner, Brownell, Happé, Blum, & Pincus, 1998) consists of two picture stories, one containing a lie and one a joke. In each story, a child character says something that the parent knows to be untrue. In the joke version, the child knows that the parent knows the truth, while in the lie version the child does not know that the parent knows the truth. Participants are asked whether the child's statement is a lie or a joke, and are asked to justify their answer.

Strange Stories (Happé, 1994) consists of 24 illustrated stories of 12 types: lie, white lie, joke, pretend, double-bluff, persuasion, forgetting, misunderstanding, figure of speech, appearance-reality, irony and contrary emotions. Participants are asked whether it is true what the character says, and why the character said it.

The child version of the *Faux Pas* task (Baron-Cohen et al., 1999; Stone, Baron-Cohen, & Knight, 1998) contains five control questions depicting a normal social event, and five test questions wherein a character says something awkward or embarrassing. After a story is told the child is asked, "Did anyone say something they shouldn't have said or something awkward?" If they respond yes, it is asked, "Who said something they shouldn't have said or something awkward?", "Why shouldn't he/she have said it or why was it awkward?", and "Why do you think he/she said it?". The original task by Baron-Cohen and colleagues (1999) contained ten control and ten test questions that differed in only one detail. However, it was thought that this repetition of stories could be confusing for children. Therefore the test was split into two versions, so that if a certain test question was in Version A, its matching control

was in Version B, and thus stories were not repeated. The examiners alternated between the versions after each child.

As previously mentioned, the typically developing group was subdivided into three age bands: 3-5 years, 6-7 years, and 8-13 years. It was hypothesized that typically developing 3-year-olds would mostly succeed on the desire and pretend tasks, while failing first-order false belief tasks. It was hypothesized that 4 and 5-year-old children would pass first-order false belief tasks, but fail second-order false belief tasks. On average, the 3-5 years age group should thus pass the early and basic ToM batteries. The 6-7 years age group should pass first- and second-order false belief tasks, but may struggle on more advance tasks of ToM, such as the Faux Pas task. The typically developing 8-13 years age group should be able to pass all the tasks. The typically developing groups were compared on level of ToM attained by comparing the total ToM score for each age group.

For the comparison between the ASD and typically developing group, performance on the basic battery was investigated, as this battery tests the critical ToM ability of false belief reasoning.

Procedure

All tasks were piloted beforehand on normally developing children ($n = 6$) in the relevant age range. Some questions on the advanced battery were adjusted to reduce language demands and be more culturally appropriate.

Written informed consent was obtained from the participants' parents or guardians beforehand. The parents or guardians also completed a demographic questionnaire (see Appendix D) to obtain information about any factors that might influence ToM development and to identify children who met any of the exclusion criteria. Informed assent was obtained from the participants on the day of testing.

Testing took place over two sessions of approximately 90 minutes each. During the first session, the WASI (Wechsler, 1999) or WPPSI-R (Wechsler, 1989) was administered. The Verbal Fluency and Colour-Word Interference subtests from the D-KEFS (Delis et al., 2001) were administered to children older than 6 years of age.

During the second session, the four subtests from the WISC-IV [UK] (Wechsler, 2004) were administered to children 6 years and above. The ToM battery was administered next. Typically developing children under 6 years of age, and all children with ASD, always started on the early ToM battery, and proceeded to the next battery if they attained at least half the maximum score. Children between 6 and 7 years-old started on the basic battery, and if they

attained at least half of the maximum score, received full credit for the early battery, and proceeded to the advanced battery. If they attained less than half the maximum score, they were tested on the early battery and did not proceed to the advanced battery. Wellman and Liu (2004) found that if children passed a more advanced ToM test, they passed all easier ToM tests. Thus, not testing those children who pass the basic battery on the early battery should not affect the validity of the results.

Similarly, children 8 years and older started on the advanced battery and if they attained at least half the maximum score, received full points for the early and basic batteries. If they attained less than half the maximum score, they were tested on the basic battery.

The stories were printed out with accompanying pictures, and left in front of the child for the duration of the questions to minimize memory and linguistic demands. Participants were also allowed to rest if they experienced fatigue during testing.

Data analysis

I looked at ToM performance in typically developing children in three age groups using descriptive statistics. Due to the small sample sizes no further analyses were done on these groups. I compared false belief reasoning ability in typically developing and ASD children in a single age group using a *t*-test. General cognitive abilities were compared using *t*-tests for VIQ and PIQ, working memory and processing speed, and a mixed ANOVA with one repeated measure to compare executive function. Four analyses of covariance were performed with VIQ, working memory, processing speed and executive function as potential covariates to ToM.

All statistical analyses were performed using STATISTICA version 8 (StatSoft, Inc, 2007). I had small and unequal sample sizes in my groups, and some of the assumptions on normality and heterogeneity of variance were not met. Furthermore, because of the large number of tests done, the possibility of making Type I errors in the analyses were high. However, using non-parametric analyses would reduce power. To compensate between lack of statistical power and the risk of having less reliable results, I used a high significance level throughout my analyses. An alpha level of 0.01 was used as the threshold for statistical significance in all analyses. This also allowed me to conduct analyses of variance in order to control for cognitive factors possibly influencing ToM performance in the ASD group.

RESULTS

ToM in typically developing children

Children were scored on the early, basic and advanced batteries and also given a total ToM score. The Pretend task in the early battery and the Sticker Hiding task in the advanced battery were not scored due to a lack of control questions on these tasks, and were only used to make qualitative observations of ToM ability.

It was hypothesized that false belief reasoning develops at around 4 years of age. In Age Group 1, the two youngest participants, who were 3 years 10 months (3:10) and 4 years 7 months (4:7) old, failed the basic battery (the 3-year-old participant also failed the early battery). The three older participants (4:10, 5:1, and 5:9) all passed the basic battery. On average, Age Group 1 passed the basic battery (see *Table 2*). This is significant because the basic battery consists mostly of false belief tasks. False belief reasoning thus developed at around 4 years of age, as was hypothesized.

Table 2. Typically developing children's ToM scores on the early, basic and advanced batteries.

	Age (Years: Months)	N	Early ToM Control (max=8)	Early ToM Test (max=8)	Basic ToM Control (max=33)	Basic ToM Test (max=33)	Advanced ToM Test (max=131)	Total ToM Score (max=172)
Age Group 1	3:0-5:11	5	7.20 (0.84)	6.20 (1.30)	27.60 (6.50)	19.40 (13.79)	35.40 (34.78)[a]	61.00 (47.71)[a]
Age Group 2	6:0-7:11	2	8.00 (0.00)	8.00 (0.00)	31.50 (2.12)	29.00 (5.66)	94.50 (7.78)	131.50 (13.44)
Age Group 3	8:0-13:0	12	8.00 (0.00)	8.00 (0.00)	33.00 (0.00)	32.50 (1.73)	105.58 (8.35)	146.08 (8.88)

[a] *n=3*
Note: Means are presented with standard deviations in parentheses.

Performance on the advanced battery similarly increased with age (see *Table 2*). Children in the age group 3-5 years performed poorly on the Strange Stories and Faux pas tasks and, on average, did not pass either of these tasks. Children in the age group 6-7 years passed these tasks, but performed more poorly than children in the 8-13 age group (see *Figure 1*). However, performance on two tasks in this battery, the Second-order False Belief and Lies and Jokes tasks, did not show a clear increase with age. *Table A* (Appendix E) shows the breakdown of scores for each task in the advanced battery.
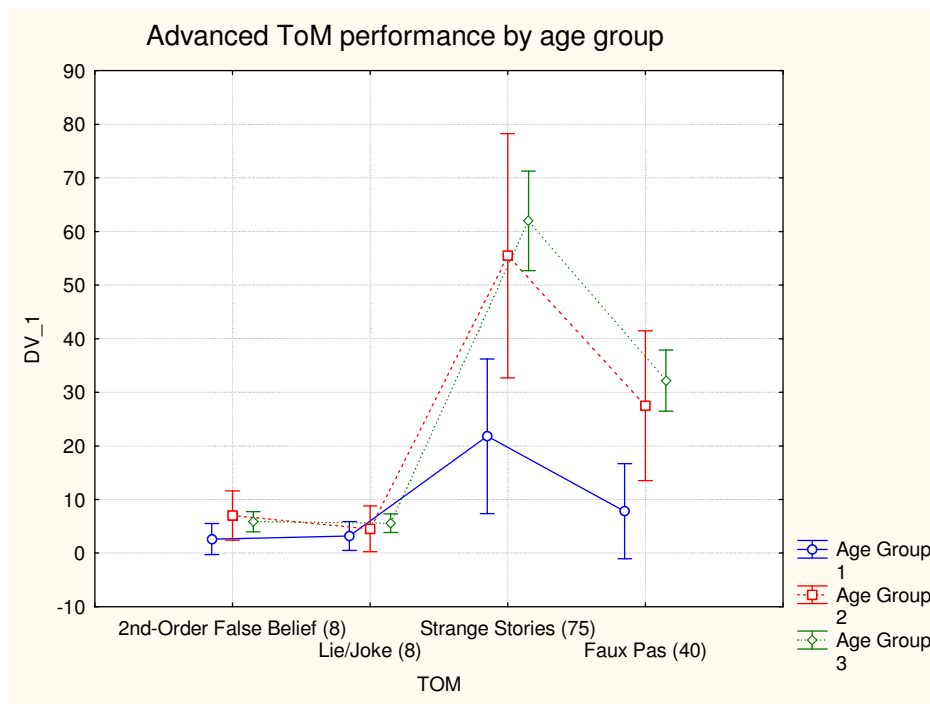
Figure 1: Typically developing children's performance on the subtests of the advanced battery.

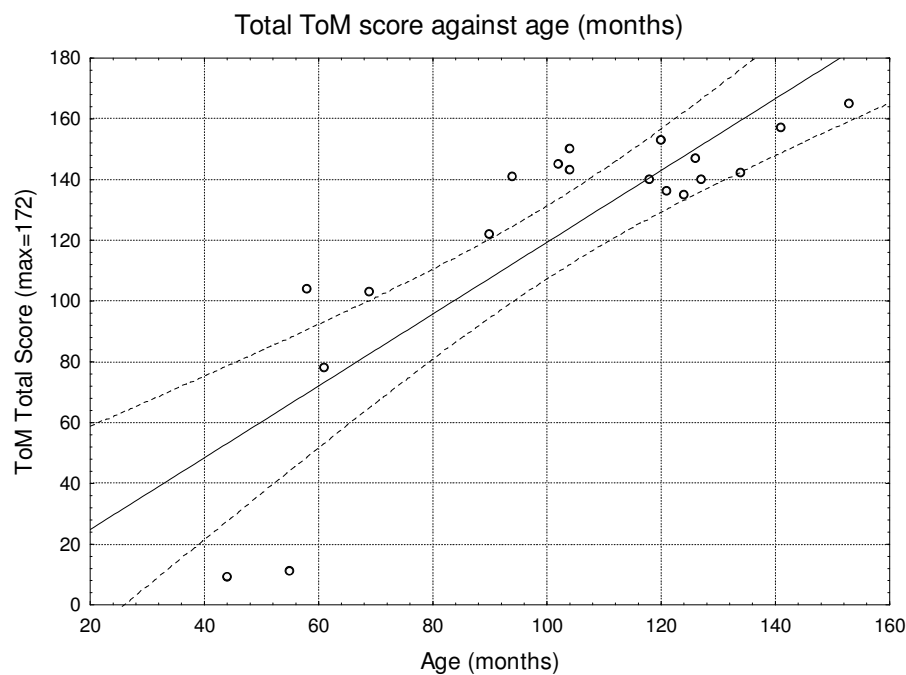Overall, ToM performance showed a clear increase with age in the Typically Developing group (see *Figure 2*).

Figure 2. ToM development in typically developing South African children aged 3-13 years.

ToM in ASD

ToM

Independent *t*-tests were conducted to investigate the hypothesis that children with ASD have a specific ToM deficit. Children with ASD (ages 6:11-11:7) were compared to similarly aged typically developing children. The mean age was 8.82 years (*SD*=1.37) for the ASD group and 9.65 years (*SD*=1.3) for the Typically Developing group, *t*(22)= -1.52, *p*=.14. There was thus no significant age difference that could lead to differences in performance between the groups.

The ASD group scored significantly lower on the ToM questions than the Typically Developing group, *t*(22)= -10.21, *p*=.0000001 (see *Table 3*). The ASD group also scored significantly lower than the Typically Developing group on the control questions *t*(22)= -3.45, *p*=.002. However, a dependent group t-test showed that the ASD group still scored significantly lower on the ToM questions than on the control questions, *t*(10)= 4.34, *p*=.001, indicating that there is a ToM deficit in the ASD group.

Table 3. Descriptive statistics for performance on the basic ToM battery.

Measure	ASD	TD	Group Differences		Effect Size
	(*n*=11)	(*n*=13)	*t* (22)	*p*	*d*
Basic ToM Control Questions	25.91 (7.13)	32.77 (0.83)	-3.4536	0.002262	1.41
Basic ToM Test Questions	12.00 (6.43)	31.92 (2.66)	-10.2121	0.0000001	4.19

Note: Means are presented with standard deviations in parentheses.
TD=Typically Developing

Performance on general intellectual functioning, executive functioning, working memory and processing speed tasks were examined next to eliminate the possibility that the ASD group's poor performance on the ToM tasks were due to factors other than a specific ToM deficit (e.g., poor inhibition or verbal ability).

General Intellectual Functioning

The Typically Developing group had VIQ and PIQ scores consistent with the established Western population norms (see *Table 4*). As expected, the ASD group performed more poorly than the Typically Developing group on VIQ, *t*(22)= -10.10, *p*=.000001. There was no significant difference in PIQ between the ASD and Typically Developing group, *t*(22)= -2.04, *p*=.054.

Table 4. IQ, working memory, and processing speed means and differences between the ASD and Typically Developing (TD) group, ages 7 -11 years.

	ASD	TD	Group Differences		Effect Size
	(*n*=11)	(*n*=13)	*t* (22)	*p*	*d*
WASI					
Verbal IQ	75.18 (5.02)	107.92 (9.69)	-10.0962	0.000001	4.14
Performance IQ	89.91 (8.31)	98.92 (12.48)	-2.0398	0.053558	0.84
WISC-IV					
Working Memory Index	10.00 (3.44)	19.38 (3.84)	-6.25493	0.000003	2.56
Processing Speed Index	8.45 (2.50)	19.77 (3.85)	-8.34404	0.000001	3.42

Note: Means are presented with standard deviations in parentheses.

Working memory and processing speed

The ASD group had significantly lower scores than the Typically Developing group on both the WISC-IV Working Memory Index, $t(22)= -6.25$, $p=.000003$, and the WISC-IV Processing Speed Index, $t(22)= -8.34$, $p=.000001$ (see *Table 4*).

Executive function

Raw scores were used to compare the participants on the tasks as the groups had similar ages. A mixed factorial analysis of variance was conducted to determine differences between the groups and task types (see *Table B*, Appendix E). There was a significant difference in type of task, $F(1,21) =183.60$, $p=.000001$, $\eta^2=.90$. Furthermore, there was a significant interaction effect between the group and type of task, $F(6,21) =18.54$, $p=.000001$, $\eta^2=.47$. The ASD group performed more poorly on both the Verbal Fluency and Colour-Word Interference tests (see *Table 5*). These findings are consistent with the literature on executive dysfunction in ASD (Hill, 2004a; Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen, 1999).

Table 5. Performance on the D-KEFS Verbal Fluency and Colour-Word Interference tasks by typically developing and ASD children, aged 7 -11 years.

Measure	*ASD*	*TD*	**Group Difference**
	(*n*=11)	(*n*=13)	*p*
D-KEFS Verbal Fluency			
Letter Fluency	13.90 (5.65)	22.38 (5.20)	0.995573
Category Fluency	18.10 (6.47)	32.62 (5.97)	0.728981
Total Correct Responses	32.00 (10.75)	55.00 (9.93)	0.065815
D-KEFS Colour-Word Interference			
Inhibition	118.30 (39.62)	85.46 (20.10)	0.000285
Inhibition /Switching	151.00 (37.35)[a]	89.31 (21.05)	0.000023
Total Errors: Inhibition	8.20 (6.43)	3.77 (2.74)	0.999997
Total Errors: Inhibition /Switching	9.60 (4.72)[a]	3.15 (2.85)	0.999748

[a] *n*=10

Means are presented with standard deviations in parentheses.

TD=Typically Developing
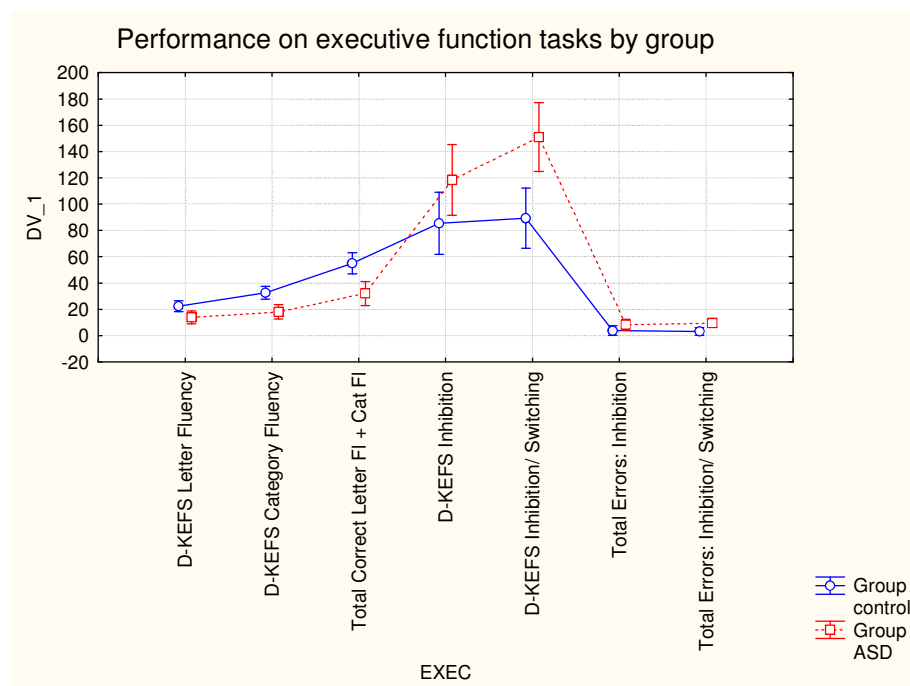
Figure 3. Cell mean plots of the interaction effect between type of executive function task and group.

It was also examined whether the observed differences in completion time for the Inhibition/Switching task between the Typically Developing and ASD groups were due to slower reading speed in the ASD group. Controlling for reading speed, there was still a significant difference between the ASD and Typically Developing groups on Inhibition/Switching, $F(1,20)=18.67$, $p=.0003$, $\eta^2=.48$. Thus, differences in performance between the groups are due to executive function differences.

Next, a series of ANCOVAs (analysis of covariance) were performed to determine whether there would still be a difference in ToM performance between the groups when controlling for VIQ, executive function, working memory and processing speed (see *Tables C-F*, Appendix E). When the influence of VIQ was held constant, ToM still differed significantly between the ASD and Typically Developing groups, $F(1,21)=9.46$, $p=.006$, $\eta^2=.31$. Verbal IQ did not have a significant effect on ToM performance, $F(1,21)=2.19$, $p=.15$.

For the ANCOVA using executive function as a possible covariate, the Inhibition/Switching task was chosen as the most representative of executive function differences between the ASD and Typically Developing groups as it showed the largest difference between the groups ($p=.00002$). When the influence of executive function was held constant, a significant difference in ToM between the ASD and Typically Developing groups was again present ($F(1,20)=54.03$, $p=.0000001$, $\eta^2=0.73$). Executive functioning did not have a significant effect on ToM performance ($F(1,20)=0.34$, $p=.56$).

When working memory was held constant, a significant difference in ToM between the ASD and Typically Developing groups was again found ($F(1,21)=36.72$, $p=.000005$, $\eta^2=0.64$). Working memory did not have a significant effect on ToM performance ($F(1,21)=0.008$, $p=.93$).

When the influence of processing speed was held constant, a significant difference in ToM score between the ASD and Typically Developing groups was still present ($F(1,21)=14.35$, $p=.001$, $\eta^2=0.41$). Processing speed did not have a significant effect on ToM performance ($F(1,21)=2.53$, $p=.13$).

In summary, ToM differences between the Typically Developing and ASD groups were significant, even after controlling for differences in VIQ, executive function, working memory and processing speed between the groups. Thus, ToM significantly contributes to false belief reasoning, over and above any effects of language ability, executive function, working memory and processing skills.

DISCUSSION

ToM in typically developing children

Some of the earliest ToM precursor abilities to develop are joint attention and pretend play. Previous studies, mostly based in the United States or United Kingdom, showed that children's understanding of desires develops at around age 2 years, and false belief reasoning at around age 4 years. Understanding second-order false belief and differentiating between

lies and jokes develops at approximately 6 years of age, and understanding socially awkward or embarrassing scenes at around 9-11 years old.

In this South African sample, false belief reasoning developed between 4 and 5 years of age. This result is consistent with results from previous studies (Callaghan et al., 2005; Wellman et al., 2001) and provides support for the hypothesis that ToM is a result of brain maturation, so that ToM universally develops at a certain age, independent of cultural factors.

The tasks used in the early battery were Desire, Pretend and Perception-Knowledge. These abilities have all been shown to develop at around 2-3 years of age (Kavanaugh et al., 1997; Pratt & Bryant, 1990; Wellman & Woolley, 1990), and typically developing children in the sample should thus perform well on all of these tasks. Indeed, this was the case for all the children, except for the 3-year-old participant. This participant performed at chance level. This may indicate that the participant was guessing, or that these abilities have started to develop, but were not fully online yet.

This study used a novel developmentally sequenced battery to examine a range of ToM abilities, from pretend play to advanced abilities such as faux pas understanding. The battery also included some tasks that were less verbally demanding such the deceptive strategy game Sticker Hiding, and the early ToM tasks that use dolls. As this battery has never been used in South Africa before, a part of this pilot study was to see whether this battery is sensitive to developmental change in ToM in a South African sample. In the early and basic batteries, ToM performance clearly increased with age, indicating that the battery is accurately measuring ToM development. However, performance on the advanced tasks showed less clear improvement with age, even though previous studies found that these abilities develop at specific ages.

The Strange Stories and Faux Pas tasks showed clear improvement in performance with age. Children in the youngest age group (3-5 years) failed both of these tasks. Children in the middle age group (6-7 years) passed the tasks, but performed more poorly than children in the highest age group (8-13 years). The Faux Pas task was also clearly the most difficult of the ToM tasks. This was expected from the results of previous studies (Baron-Cohen et al., 1999; Happé, 1994).

However, second-order false belief development in the sample was less clear. This may be because the two tasks on which second-order false belief was measured were not equal in difficulty. The second task proved to be more difficult than the first task, though both dealt with second-order false belief understanding. Adjusting the tasks so that they are of an equal

difficulty level may render the age at which this ability develops in typical South African children more apparent.

Similarly, the task measuring the ability to distinguish a lie from a joke did not show a clear increase in performance with age. This may be due to the different cultural evaluations of the scenario. The task features two stories wherein a child tells a parent something that is not true about a task that he or she was asked to complete. In one version the child does not know that the parent knows the truth, while in the other version the child *knows* that the parent knows, and thus has nothing to gain by lying. It is possible that participants in this sample always interpreted the child's statement, "I did a really good job [on the task]", as a lie rather than as a joke because a joke seemed inappropriate in a setting where the child is talking to an authority figure. Future work should focus on adapting the task to a South African setting. Also important is that the adult version of this task phrases the question so that the underlying mental state is much more apparent. In the child version the participant is simply asked, "Was he lying or just joking?", while in the adult version the participant is asked "Was he lying to avoid getting caught, or joking to cover up his embarrassment?" By including the speaker's motivation for the false utterance, the distinction between lying in joking is made clear so that participants do not fail due to different interpretation of the words *lying* and *joking*.

Overall, ToM performance increased with age in the sample, as is expected. ToM ability at different ages in the sample was also roughly consistent with the norms of previous studies (e.g., Chasiotis et al., 2006; Wellman et al., 2001). Of specific importance is the development of false belief reasoning, which has been used as the standard task to compare ToM across cultures. South African children older than 4 years passed the false belief task, which is consistent with performance in other countries.

Comparing ToM in ASD and typically developing children

Individuals with ASD do not engage in pretend play or joint attention. They struggle to understand simple mental states such as desire, as well as the more complex mental states such as *think* and *know* that are typically assessed in false belief reasoning tasks. Autistic individuals furthermore do not understand non-literal speech, such as irony.

The ASD children tested in this study ranged between 7 and 11 years of age, and were compared with similarly-aged typically developing children. Typically developing children in this age group perform well on false belief tasks, as well as on more complex ToM tasks such as understanding non-literal speech. It was hypothesized that the ASD group would not pass

the basic ToM battery, which is made up of several false belief tasks, as well as a task requiring the ability to identify mental states influencing behaviour. As predicted, a significant difference in performance on the basic ToM battery was found between the ASD and Typically Developing group. This deficit in ToM is consistent with the results of previous studies on ToM in ASD (e.g., Baron-Cohen et al., 1985; Naito et al., 1994; Steele et al., 2003).

As for performance on the early ToM battery, most children with ASD performed at higher-than-chance levels. These results indicate that many individuals with ASD *do* have an understanding of simple mental state concepts, such as desire, consistent with some previous finding on ASD (see Baron-Cohen & Swettenham, 1997; Steele et al., 2003). Interestingly, although a lack of pretend play is common in ASD, all the ASD participants excelled in the Pretend task in the early ToM battery. This may be due to play therapy sessions given at the school, and is a testimony to the beneficial effects that early intervention in ASD can have.

There is some dispute over what the core deficits in ASD are that lead to autistic children failing ToM tasks. It is argued that poor ToM performance may be the result of a broader domain-general deficit in executive function (Hill, 2004; Joseph, 1999), rather than a specific ToM deficit. Poor working memory, needed to hold in mind the true location of the object as well as the protagonist's belief of where the object is, may cause participants to fail false belief tasks (Bloom & German, 2000). The participant is furthermore required to inhibit the response of where the object really is, and give the location where the protagonist believes the object to be. Individuals with executive dysfunction should thus perform more poorly on ToM tasks. Importantly, however, after controlling for the influence of executive function, a significant difference in ToM between the ASD and Typically Developing group still remained, indicating a Tom deficit over and above the executive function deficits seen in ASD.

Studies have shown correlations between language ability and ToM (see Milligan, Astington, & Dack, 2007). False belief tasks can have high language demands as participants are asked to justify their answers to ToM questions. Poor verbal ability, rather than a lack of ToM, may therefore cause individuals to fail false belief tasks. Furthermore, good linguistic skills may be necessary for the higher-order representations needed for advanced ToM tasks, such as second-order false belief. An ANCOVA with VIQ as a potential covariate was therefore performed to assess what influence linguistic ability has on ToM performance. After controlling for VIQ, a significant difference in ToM ability between the ASD and Typically Developing group remained. This shows that, although ASD participants have lower VIQ

scores than typically developing participants, poor performance on ToM tasks in ASD is not solely due to poor language skills. An alternate explanation for the correlation between language and ToM may be that ToM is needed for language development. For instance, a powerful way of learning is through joint attention; a skill which is absent in autism.

It is clear from these results that the executive dysfunction hypothesis cannot adequately explain the deficits in ToM seen in ASD. The ToM account of ASD explains the deficits in social interaction and communication, but is unable to explain the repetitive and stereotyped behaviours associated with ASD. The systemizing-empathizing theory (Baron-Cohen, 2008) therefore proposes that individuals with ASD are hypersystemizers and poor empathizers. This account of ASD can explain both its social and non-social aspects. The systemizing-empathizing theory explains repetitive behaviours as resulting from autistic individuals' search for underlying rules in systems. Empathy includes both the understanding of others' mental states – thus, having ToM – and responding appropriately to these mental states. Individuals with ASD struggle with both verbal and non-verbal communication, as well as social interaction, because of difficulties in understanding others' mental states. A lack of empathy thus explains these social deficits seen in ASD. Furthermore, it is proposed that social intelligence is separate from general intelligence (Baron-Cohen et al., 2008), which explains why general cognitive factors such as IQ or executive function cannot fully account for ToM deficits in ASD. In summary, the systemizing-empathizing hypothesis of ASD provides a way of explaining the social and communicative aspects of autism, which cannot be explained by the executive dysfunction hypothesis, as well as the non-social aspects of autism, which cannot be explained by the ToM hypothesis of ASD.

Limitations and future directions

This study was a pilot for a larger study which will be conducted next year, and had small sample sizes and unequal groups. This meant that some of the assumptions on normality of data distribution and homogeneity of variance were violated, threatening the reliability of the results. Furthermore, because of the large number of tests done, the possibility of making Type I errors in the analyses were high. Due to the small sample sizes, the study also had very little statistical power. To simultaneously limit the possibility of Type I errors and increase statistical power, I conducted parametric tests and increased my significance level to 99%. By doing so, there was less possibility of finding false significant results and a better chance to correctly reject false null hypotheses. This limitation will further be addressed next year by getting a larger sample with equal numbers of participants in the groups. As all the

groundwork has been done this year to set up contacts with the relevant schools in the Cape Town area, it will not be difficult to gain entry to the schools and expand the sample size.

Three ASD participants could have gone on to the advanced battery. Due to time constraints this was not possible. This meant that the total ToM score of the typically developing and ASD groups could not fairly be compared, and thus performance on the basic battery was used to compare the groups. As most ASD participants failed the basic battery, the results should not be significantly affected by the fact that these children could not complete the advanced battery. This can also easily be addressed in the future when there is more time to conduct all the relevant tests. It is interesting to note that these participants were not older than the others, and did not score notably higher on VIQ or executive function. Any factors correlated with their increased ToM performance can be appropriately explored next year when the sample size is larger.

Only high-functioning autistic participants were tested in this study. This is, in fact, the case with most studies on ToM in autism. It is important for future studies to determine whether the development of ToM in HFA and LFA individuals is the same. If different development patterns are observed between these groups, for instance a developmental delay in one group and deviance in the other, this impacts on the interpretation of results of previous studies where only HFA or only LFA participants have been studied. This, in turn, would lead to a greater understanding of ToM ability and its development in ASD.

CONCLUSION

ToM abilities develop from a young age. Typically developing children show a progression from understanding simple mental states such as desire to understanding complex social situations. ToM deficits in ASD lead to impaired communication, socialization and imagination in these individuals. Using a developmentally sequenced ToM battery, it was found that ToM abilities in typically developing South African children develop at the same age as that seen in previously studied children from other countries. Children with ASD performed consistently more poorly on the ToM tasks than typically developing children. A good understanding of ToM development is needed to develop better targeted intervention programmes for children with autism spectrum disorders. ToM development is not only important for educators and therapists working with children with ASD, however. It is as important for those working with typically developing children, because of the critical role of ToM in our everyday social interactions and communication with others.

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APPENDIX A

DSM-IV-TR diagnostic criteria for autistic disorder

A. A total of six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):
    1. qualitative impairment in social interaction, as manifested by at least two of the following:
        a. marked impairment in the use of multiple nonverbal behaviours such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
        b. failure to develop peer relationships appropriate to developmental level
        c. a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
        d. lack of social or emotional reciprocity
    2. qualitative impairments in communication as manifested by at least one of the following:
        a. delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)
        b. in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others
        c. stereotyped and repetitive use of language or idiosyncratic language
        d. lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level
    3. restricted repetitive and stereotyped patterns of behaviour, interests, and activities, as manifested by at least one of the following:
        a. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
        b. apparently inflexible adherence to specific, nonfunctional routines or rituals
        c. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)
        d. persistent preoccupation with parts of objects
B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.
C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder.

APPENDIX B

Ethical approval to conduct research

UNIVERSITY OF CAPE TOWN

Department of Psychology
Research Ethics Committee
Rondebosch, 7701
Tel: 27 21 6504608 Fax: 27 21 6504104
E-mail: kevin.thomas@uct.ac.za

02 May 2008

REFERENCE NUMBER: 2008004

Michelle Robberts
Department of Psychology
University of Cape Town

Dear Ms. Robberts:

PROJECT TITLE: Theory of mind abilities in children with autistic spectrum disorders and normally developing children

Thank you for your submission to the Department of Psychology Research Ethics Committee.

It is a pleasure to inform you that the Committee has **granted approval** for you to conduct the study, on the **condition** that you address the following:

- In your application form, you state that you will be recruiting 160 participants and that each of them will be involved in three test sessions. This procedure requires a time commitment from the researcher that is beyond the scope of an Honours project.
- In point #5 of your informed consent document (the purpose of the study), you give information ("theory of mind") that participants are unlikely to understand; please find a way to put re-state this part of the document in terms that are accessible to the intended readers.
- The first paragraph of your informed consent document should be modified to make it clear that parents are being asked to allow their child to take part in a research study.
- No assent forms have been provided for the children. The Committee thinks it is important that the children themselves should be given an opportunity to agree (or decline) to participate, and that this assent is obtained by the researcher and not simply left to the discretion of the parent.

Please make the appropriate revisions to the satisfaction of your research supervisor.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator and the research supervisor.

Please quote your REFERENCE NUMBER in all your correspondence.

Yours sincerely,

Professor Johann Louw
Chairman, Department of Psychology Research Ethics Committee

Navrae	
Enquiries	**Dr RS Cornelissen**
IMibuzo	
Telefoon	
Telephone	**(021) 467-2286**
IFoni	
Faks	
Fax	**(021) 425-7445**
IFeksi	

Wes-Kaap Onderwysdepartement

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

Verwysing	
Reference	**20080827-0056**
ISalathiso	

Ms Michelle Robberts
A702 The Claremont
CLAREMONT
7708

Dear Ms M. Robberts

RESEARCH PROPOSAL: THEORY OF MIND DEVELOPMENT: A COMPARISON OF CHILDREN WITH AUTISM SPECTRUM DISORDERS AND TYPICALLY DEVELOPING SOUTH AFRICAN CHILDREN.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1.   Principals, educators and learners are under no obligation to assist you in your investigation.
2.   Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3.   You make all the arrangements concerning your investigation.
4.   Educators' programmes are not to be interrupted.
5.   The Study is to be conducted from **1st September 2008 to 26th September 2008**
6.   No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7.   Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
8.   A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9.   Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:
     The Director: Research Services
     Western Cape Education Department
     Private Bag X9114
     CAPE TOWN
     8000
We wish you success in your research.

Kind regards.

Signed: Ronald S. Cornelissen
for: **HEAD: EDUCATION**
DATE: 29th **August 2008**

MELD ASSEBLIEF VERWYSINGSNOMMERS IN ALLE KORRESPONDENSIE / PLEASE QUOTE REFERENCE NUMBERS IN ALL CORRESPONDENCE / NCEDA UBHALE IINOMBOLO ZESALATHISO KUYO YONKE IMBALELWANO

GRAND CENTRAL TOWERS, LAER-PARLEMENTSTRAAT, PRIVAATSAK X9114, KAAPSTAD 8000
GRAND CENTRAL TOWERS, LOWER PARLIAMENT STREET, PRIVATE BAG X9114, CAPE TOWN 8000

WEB: http://wced.wcape.gov.za

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UNIVERSITY OF CAPE TOWN
DEPARTMENT OF PSYCHOLOGY

Informed Consent to Participate in Research and
Authorization for Collection, Use, and Disclosure
of Cognitive Performance and Other Personal Data

You are being asked permission for your child to take part in a research study. This form provides you with information about the study and seeks your authorization for the collection, use and disclosure of your child's cognitive performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and your child and answer all of your questions. Your child's participation is entirely voluntary. Before you decide whether or not to take part, read the information below and ask questions about anything you do not understand. By participating in this study neither you nor your child will not be penalized or lose any benefits to which you would otherwise be entitled.

1. Name of Participant ("Study Subject")

_____

2. Title of Research Study

Theory of mind development: A comparison of children with autism spectrum disorders and normally developing South African children.

3. Principal Investigator and Telephone Number(s)

Kevin G. F. Thomas, Ph.D.
Senior Lecturer
Department of Psychology
University of Cape Town
021-650-4608

4. Source of Funding or Other Material Support

None

5. What is the purpose of this research study?

Theory of mind is the ability to understand what other people want, feel and believe, and being able to predict people's actions using this knowledge. Thus, theory of mind is very important for everyday social interactions. We know that people with autistic spectrum disorders have impaired and delayed theory of mind abilities, as well as impaired social and communication skills.

The current research will look at how theory of mind abilities, and the development of these abilities, differ between normally developing and autistic children. Thus, this study will look at the differences in theory of mind ability between high functioning autistic /Asperger's syndrome children, low functioning autistic children, and normally developing children, aged 4 to 16 years. Theory of mind has not been studied in South African children. This study will aid in the understanding of whether theory of mind has a universal age of onset in normal development by seeing whether South African children develop these abilities at the same age as previously studied children from other countries. It will also increase our understanding of how theory of mind ability differs in low-functioning and high-functioning autistic children compared to normally developing children at different ages.

6. **What will be done if your child takes part in this research study?**

In this study, your child will be administered a series of paper-and-pencil tests measuring cognitive and theory of mind abilities.

Your child's testing session will be held at a location of your preference. Possible locations are the University of Cape Town's Department of Psychology, or your child's school or support centre. Each testing session will be individually conducted by either the principal investigator or a trained member of his research team. You, another caregiver, or a tutor may be present at the testing session.

After the testing session is over, you will be informed in detail about the design of the study and the research questions we hope to answer. You will also have the opportunity to ask questions and thus learn more about psychological research.

If you have any questions now or at any time during the study, you may contact the Principal Investigator listed in #3 of this form.

7. **If you choose to allow your child to participate in this study, how long will he/she be expected to participate in the research?**

The study consists of 2 sessions of 60 to 90 minutes each. If at any time during the experiment you or your child finds any of the procedures uncomfortable, you are free to discontinue participation without penalty.

8. **How many children are expected to participate in the research?**

Approximately 40 children will participate in this study. Twenty of these children will have been previously diagnosed with ASD. The other 20 participants will be typically developing children.

9. **What are the possible discomforts and risks?**

There are no known risks associated with participation in this study. The only possible discomfort your child may experience is slight fatigue. If he/she becomes tired during any of the procedures, we will take a break. Your child will be allowed to take breaks whenever requested. You may find out that some of your child's theory of mind abilities, such as understanding of other people's beliefs and interpreting verbal and non-verbal

communication, are worse than you expected and this may cause some sadness or distress. If this happens, we will talk with you and give a referral for care.

If you wish to discuss the information above or any discomforts you or your child may experience, you may ask questions now or call the Principal Investigator listed on the front page of this form.

10a. What are the possible benefits to you and your child?

You and your child may or may not personally benefit from participating in this study. Participation in this study may, however, improve your child's mental test performance due to training and practice.

10b. What are the possible benefits to others?

The information from this study may help improve our understanding of autism spectrum disorders, particularly with regard to differing theory of mind abilities in individuals with high functioning autism/Asperger's syndrome and individuals with low-functioning autism. It will also aid in the understanding of whether theory of mind has a cross-culturally universal age of onset in normal development, and how this differs in autistic spectrum disorders. Any information we obtain might benefit the future diagnosis and treatment of autistic spectrum disorders in regards to theory of mind abilities. The study might also help us to identify factors causing ToM delays in typically developing children, so that interventions can then be planned.
.

11. If you choose to take part in this research study, will it cost you anything?

Participating in this study will not cost you anything.

12. Will you receive compensation for taking part in this research study?

You will receive no compensation for taking part in this study.

13a. Can you withdraw your child from this study?

You are free to withdraw your consent and to stop participating in this research study at any time. If you do withdraw your consent, there will be no penalty.

If you have any questions regarding your child's rights as a research participant, and your rights as the individual granting consent for research participation, you may phone the Psychology Department offices at 021-650-3430.

13b. If you withdraw your child from this study, can information about you still be used and/or collected?

Information already collected may be used.

14. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect your privacy?

Information collected will be stored in locked filing cabinets or in computers with security passwords. Only certain people have the right to review these research records. These people include the researchers for this study and certain University of Cape Town officials. Your research records will not be released without your permission unless required by law or a court order.

15. What information about your child may be collected, used and shared with others?

The information gathered from your child will be demographic information and records of his/her performance on cognitive tests. If you agree that your child can be in this research study, it is possible that some of the information collected might be copied into a "limited data set" to be used for other research purposes. If so, the limited data set may only include information that does not directly identify you or your child. For example, the limited data set cannot include your or your child's name, address, telephone number, ID number, or any other photographs, numbers, codes, or so forth that link you or your child to the information in the limited data set.

The results of the research will be presented as part of an Honours research project for the University of Cape Town. Also, the results may be submitted for publication in a peer-reviewed journal. In both instances neither you nor your child will be identified in any way.

16. What should you tell your child?

You may wish to discuss the study with your child to find out determine whether he/she feels comfortable taking part. Your child should know that he/she can choose not to participate in the study. Your child should also know that if he/she does choose to participate, he/she can withdraw at any time during the study with no negative consequences.

17. How will the researcher(s) benefit from your being in the study?

In general, presenting research results helps the career of a scientist. Therefore, the Principal Investigator and others attached to this research project may benefit if the results of this study are presented at scientific meetings or in scientific journals.

This study is also done for the partial fulfilment of the requirements of the degree HonsBSocSc Psychology.

18. Signatures

As a representative of this study, I have explained to the parent/guardian of the participant the purpose, the procedures, the possible benefits, and the risks of this research study; and how the participant's performance and other data will be collected, used, and shared with others:

_____   _____

Signature of Person Obtaining Consent and Authorization   Date

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your child's performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You voluntarily consent to allow your child to participate in this study. You hereby authorize the collection, use and sharing of your child's performance and other data. By signing this form, you are not waiving any of your legal rights.

_____   _____

Signature of Person Consenting and Authorizing   Date

Please indicate below if you would like to be notified of future research projects conducted by our research group:
_____ (initial) Yes, I would like to be added to your research participation pool and be notified of research projects in which I or my child might participate in the future.

Method of contact:

Phone number: _____
Cell phone number: _____
E-mail address: _____
Mailing address: _____
                    _____
                    _____

UNIVERSITY OF CAPE TOWN
DEPARTMENT OF PSYCHOLOGY
Assent Form

Title of Study:

Theory of mind development: A comparison of children with autism spectrum disorders and normally developing South African children.

Principal Investigator: Kevin G. F. Thomas, Ph.D.
                                                    Senior Lecturer
                                                    Department of Psychology
                                                    University of Cape Town
                                                    021-650-4608

Hello! We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about how people understand how *other people* are feeling, and what they think. This is called theory of mind. You are being asked to join the study because we want to compare the way children with autism think about certain things with how other children think about these things.

If you agree to join this study, you will be asked to listen to a few stories and look at some pictures. You will also be asked to do some tasks like drawing pictures, telling me about the meaning of some words, and building puzzles with blocks. I will then ask you some questions about the stories. There will be two sessions, both about an hour and a half long. If you get tired, we can take a break at any time. You can also have a parent, guardian or friend with you if you want.

We do not know if being in this study will help you. We may learn something that will some day help other children with autism or children who struggle to understand how other people think and feel. This study will also help us learn more about how children from South Africa compare with children from other countries who have already been studied.

You do not have to join this study. It is up to you. You can say okay now and change your mind later. All you have to do is tell us you want to stop. No one will be mad at you if you don't want to be in the study or if you join the study and change your mind later and stop.

Before you say **yes or no** to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell the researcher that you have a question.

If you have any questions about this study please feel free to phone the principal investigator at the top of this page.

If you sign your name below, it means that you agree to take part in this research study.

_____ _____
  Date (MM/DD/YEAR) Signature of Child/Adolescent Participant

APPENDIX C

Pretend-Attributing Agency Task

This is the one task that was changed for this study, as the original task (see below) was deemed to gender biased, especially for the ASD group who consisted mostly of male participants. This task was about maternal feelings rather than understanding pretend play, and thus the task scenarios were changes to be appealing to both boys and girls.

Original task from Kavanaugh, Eizenman and Harris (1997). Young children's understanding of pretense expressions of independent agency. *Developmental Psychology*, *33*, 764-770.

Feeding

> "The baby is hungry. Watch what the Mommy doll does.
> Look. The Mommy doll is getting the baby's food."
> E makes Mommy pick up spoon and dip in bowl.
> "Show me what the Mommy doll does next."

Putting to bed

> "The baby is tired. Watch what the Mommy doll does.
> Look. The Mommy doll is putting the baby into the crib."
> E makes Mommy put baby in crib. (Leave blanket on the side of crib.)
> "Show me what the Mommy doll does next."

Brushing teeth

> "It's time to brush the baby's teeth. Watch what the Mommy doll does.
> Look. The Mommy doll is putting toothpaste onto the baby's toothbrush."
> E makes Mommy squeeze toothpaste onto toothbrush.
> "Show me what the Mommy doll does next."

Going outside

> "It's time for baby to go outside. Watch what the Mommy doll does.
> Look. The Mommy doll is getting the baby's hat."
> E makes Mommy take hat out.
> "Show me what the Mommy doll does next."

New pretend task designed for this study:

Four stories are administered in random order. If the child acted as the agent (e.g., watered plant him/herself), the experimenter said, "That's right. Now show me what *Sam the doll* does." The child's response was recorded.

Watering the plants

"It's time to water the plants.
Watch what Sam does. Look. Sam is getting the watering can."
Experimenter makes doll take watering can.
"Show me what Sam does next."

Washing the car

"The car is really dirty! It's time to wash the car.
Watch what Sam does. Look. Sam is getting the wash cloth."
Experimenter makes doll take the cloth.
"Show me what Sam does next."

Brushing the dog

"It's time to brush the dog!
Watch what Sam does. Look. Sam is getting the doggy brush."
Experimenter makes doll take the brush.
"Show me what Sam does next."

Feeding the dog

"The dog is hungry! It's time to feed the dog.
Watch what Sam does. Look. Sam puts the dog food in the bowl."
Experimenter makes doll put food into the bowl.
"Show me what Sam does next."

APPENDIX D

Demographic questionnaire

Participant no.: _____ Date: _____

DEMOGRAPHIC QUESTIONNAIRE

A. Child's Information:

1. Name: _____
2. Age: _____
3. Date of Birth (dd/mm/yy): _____
4. Sex (circle one):   Male   Female
5. Ethnicity: White   Black   Indian   Coloured

   Asian   Other   If other please specify: _____
6. Home Language: _____
7. Handedness (circle one):   Left   Right   Ambidextrous
8. Number of siblings: _____

9. Has your child ever experienced a head injury? (e.g., being hit on the head with an object and losing

   consciousness as a result)   YES   NO

   If yes, please give details:_____

   _____

   _____

10. Has your child ever experienced any of the following medical conditions:

    a. Neurological problems   YES   NO

       If yes, please specify: _____

    b. Depression   YES   NO

       If yes, please specify: _____

    c. Memory problems   YES   NO

       If yes, please specify: _____

    d. Problems with your vision   YES   NO

       If yes, please specify: _____

    e. Problems with your hearing   YES   NO

If yes, please specify:_____

    f.   Is he/she currently taking any prescription medication?   YES   NO

        If yes, what medication(s)?

_____

11. Has your child ever been diagnosed with a social disorder such as conduct disorder or oppositional defiant disorder (ODD)?   YES   NO

    If yes, please specify:_____

12. Has your child ever had a communication disorder? (For example: Having problems with understanding or producing speech, slow vocabulary development, difficulties recalling words or problems with producing sentences appropriate for his/her age.)   YES   NO

    If yes, please specify:_____

13. Has your child ever been diagnosed with a pervasive developmental disorder such as autism, Asperger's syndrome, Rett's disorder or childhood disintegrative disorder?   YES   NO

    If yes, please specify:_____

14. Has your child ever experienced learning difficulties such as dyslexia or attention-deficit / hyperactivity disorder (ADD/ ADHD)?   YES   NO

    If yes, please specify:_____

B. Parent Information:

1. What is the total yearly income of the household in which you live? (Circle one):
[NOTE: This should be household income, not personal income.]

| Less than R80 000 | R80 001 - R130 000 | R130 001 - R180 000 |
| R180 001 - R230 000 | R230 001 - R300 000 | More than R300 001 |

2. Education (highest degree or grade completed) of mother: _____

3. Education (highest degree or grade completed) of father: _____

4. Highest occupational level of mother: (The best job you've had, not necessarily in terms of job satisfaction or pay, but rather in terms of things like prestige or social status attached to job.)

_____

5. Highest occupational level of father: (The best job you've had, not necessarily in terms of job satisfaction or pay, but rather in terms of things like prestige or social status attached to job.)

_____

APPENDIX E

Additional results of data analysis

Table A. Performance on the subtests of the advanced battery for typically developing children aged 3-13 years. Means are presented with standard deviations in parentheses.

	Group 1: Ages 3:0-5.11 (n=2)	Group 2: Ages 6:0-7.11 (n=2)	Group 3: Ages 8:0-13:0 (n=12)
Second-Order False Belief Control	7.00 (1.41)	7.00 (1.41)	7.83 (0.58)
Second-Order False Belief Test	5.00 (1.41)	7.00 (1.41)	5.83 (2.12)
Lie/Joke Control	8.00 (0.00)	8.00 (0.00)	7.33 (1.56)
Lie/Joke Test	5.00 (1.41)	4.50 (2.12)	5.58 (1.56)
Strange Stories Test	40.00 (1.41)	55.50 (9.19)	62.00 (4.24)
Faux Pas Control	34.00 (2.83)	35.00 (7.07)	36.50 (3.32)
Faux Pas Test	19.50 (0.71)	27.50 (4.95)	32.17 (4.80)
ToM Advanced Score	69.50 (0.71)	94.50 (7.78)	105.58 (8.35)

Table B. Results of the mixed factors ANOVA on differences in executive functioning between the typically developing and ASD groups.

	SS	df	MS	F	P	Partial eta-squared	Non-centrality	Observed power (alpha=0.01)
Group	2849.7	1	2849.7	7.8419	0.010722	0.27	7.84	0.50
Error	7631.4	21	363.4					
EXEC	293936.2	6	48989.4	183.5972	0.000001	0.90	1101.58	1.00
EXEC*Group	29690.8	6	4948.5	18.5454	0.000001	0.47	111.27	1.00
Error	33620.7	126	266.8					

Table C. Analysis of covariance, with Verbal IQ as a possible covariant to ToM.

	SS	df	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0.01)
VIQ	47.14	1	47.14	2.191202	0.153648	0.09	2.19	0.11
Group	203.43	1	203.43	9.456165	0.005743	0.31	9.46	0.60
Error	451.78	21	21.51					

Table D. Analysis of covariance, with executive function as a possible covariant to ToM

	SS	df	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0.01)
D-KEFS Inhibition/Switching (raw)	7.754	1	7.75	0.34342	0.564420	0.02	0.34	0.02
Group	1220.01	1	1220.01	54.03402	0.0000001	0.73	54.03	1.00
Error	451.57	20	22.58					

Table E. Analysis of covariance, with working memory as a possible covariant to ToM

	SS	df	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0.01)
WISC Working Memory	0.20	1	0.20	0.00828	0.928378	0.0004	0.008	0.01
Group	872.05	1	872.05	36.71974	0.000005	0.64	36.72	1.00
Error	498.73	21	23.75					

Table F. Analysis of covariance, with processing speed as a possible covariant to ToM

	SS	df	MS	F	p	Partial eta-squared	Non-centrality	Observed power (alpha=0.01)
WISC Processing Speed	53.70	1	53.70	2.53286	0.126440	0.11	2.53	0.13
Group	304.23	1	304.23	14.34990	0.001077	0.41	14.35	0.82
Error	445.22	21	21.20					