Empathic accuracy in adolescents with autism spectrum disorders and adolescents with attention-deficit/hyperactivity disorder

Ellen Demurie, M.Sc.[a]

Maaike De Corel, M.Sc.[a]

Herbert Roeyers, Ph.D.[a]

[a] Ghent University, Research Group Developmental Disorders, Henri Dunantlaan 2, B-9000 Ghent, Belgium.

Corresponding author:

Ellen Demurie

Ghent University, Research Group Developmental Disorders, Henri Dunantlaan 2, B-9000 Ghent, Belgium. Telephone: +32(0)9-264 94 11 - Fax.: +32(0)9-264 64 89

Email: Ellen.Demurie@UGent.be

Abstract

In research on theory of mind (ToM) in individuals with an autism spectrum disorder (ASD) mainly static mind-reading tasks were used. In this study both a static (Eyes Test) and a more naturalistic (Empathic Accuracy Task) ToM measure were used to investigate the perspective taking abilities of adolescents with ASD (n = 13), adolescents with attention-deficit/hyperactivity disorder (ADHD; n = 13) and typically developing adolescents (n = 18). An innovative aspect concerns the standard stimulus tapes of the Empathic Accuracy Task, which showed interactions between dyads of one adolescent with ADHD and one adolescent without ADHD. In this way, we were able to compare the 'readability' of the thoughts and feelings of adolescents with and without ADHD. The results clearly demonstrate the impairment in perspective taking abilities of adolescents with ASD, both on the static and naturalistic mind-reading task. Moreover, the Empathic Accuracy Task seems to be a useful and promising method to assess ToM abilities in adolescents, with or without clinical problems. Finally, thoughts and feelings of target persons with ADHD seemed to be less easy to read than the thoughts and feelings of typically developing target persons.

Keywords: autism, ADHD, empathic accuracy, perspective taking, social cognition

1. **Introduction**

In the last decade there has been great interest in measuring perspective taking and social cognition, especially in persons with autism spectrum disorders (ASD). One aspect of social cognition that has been studied intensively is theory of mind (ToM). ToM can be described as the ability to attribute mental states, such as intentions, beliefs and desires, to oneself and others and then using them to explain and predict behaviour (Baron-Cohen, Leslie, & Frith, 1985). The terms 'mind-reading' and 'perspective taking' are often used as synonyms of the term Theory of Mind (Baron-Cohen, 1995; Baron-Cohen & Wheelwright, 2004). Many studies within this domain focused on the perspective taking abilities of children with ASD, who clearly experience difficulties in their ToM competence (Baron-Cohen, 1995; Baron-Cohen et al., 1985; Leekam & Perner, 1991). These ToM impairments may underlie the social and communicative abnormalities that are characteristic of the disorder (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997). However, some individuals with high-functioning autism (HFA) or Asperger Syndrome (AS) may pass the simple false-belief tasks, used to investigate ToM in children with ASD, in their teens (Bowler, 1992; Ozonoff, Pennington, & Rogers, 1991).

This observation has given rise to a few "advanced" ToM tasks, which make it possible to cope with potential ceiling effects in the simple ToM tasks (Happé, 1994). One of the first advanced ToM measures was the "Reading the Mind in the Eyes" Test (Eyes Test), used in high-functioning adults with autism or AS (Baron-Cohen, Jolliffe et al., 1997). In the Eyes Task participants have to look at photographs of the eye region of faces and make a forced choice between which of two words best describes what the person in the picture might be thinking or feeling (Baron-Cohen, Jolliffe et al., 1997). This adult Eyes Test was revised in 2001 (Baron-Cohen,

Wheelwright, Hill, Raste, & Plumb, 2001) and in the same year an adaptation of the test for children was used in a study with children with AS (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001). Research in adults with ASD, using the Eyes Test, yielded mixed results. In some studies, adults with ASD showed subtle theory of mind deficits on this task (Baron-Cohen, Jolliffe et al., 1997; Baron-Cohen, Wheelwright, & Jolliffe, 1997), while in other studies, where another set of facial pictures was used, adults with ASD performed as well as controls on the Eyes Test (Ponnet, Roeyers, Buysse, De Clercq, & Van Der Heyden, 2004; Roeyers, Buysse, Ponnet, & Pichal, 2001).

However, the ecological validity of these static tests of perspective taking is limited (Ponnet et al., 2004). Social interaction in the real world is much more complex and the Eyes Test can hardly be seen as a naturalistic measure of social understanding (Baron-Cohen, Wheelwright, Hill et al., 2001). A more naturalistic way of measuring empathic ability is provided by the empathic accuracy design of Ickes and colleagues (Ickes, 1993; Ickes, Stinson, Bissonnette, & Garcia, 1990). Good evidence for both the reliability and the validity of this method has been provided (Marangoni, Garcia, Ickes, & Teng, 1995). Empathic accuracy is defined as the degree to which an individual is able to accurately infer the specific content of another person's thoughts and feelings (Ickes et al., 1990; Zaki, Bolger, & Ochsner, 2008). In the current study, the standard stimulus design was used to investigate the empathic accuracy abilities in different groups of adolescents. In the standard stimulus paradigm, individual participants each view the same standard set of videotaped interactions and try to infer the thoughts and feelings of the same set of target persons (Marangoni et al., 1995). Roeyers et al. (2001) and Ponnet et al. (2004) found that adults with pervasive developmental disorders (PDD) and adults with AS

were able to infer the thoughts and feelings of target persons while watching a structured interaction (game situation – target persons immediately started to play a board game), but performed worse than the control group when they watched an unstructured situation (getting acquainted situation – target persons had a conversation of the 'getting acquainted' type). Ponnet, Buysse, Roeyers, and De Clercq (2008) found that the structure of the situation matters for the mind-reading abilities of subjects with ASD. The mind-reading differences between young adults with ASD and typically developing controls were more pronounced when subjects had to infer the thoughts and feelings of other persons in a less structured conversation. Gleason, Jensen-Campbell, and Ickes (2009) extended the standard stimulus paradigm by studying adolescents. Their results revealed that adolescents who obtained higher empathic accuracy scores were more likely to have better quality friendships, and experienced lower levels of relational victimization. Additionally, adolescents who were at highest risk for internalizing and social problems were adolescents who had low scores on the empathic accuracy task, and on peer dimensions such as number of friends and friendship quality. Gleason et al. (2009) suggested that empathic accuracy in childhood relationships might be a buffering mechanism that protects children against the development of impaired peer relationships and adjustment problems.

In the current study, a few shortcomings in research on perspective taking and empathic accuracy are considered and dealt with. First of all, as Baron-Cohen suggested (Baron-Cohen, Wheelwright, Hill et al., 2001; Baron-Cohen, Wheelwright, Spong et al., 2001), developmentally appropriate tests are needed in order to reveal the manifestations of the ToM abnormalities in people with autism. As mentioned earlier, ToM instruments underwent an evolution that started with the use of false-

belief tasks in children with autism. As a second step these simple tasks were adapted with the 'advanced' mindreading tasks as result. Today, a more naturalistic design for measuring empathic abilities can be found in the empathic accuracy task that has been used primarily in adults with ASD (Ponnet et al., 2004; Roeyers et al., 2001). The empathic accuracy task has proven to be a useful method to measure the capacity for perspective taking in adolescents (Gleason et al., 2009; Haughen, Welsh, & McNulty, 2008). To our knowledge, the current study is the first to administer the empathic accuracy task in adolescents with ASD. Since adults with ASD are performing quite well on static mind-reading tasks and manage to infer the thoughts and feelings of target persons in a structured interaction during an empathic accuracy task (Ponnet et al., 2004; Roeyers et al., 2001), while children with ASD fail most of the mind-reading tasks (Baron-Cohen, 1995; Baron-Cohen et al., 1985; Leekam & Perner, 1991), a delay in the development of perspective taking abilities can be considered as one possible explanation of the mind-reading disabilities in children with ASD. Hence, we expect that adolescents with ASD will perform more poorly than typically developing adolescents on the Eyes Test and the empathic accuracy task. These expectations are in line with the research findings of previous studies with static ToM measures in adolescents with ASD (Baron-Cohen, Wheelwright, Spong et al., 2001; Dyck et al., 2001; Kaland, Callesen, Moller-Nielsen, Mortensen, & Smith, 2008).

Furthermore, most research on perspective taking compared the ToM abilities in persons with ASD and a non-clinical control group. As one of the exceptions, Buitelaar, Van der Wees, Swaab-Barneveld, and Van der Gaag (1999) examined differences in ToM performance between autistic, pervasive developmental disorder-not otherwise specified (PDD-NOS), psychiatric control and typically developing children. This study revealed that autistic and PDD-NOS children could not be

differentiated from the psychiatric controls with a diagnosis of attention-deficit/hyperactivity disorder (ADHD). These results support the notion that ToM deficits are not specific to autism and ASD (Dyck et al., 2001). Gillberg (1992) suggested ten years earlier that both ASD and ADHD are part of a class of 'Empathy Disorders'. Moreover, Braaten and Rosén (2000) found that boys with ADHD were less empathic than boys without ADHD, as measured by an empathy response task. Although children with ADHD do not always seem to show ToM deficits (Dyck et al., 2001; Perner, Kain, & Barchfeld, 2002), their impaired empathic abilities were confirmed in different studies (Dyck et al., 2001; Marton, Wiener, Rogers, Moore, & Tannock, 2009). In the present study, the mind-reading abilities of adolescents with ASD were compared with both a clinical control group of adolescents with ADHD and a non-clinical control group of typically developing adolescents. We expect that both adolescents with ASD and adolescents with ADHD will show aberrant mind-reading abilities. These problems can be related to the social problems that persons with ASD and persons with ADHD experience (Luteijn et al., 2000).

A static Eyes Test and a more naturalistic Empathic Accuracy Test were used to investigate the mind-reading performance of the adolescents. To gain an insight into their perceived mind-reading abilities, both the adolescents and their parents were asked to complete a questionnaire, measuring the tendency to take another person's point of view. We expect that both adolescents with ASD, adolescents with ADHD and their parents will report that mind-reading abilities are to some extent impaired in ASD and ADHD.

An innovative aspect in this study concerns the standard stimulus tapes. These tapes showed interactions between dyads of one adolescent with ADHD and one adolescent without ADHD. In this way, we were able to compare the 'readability' of

the thoughts and feelings of adolescents with and without ADHD. After all, although it is known that recognition of emotions and mental states is based on the integration of multimodal information, such as semantic information, prosody and nonverbal visual cues (body postures and facial expressions) (Golan, Baron-Cohen, & Golan, 2008; Herba & Phillips, 2004), it is unknown how these factors contribute to the readability of specific thoughts and emotions. A certain amount of variability in behaviour within the chosen target dyads was expected, such as the degree of restlessness, expressivity, hyperactivity and the congruency of the thought/feeling with the overt behaviour. The effect of these factors on the readability of thoughts and feelings of target persons with and without ADHD was investigated in this study (see supplementary material).

2. Material and methods

2.1 Participants

Three groups of adolescents took part in this study: 19 adolescents with ASD, 16 adolescents with ADHD and a control group of 18 typically developing (TD) adolescents. Participants from the clinical groups were recruited from the child psychiatry department of the Ghent University hospital and from a special school. All participants with ASD or ADHD had been diagnosed by a multidisciplinary team of experienced clinicians and fulfilled DSM-IV-TR criteria of the disorders. The diagnosis of the children with ASD was confirmed by the Autism Diagnostic Interview, Revised (ADI-R; Lord, Rutter, & Lecouteur, 1994), the Autism Diagnostic Observational Schedule, Generic (ADOS-G; Lord et al., 2004), the Childhood Autism Rating Scale (CARS; Schopler, Reichler, Devellis, & Daly, 1980) or a combination of these measures. Three adolescents who fulfilled criteria for both disorders were

removed from the sample. Furthermore, 3 adolescents with ASD and 2 adolescents with ADHD were removed from the sample, because their IQ scores did not fall within the normal range.

Participants were in the age range of 11-17 years. Only the IQ scores of the clinical groups were known, but since the TD group consisted of a random group of typically developing children, who were average performing students in mainstream education, the mean IQ of the control group can be considered to be in the normal range. A series of univariate analyses of variance (ANOVAs) revealed no significant between group differences for full scale IQ, verbal IQ or performance IQ of the ASD group and ADHD group. Age and IQ information are presented in Table 1.

Insert Table 1 here

2.2 Materials

2.2.1 Interpersonal Reactivity Index (IRI): The IRI (Davis, 1983) is a self-report questionnaire with 28 items, subdivided in four 7-item subscales. The participant scores each item on a 5-point Likertscale, ranging from 'does not describe me well' to 'describes me very well'. Each subscale measures a specific aspect of 'empathy', based on a multidimensional approach of empathy (cognitive and emotional) (Davis, 1983).

The perspective-taking (PT) subscale measures the tendency to adopt other people's position in everyday life. The empathic concern (EC) subscale measures the tendency to experience feelings of warmth, compassion and concern for other people. The personal distress (PD) subscale investigates feelings of unease and discomfort in reaction to the emotions of others. The last IRI subscale, the fantasy (F) subscale,

measures the tendency to imagine oneself in the feelings and actions of fictive figures in books, movies and plays (Davis, 1983). Evidence for the reliability and validity of the IRI subscales comes from different sources (Davis, 1983; Yarnold, Bryant, Nightingale, & Martin, 1996). The internal consistency (Cronbach's alpha) in this study is .85 for the ASD group, .80 for the ADHD group and .78 for the TD group. In this study, we used a Dutch translation of the IRI (Ponnet, Buysse, Roeyers, & De Corte, 2005). Both adolescent participants and their parents completed the questionnaire.

2.2.2 "Reading the Mind in the Eyes" Test (Eyes Test): The Eyes Test is a static measure of empathic accuracy. We used the child version of the "Reading the Mind in the Eyes" Test (Baron-Cohen, Wheelwright, Spong et al., 2001). With permission of the authors, this test was translated into Dutch and the backtranslation was authorized by the authors as well.

The Eyes Test consists of 28 photographs of the eye region of human faces. The participants are asked to make a forced choice between four mental state terms and to choose the word that best describes what the person in the photo is thinking or feeling (Dorris, Espie, Knott, & Salt, 2004). Only one of the four mental state terms is considered correct. The mental state terms comprise both affective and non-affective (cognitive) mental state terms (Baron-Cohen, Wheelwright, Spong et al., 2001). The Eyes Test includes a control task for non-mentalistic social intelligence: the adolescents are asked to identify the gender of the person in each photograph (Gender Task).

2.2.3 Empathic Accuracy Task: The Empathic Accuracy Task, a naturalistic task of empathic accuracy, is based on the standard stimulus paradigm of Ickes. In this paradigm, individual participants look at the same standard set of videotaped interactions and try to infer the thoughts and feelings of the same set of target persons (Marangoni et al., 1995; Roeyers et al., 2001). Ickes and his colleagues provided good evidence for the reliability and the validity of this method (Ickes, 1993; Ickes et al., 1990; Marangoni et al., 1995; Roeyers et al., 2001).

The standard stimulus tape in this study consisted of ten fragments with interactions between five dyads of adolescents who were initially strangers to each other (for more information about the making of the standard stimulus tape – see supplementary material). The dyads consisted of one adolescent with ADHD and one adolescent without ADHD. These adolescents were filmed without their knowledge during two interaction situations: an acquaintance situation and a game situation. After the two interaction situations and a partial debriefing, the targets were asked to view their videotape and to make a written record of all their unexpressed thoughts and feelings (Ponnet et al., 2004; Roeyers et al., 2001). To be sure that the two videotapes showed similarly structured situations, the degree of structure of the target interactions was evaluated by 5 naive observers. No significant difference was found in the extent to which both videotapes showed more or less structured situations.

The resulting standard stimulus tape contained ten fragments of the five dyads, with 33 thoughts and feelings to infer for the perceiving participants. Only film fragments that were meaningful without seeing the rest of the video were included in the standard stimulus tape. The standard stimulus tape lasted for 18 min 24 s. The acquaintance situation lasted for 8 min 24 s and contained 15 thoughts/feelings to

infer (8 of an adolescent with ADHD) and the game situation lasted for 10 min and contained 18 thoughts/feelings to infer (10 of an adolescent with ADHD).

Through the making of the standard stimulus tapes, we were able to study both the overt behaviour and the covert thoughts and feelings of the targets. Four independent adult judges coded the measures relevant for this study. The overt measures included behaviours typical for children with ADHD: expressivity, hyperactivity, inattention and restlessness of the children. For every thought/feeling of the children, and after each of the two situations (as a global measure) the judges rated these behaviours on a 7-point scale. The covert measures, rated for each thought or feeling, were measured on the same scale and included the difficulty of inferring the specific content of each reported thought/feeling, the abstractness, and congruency between the (non)-verbal behaviour and the reported thought/feeling. Our analyses revealed no significant within-dyad and between-group differences with regard to any of these measures (see Table S1 and S2 in supplementary material).

Based on the guidelines of Ickes and colleagues, the empathic accuracy scores were calculated by comparing each inference of the perceiving participant with the original thought/feeling entry obtained from the targets (Ickes et al., 1990). Six naive and independent coders were asked to compare each participant's inferred thought/feeling with the corresponding original thought/feeling entry and to rate the level of similarity on a 3-point scale, ranging from 0 (essentially different content) through 1 (somewhat similar but not the same content) to 2 (essentially the same content) ('I don't know' and missing answers were rated 0). The internal consistency (Cronbach's alpha) of the six judges' empathic accuracy ratings was .88 for the ASD group, .63 for the ADHD group and .85 for the control group.

2.3 Procedure

All participants started with the Empathic Accuracy Task. While the participants were watching the videotape, the tape was paused at the precise moments when a target had recorded a specific thought or feeling. The participants were then asked to make inferences about the thought/feeling entries of the targets and to write down the specific content of it. To ensure that the task was fully understood, the context of the tapes was described and the participants could practise first with another, short videotape. Subsequently, the child version of the "Reading the Mind in the Eyes" Test (Baron-Cohen, Wheelwright, Spong et al., 2001) was administered. Finally, the participants and their parents were asked to fill in the IRI (Davis, 1983).

All participants and their parents gave written informed consent. The study was approved by the ethical committee of the Faculty of Psychology and Educational Sciences of Ghent University.

3. Results

3.1 Interpersonal Reactivity Index (IRI)

For each IRI subscale a 3 ('Group': ASD vs ADHD vs controls) x 2 ('Judge': self vs parent) design was used in a series of repeated measures analyses. The group means are presented in Table 2. Table 3 presents the F-values of the statistical analyses.

Insert Table 2 and Table 3 here

As can be seen in Table 3, a main effect of Group was found for all IRI subscales. Furthermore, a main effect of Judge was found for the Perspective Taking subscale and interaction effects between Judge and Group were found for the Perspective Taking, Empathic Concern and Personal Distress subscales. Post hoc analyses (Bonferroni) showed that adolescents with ASD obtained significantly lower scores than adolescents with ADHD and TD adolescents on the IRI subscale Fantasy ($p < .001$ for both contrasts). A closer look at the interaction effects revealed that only for adolescents with ASD a significant difference between self and parent report was observed for the Perspective Taking ($p < .01$) and Personal Distress ($p < .05$) subscales. Adolescents with ASD reported significantly higher scores for Perspective Taking and significantly lower scores for Personal Distress than their parents. For the Empathic Concern subscale only the control adolescents showed a significant difference between self and parent report ($p < .05$). Typically developing adolescents reported significantly lower scores on this subscale than their parents. As a consequence of the interaction effects the group contrasts were different according to the judge (see Table 3).

3.2 "Reading the Mind in the Eyes" Test (Eyes Test)

The MANOVA revealed significant between-group differences for scores on the Eyes Test and Gender Task (see Table 4). Post hoc analyses (Bonferroni) showed a significant difference for Eyes Test scores between adolescents with ASD and the control group, in favour of the TD adolescents ($p < .05$). For the Gender Task, there were no differences between the adolescents with ADHD and the control group. Both groups outperformed the adolescents with ASD ($p < .01$). As the time needed to complete the test was not normally distributed, a Kruskal-Wallis test was used (see

Table 4). There were no differences between the adolescents with ADHD and the control group. Both groups were faster than the adolescents with ASD ($p < .001$).

Insert Table 4 here

3.3 Empathic Accuracy Task

A 3 ('Group': ASD vs ADHD vs controls) x 2 ('Target': Target with ADHD vs Typically developing target) design was used in a repeated measures analysis, with Group as between-subjects factor and Target as within-subjects factor (see Table 5). Significant main effects for Group ($F(2,41) = 4.74$, $p < .05$) and for Target ($F(1,41) = 31.54$, $p < .001$) were found. The adolescents with ASD obtained significantly lower empathic accuracy scores than the typically developing adolescents ($p < .05$). The empathic accuracy scores of adolescents with ADHD were not significantly different from those of the adolescents with ASD ($p = .25$) nor from those of the TD adolescents ($p = .94$). Furthermore all participants obtained better empathic accuracy scores when inferring the thoughts and feelings of a target person without ADHD in comparison to the thoughts and feelings of a target person with ADHD. Mean empathic accuracy scores are presented in Table 6. To control for external factors influencing the readability of the targets in the standard stimulus tapes, we looked at the between group differences with regard to the targets' behavioural and actual thought/feeling measures and the between group differences with regard to the thematic topic of the targets' thoughts and feelings. No differences were found for these measures between target persons with and without ADHD (see supplementary material). Finally the correlations between the total empathic accuracy score, age and IQ scores were calculated. In the group of adolescents with ASD a significant positive

correlation was found between age and the total empathic accuracy score ($r(13) = .63$, $p < .05$). In the total sample and the other subgroups no significant correlations with empathic accuracy score were found.

Insert Table 5 and Table 6 here

4. Discussion

In the present study, the mind-reading abilities of adolescents with ASD, adolescents with ADHD and typically developing adolescents were investigated and compared. For this purpose, a static and a more naturalistic measure of empathic accuracy and an empathy questionnaire were used. This study is the first to administer the empathic accuracy task in adolescents with ASD and adolescents with ADHD.

As expected, adolescents with ASD obtained lower scores than the typically developing adolescents on all mind-reading measures. The results of the static Eyes Test are in line with the research findings of Baron-Cohen, Wheelwright, Spong et al. (2001), who found children with ASD to be significantly impaired on the Eyes Test. On the other hand, the results differ from those of both Roeyers et al. (2001) and Ponnet et al. (2004) who failed to find a difference between adults with ASD and typically developing adults. It is possible that age and developmental level account for the poorer performance of the adolescents with ASD on the Eyes Test. The development of theory of mind in children with ASD seems to be both delayed and deviant (Serra, Loth, Van Geert, Hurkens, & Minderaa, 2002). However, even adults with HFA and AS sometimes fail this static measure of perspective taking (Baron-Cohen, Jolliffe et al., 1997; Baron-Cohen, Wheelwright et al., 1997), so there might be other factors that also influence the performance on this task.

On the more naturalistic Empathic Accuracy Test, adolescents with ASD again performed worse than typically developing adolescents. Clearly, adolescents with ASD experience difficulties in inferring the thoughts and feelings of others. These results are consistent with previous research, where persons with ASD showed impaired empathic accuracy abilities if the task was sufficiently complex (Roeyers et al., 2001; Ponnet et al., 2004).

For both measures of empathic accuracy (Eyes Test and Empathic Accuracy Test) adolescents with ADHD performed as an intermediate category between the adolescents with ASD and the control group. Their scores did not differ significantly from those of the control group nor from those of the adolescents with ASD. Probably these non-significant findings are due to limited power (.37 for ADHD vs ASD and .20 for ADHD vs controls), but they may suggest that the mind-reading performance of the adolescents with ADHD cannot be considered to be normal. Barkley (2006) also argued that children with ADHD would show less empathy and a reduced perspective taking ability due to their inhibitory control deficits.

Besides the performance-based measures of perspective taking, the empathy questionnaire IRI was administered to the adolescents and their parents to assess perceived mind-reading abilities. As expected, adolescents with ASD and their parents reported lower scores on all subscales of the IRI in comparison with TD adolescents and their parents. Furthermore, in the ASD group an informant effect was found for the PT and PD subscales. Adolescents with ASD reported significantly higher scores for Perspective Taking and significantly lower scores for Personal Distress than their parents. This informant effect with regard to perspective taking was also found in the study of Roeyers, Buysse, Ponnet, & De Corte (2010). Despite this informant effect, adolescents with ASD seem to have insight into their poor

perspective taking abilities, at least to a certain extent. These results are consistent with Ponnet's study (Ponnet et al., 2004), where adults with ASD seemed to be aware of their empathic impairment.

Parents of adolescents with ADHD reported lower scores for the IRI subscales 'Perspective Taking' and 'Empathic Concern', in comparison with the parents of the TD group. Thus, parents of adolescents with ADHD consider their children as less prone to take the perspective of someone else and to experience feelings of warmth, compassion and concern for other people, which supports the idea of ADHD as an empathic disorder (Gillberg, 1992). The adolescents with ADHD themselves did not report a significant difference for their perspective taking tendency in comparison with the TD group. These results are in line with those of Marton et al. (2009), who also failed to find a difference between ADHD and comparison children in self-reported empathy, while their parents rated the children with ADHD as less empathic. It is possible that the adolescents with ADHD have less insight into their impaired empathic abilities. Another explanation can be found in a social desirable way of answering the questionnaire (Marton et al., 2009).

An innovative aspect in the Empathic Accuracy task was the use of standard stimulus tapes with target dyads, which consisted of one adolescent with ADHD and one adolescent without ADHD. We did find a difference in the 'readability' of targets with and without ADHD. All participants obtained higher empathic accuracy scores when inferring the thoughts and feelings of TD targets than when they had to infer the thoughts and feelings of the targets with ADHD. Not only the empathic abilities and other characteristics of the perceivers seem to have an impact on the final empathic accuracy score. Characteristics of the target persons can influence the performance of

the perceivers on the empathic accuracy task as well (Luteijn et al., 2000). It could be possible that the TD target persons reported thoughts/feelings that are easier to infer, more concrete or more clearly formulated, or that their behaviour was more congruent with their unspoken thoughts/feelings. Furthermore, it could be possible that target children with ADHD performed high levels of impulsivity, hyperactivity, restlessness and expressivity, and that this would diminish their readability. To rule out this possibility, we compared the mean scores on the covert and overt measures, but no differences were found between targets with and without ADHD (see supplementary material). The lack of difference on these measures indicates that the lower 'readability' of targets with ADHD is not the consequence of having less apparent thoughts and feelings because of their (non) verbal cues. So we were not able to clarify which factors attribute to the readability of the thoughts and feelings of the two groups of target persons. This issue remains a challenge that can be addressed in future research.

We acknowledge that our study has some limitations, with limited sample sizes as the most important one. A second hiatus of the current study concerns the absence of IQ information of the control group. However, since IQ was not correlated with any of the dependent measures, we do not expect group differences to be due to differences in IQ.

5. Conclusions

In summary, our findings indicate that adolescents with ASD are less able to infer the thoughts and feelings of others in comparison to typically developing adolescents. This result confirms our hypothesis that adolescents with ASD show

impaired mind-reading abilities and is consistent with the ToM hypothesis. Adolescents with ADHD do not show clear deficits in mind-reading abilities, but their mind-reading performance does not differ significantly from that of the adolescents with ASD either. Moreover, their parents report an impaired tendency of their children with ADHD to take the perspective of someone else in comparison to the control group. These findings challenge claims that problems with ToM are specific to ASD (Buitelaar et al., 1999). This implicates that ToM measures cannot be used in a diagnostic process to differentiate between ASD and ADHD.

In addition, the Empathic Accuracy Task proved to be a valid and reliable method to measure adolescents' ability to infer the thoughts and feelings of others, even in adolescents with ASD and adolescents with ADHD.

In future research, it would be worthwhile to examine the effect of characteristics of the target persons in the empathic accuracy task. As we found a significant difference in the empathic accuracy scores for thoughts and feelings of targets with and without ADHD, it should be possible to identify factors that influence the readability of a target person. We controlled for several of these factors, but there can be others that we did not take into account. It might also be useful to include a set of control videos with two TD targets to compare their readability with that of the control target in interaction with the target with ADHD.

Another topic that can be addressed in future studies concerns the fact that, despite the average lower empathic accuracy scores of adolescents with ASD, some participants of this group managed to infer the thoughts and feelings of the targets quite well. It would be interesting to investigate how these 'empathic' adolescents with ASD differ from those with a poor empathic accuracy score. In our sample, only

an effect of age was found on the empathic abilities of the adolescents with ASD. This finding supports the notion that the development of theory of mind in children with ASD seems to be delayed (Serra et al., 2002).

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TABLES

Table 1
Descriptive characteristics of the sample

	ASD n = 13		**ADHD** n = 13		**Controls** n = 18		
Sex							
Male	12		12		14		$\chi^2(2) = 1.91$
Female	1		1		4		
	M	**SD**	**M**	**SD**	**M**	**SD**	
Age	14.35	1.24	13.69	1.43	13.86	1.73	$F(2,41) < 1$
IQ							
TIQ	101.54	11.56	102.92	11.59	-	-	$F(1,24) < 1$
VIQ	98.00	11.92	106.08	9.50			$F(1,24) = 3.65$
PIQ	105.23	14.31	99.62	15.63			$F(1,30) < 1$

***** $p < .05$

Table 2
Group means and standard deviances for the IRI

	ASD				**ADHD**				**Control group**			
	Self		**Parent**		**Self**		**Parent**		**Self**		**Parent**	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
PT[a]	12.83	4.49	3.50	4.93	19.54	3.91	16.46	4.27	24.13	5.14	21.88	5.84
F[b]	12.29	4.46	8.00	4.50	22.15	5.58	22.46	4.50	22.31	4.77	22.38	5.16
EC[c]	13.63	7.22	9.50	2.43	22.54	4.58	23.23	4.80	25.44	3.05	27.88	4.08
PD[d]	12.14	4.78	18.57	4.76	19.85	5.05	21.85	5.64	19.38	4.67	17.31	7.02

[a] PT = Perspective Taking, [b] F = Fantasy, [c] EC = Empathic Concern, [d] PD = Personal Distress

Table 3

Repeated Measures analyses on IRI subscales: F-values and contrasts

	F-values		Contrasts
Perspective Taking			
Group	F(2,32) = 31.90	***	ASD < ADHD < TD[e]
Judge	F(1,32) = 20.00	***	Parent < Self
Group x Judge	F(2,32) = 3.26	p = .05	Self report: ASD < TD[e]
			Parent report: ASD < ADHD < TD[e]
Fantasy			
Group	F(2,33) = 28.96	***	ASD < ADHD = TD[e]
Judge	F(1,33) = 1.46		
Group x Judge	F(2,33) = 1.51		
Empathic Concern			
Group	F(2,32) = 38.32	***	ASD < ADHD < TD[e]
Judge	F(1,32) = 0.20		
Group x Judge	F(2,32) = 4.13	*	Self report: ASD < ADHD = TD[e]
			Parent report: ASD < ADHD < TD[e]
Personal Distress			
Group	F(2,33) = 3.33	*	ASD < ADHD
Judge	F(1,33) = 3.74		
Group x Judge	F(2,33) = 4.80	*	Self report: ASD < ADHD = TD[e]
			Parent report: ns

* $p < .05$, *** $p < .001$

[a] PT = Perspective Taking, [b] F = Fantasy, [c] EC = Empathic Concern, [d] PD = Personal Distress, [e] TD = typically developing controls

Table 4

Mean scores on the Eyes Test and Gender Task, Medians for Needed time and F- and γ^2-values

	ASD n = 13		**ADHD n = 13**		**Controls n = 18**				
	M	**SD**	**M**	**SD**	**M**	**SD**	**F(2,47)**		**Contrasts**
Eyes Test	16.23	3.92	18.62	2.93	19.17	2.55	3.57	*	ASD < TD[a]
Gender Task	25.77	1.69	27.69	0.48	27.28	0.75	11.95	***	ASD < ADHD = TD[a]
	Md		**Md**		**Md**		**γ2 (2)**		
Needed time	579.00		339.00		347.00		18.15	***	ADHD = TD[a] < ASD

* $p < .05$, *** $p < .001$

[e] TD = typically developing controls

Table 5

Repeated Measures analysis on EA scores: F-values and contrasts

	F-values		Contrasts
Group	F(2,41) = 4.74	*	ASD < TD[a]
Target	F(1,41) = 31.54	***	ADHD target < TD[a] target
Target * Group	F(2,41) = 0.37		*ns*

* $p < .05$, *** $p < .001$

[a] TD = typically developing controls

Table 6

Mean results and standard deviances for the Empathic Accuracy Task

	ASD n = 13		**ADHD** n = 13		**Controls** n = 18	
	M	**SD**	**M**	**SD**	**M**	**SD**
Empathic Accuracy	17.75	5.40	21.13	3.38	22.90	5.16
Target with ADHD	15.60	4.14	18.59	3.74	19.80	5.58
Target without ADHD	20.34	8.31	24.19	5.37	26.60	6.71

SUPPLEMENTARY MATERIAL

METHODS – MAKING OF THE STANDARD STIMULUS TAPE

Procedure

The procedure used was based on Ickes and colleagues (Ickes, Stinson, Bissonnette, & Garcia, 1990; Marangoni, Garcia, Ickes, & Teng, 1995) and Ponnet and colleagues (Ponnet, Buysse, Roeyers, & De Corte, 2005). The dyad members (one with ADHD and one without ADHD), previously unacquainted to each other, were scheduled to come to the research centre at the same time. They were asked to participate in a study on "social interactions between peers"'.

The procedure of the making of the standard stimulus tapes can be divided in two phases.

Phase 1: Collection of the videotape data

In order to avoid interaction prior to the experiment, participants were brought to different waiting rooms. Control children were kept unaware that their dyad member had the diagnosis of ADHD. Even so, the dyad member with ADHD was kept unaware whether or not his/her interaction partner had any kind of diagnosis. After checking that the participants were indeed strangers to each other, they were escorted to the observation room and directed to take place on the chairs. The experimenter told that they would play a game together and that they would be filmed after a period of 10 minutes practicing the game together without the experimenter. The participants signed a first informed consent and immediately after doing so, the experimenter was telephoned by another researcher who was sitting in the control room. This way, the

experimenter could pretend that there was an urgent problem, and leave the participants alone. On the moment the experimenter had left the observation room, a second experimenter in the control room started the cameras. After 8 minutes, the videotaping stopped. The experimenter came back, apologized for the disruption, and gave an unfamiliar game to the subjects. The experimenter told that they would get some time alone, and that the videotaping and the real experiment would start when she came back. For the second time, the cameras were started at the moment that the experimenter left the room, so the participants were still unaware that the cameras were already videotaping. After 8 minutes, the experimenter returned and debriefed the participants. They were told that they were videotaped unobtrusively in order to study the spontaneous interaction that takes place between two peers. After signing a second, more detailed informed consent, participants were asked whether their tape could be used as data. It was made clear that if either of them did not want the tape to be used, it could be erased immediately. None of the participants refused the tape to be released and each of them signed all the consent forms. Ethical permission was sought and granted for this study.

Phase 2: Collection of the thought/feeling data

In the next part of the study, each participant was brought by an experimenter to one of two separate rooms, where he/she was asked to view the videotape and make a written record of all the unexpressed thoughts and feelings he/she remembered having had during the two 8-min interaction periods. The participants were instructed not to report thoughts and feelings that occurred to them for the first time while viewing the videotape. They were encouraged to report all of the thoughts as accurately and honestly as possible. The participants were assured that their interaction partner

would never see the reported thoughts and feelings. The experimenter stopped the videotape when the participants wanted to report a thought or feeling, and asked the participants to write on a standardized thought/feeling coding form (a) the time the thought/feeling occurred, (b) whether the entry was a thought or a feeling, and (c) the specific content of the thought/feeling entry. No restriction of time was given.

Behavioural and Actual Thought/Feeling Measures

Through the dyad interaction design, we were able to study both the overt behaviour of the interacting dyad members, and the covert thoughts and feelings of the target participants. Four independent adult judges coded the measures relevant for this study. The overt behavioural measures included behaviours typical for children with ADHD: expressivity, hyperactivity, inattention and restlessness of the children. For every thought/feeling of the children, and after each of the two situations (as a global measure) the judges rated these behaviours on a 7-point scale. The covert measures, rated for each thought or feeling, were measured on the same scale and included the readability of the reported thought/feeling (how difficult it was to infer the specific content of each thought or feeling), the abstractness, and congruency between the (non)-verbal behaviour and the reported thought/feeling.

RESULTS

Between group differences with regard to the behavioural and actual thought/feeling measures

As shown in Table S1, a series of paired *t*-tests revealed that there were no significant within-dyad differences in difficulty of inferring the thought/feeling (or the 'readability'), in the level of abstractness, in the congruency of the thought/feeling

with the overt behaviour, and in the clearness of the formulation of the thought/feeling. In order to know more of the overt behaviours of the participants, we analyzed the expressivity, the restlessness, the hyperactivity or the inattention of the target. Between group comparisons revealed no significant differences with regard to any of these measures. All the mean scores were on a 7-point likert scale.

Table S1
The mean scores of the (c)overt measures of the ADHD and the control group on a 7-point Likert Scale

	Situation 1			**Situation 2**		
	ADHD	**Control**		**ADHD**	**Control**	
	M (SD)	M (SD)	*t*(18)	M (SD)	M (SD)	*t*(18)
Difficulty	4.00 (.52)	4.01 (.44)	-.07	3.74 (.68)	3.58 (.52)	.98
Abstractness	2.78 (.42)	2.66 (.44)	1.21	2.81 (.57)	2.83 (.55)	-.10
Congruency	2.88 (.51)	2.87 (.44)	.09	2.55 (.55)	2.48 (.52)	.46
Clearness	1.54 (.26)	1.55 (.18)	-.25	1.39 (.28)	1.41 (.18)	-.28
Expressivity	4.38 (.79)	4.50 (.77)	-.65	3.72 (.77)	3.97 (.82)	-.91
Restlessness	4.62 (.94)	4.77 (.89)	-.51	4.41 (.86)	4.83 (.76)	-1.54
Hyperactivity	4.54 (.85)	4.60 (.84)	-.28	4.11 (.70)	4.51 (.63)	-1.97
Inattention	4.54 (.60)	4.52 (.67)	.10	4.86 (.55)	5.07 (.56)	-1.43

Between group with regard to the thematic topic of the reported thoughts/feelings

Furthermore, we were interested in between group differences with regard to the thematic topic of the reported thoughts and feelings. We analyzed the thematic topic of the thought/feelings and made two broad categories, person and subject, each divided in subcategories. A series of univariate analyses of variance (ANOVA) was performed with the divisions of the topic as dependent variables and group as the independent variable.

Table S2

The mean percentages of thought/feeling entries belonging to the ADHD and the control group

	Situation 1			Situation 2		
	ADHD	**Control**		**ADHD**	**Control**	
	M (SD)	M (SD)	*t*(18)	M (SD)	M (SD)	*t*(18)
Person						
Itself	38.34 (23.53)	22.79 (14.44)	2.39*	25.28 (28.01)	28.86 (23.01)	-.37
Interaction partner	20.06 (18.33)	27.01 (17.57)	-1.13	26.46 (22.19)	22.37 (17.41)	.71
Researcher	11.64 (12.51)	12.54 (16.22)	-.19	4.23 (7.01)	1.17 (3.50)	1.57
None	32.08 (19.48)	40.50 (24.71)	-1.22	52.65 (30.78)	49.93 (31.25)	.28
Subject						
The room	43.82 (27.34)	49.18 (22.59)	-.94	3.11 (7.26)	3.93 (6.57)	-.41
Context/ game	44.49 (75.33)	32.50 (24.24)	.82	92.91 (9.31)	89.63 (12.87)	1.67
Extern	19.03 (33.31)	14.84 (19.08)	.79	01.96 (6.54)	04.44 (08.56)	-.93

*p<.05

As shown in Table S2, no significant differences with regard to the subject of the though/feeling entries were found. However, a significant difference was found with regard to the thoughts and feelings that focused on the person itself, $t(18) = 2.39$, $p < .05$, indicating that children with ADHD had more thoughts and feelings that focused on themselves than the control children. This difference was found only in the first situation.

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