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Explicit vs. applied theory of mind competence: A comparison of typically developing males, males with ASD, and males with ADHD

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ABSTRACT

Using laboratory-type Theory of Mind (ToM) tasks (our measure of 'explicit' ToM competence) and a more ecologically-valid measure of ToM (our measure of 'applied' ToM competence), we found that for composite scores, typically developing (TD) males performed near ceiling levels on both indices and age-matched males with autism spectrum disorder (ASD) performed near floor levels on both indices. The scores for age-matched males with attention-deficit hyperactivity disorder (ADHD) showed a different pattern such that the ADHD group had high scores on the explicit measure and low scores on the applied measure. Subscale scores (early, basic, advanced ToM) for the two indices also revealed that (1) despite variable complexity, explicit ToM almost always distinguished the ASD group from the other two groups but never distinguished the ADHD and TD groups and (2) level of complexity was critical for distinguishing groups with regard to applied ToM. We suggest that although children with ADHD can calculate the content of traditional laboratory ToM tasks, this explicit ToM competence fails to be applied and expressed in real world demonstrations of ToM (especially when advanced ToM skills are assessed). By contrast, the ToM difficulties of children with ASD seem to be attributable to a deeper metarepresentational deficit. Our results have implications for practice and extend current models of social cognition in developmental disabilities by isolating variable aspects of competence that predict specific and testable models for future research.

1. Introduction

Children with developmental disabilities evidence social and behavioral dysfunction which, left untreated, can lead to peer rejection, social isolation, and psychological maladjustment (Hoza, 2007; Hutchins & Prelock, 2013). Attention-deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) are common and debilitating neurodevelopmental disorders with a chronic course. Although they are distinct diagnostic categories, these psychiatric disorders are frequently comorbid with a little over 28% of persons with ASD also meeting criteria for ADHD (Simonoff et al., 2008). An overlap of

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symptoms and impairments between the two disorders is also well-documented (Memari, Ziaee, Mifrazeli, & Kordi, 2012). For example, compared to their typically developing (TD) peers, children with ADHD and children with ASD demonstrate more inattention and over-activity (Dickerson, Calhoun, Mayes, & Molitoris, 2012), mood and behavior problems (Mayes & Calhoun, 2007), irritability, anger (Brereton, Tonge, & Einfled, 2006), anxiety, and depression (Matson & Cervantes, 2014; Stratis & Lecavalier, 2013), and have higher rates of executive dysfunction (Lawson, Papadakis, Higginson, Barnett, & Willis, 2014) and language delay (Miniscalco, Hagberg, Kadesjo, Westerlund, & Gillberg, 2007). Although there is agreement that children with ASD and children with ADHD have many similar comorbid problems, consensus is lacking as to whether, or to what extent, certain 'Theory of Mind' deficits typical of ASD are common in ADHD.

1.1. Theory of mind

Theory of Mind (ToM) has been defined as "a body of conceptual knowledge that underlies access to both one's own and others' mental states" (Sodian, Hulsken, & Thoermer, 2003, p. 778). Originally used in a narrow sense (i.e., merely to describe performance on the false belief task), ToM has come to be construed as a broad, complex, and multifaceted construct. To illustrate, ToM includes (but is not limited to) the ability to engage in joint attention and pretense, the understanding of play pragmatics, empathy, intentionality, and the capacity to distinguish appearance from reality and the mental from the physical world. It involves affect recognition, first- and second-order thinking, visual perspective-taking, and the understanding that seeing leads to knowing. One with a mature ToM also comprehends the mind as an active interpreter and can make inferences and reason about the causes and consequences of one's own and others' thoughts and feelings. Indeed, ToM has been described as a construct that "refuses to be corralled" (Astington & Baird, 2005, p. 4) and it is often used interchangeably with terms like 'social cognition', 'mind-reading', 'mentalizing', and 'perspective-taking' (Hutchins, Prelock, & Bonazinga, 2012).

1.1.1. ToM and ASD

The widening scope of the term ToM is primarily attributable to the breadth and pervasiveness of the social-cognitive impairments that have been documented in ASD. Owing to nearly three decades of robust empirical findings revealing deficits in ToM in ASD (for a review see Wellman & Peterson, 2013), energy and enthusiasm for the notion of ToM as a core deficit has endured. Specific empirical evidence for this 'Theory of Mind Hypothesis' of autism (Baron-Cohen, 1995) first came from two landmark studies (Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983) demonstrating that children with ASD had significant difficulties understanding that others could have a belief that contradicted reality (i.e., a false belief). The fact that individuals with ASD performed poorly on a variety of ToM tasks but succeeded on carefully designed control tasks suggested that ToM impairments were not the result of more general cognitive dysfunction. Although differences in the measurement of ToM are known to influence performance (e.g., van Buijsen, Hendriks, Ketelaars, & Verhoeven, 2011), research shows that persons with ASD generally underperform TD individuals on assessment of an extensive range of mental states (e.g., Sterck & Begeer, 2010).

Although it has some serious limitations (see Hutchins & Prelock, 2015), the ToM hypothesis makes intuitive sense and parsimoniously explains the social communication and social interaction deficits that are the defining features of ASD. These deficits include a limited range of communicative functions, less diverse and elaborate functional play, difficulty modulating the use of prosody and gesture to aid communication, lack of social responsiveness, and failure to establish or maintain eye contact, to name a few. Whatever specific explanation is provided for the social communication and social interaction difficulties in ASD, it seems clear to many researchers and practitioners that they are a result of some underlying cognitive process that has come to be broadly referred to as ToM.

1.1.2. ToM and ADHD

Social cognition deficits are not strictly limited to people with ASD and there are a variety of circumstances and disorders that can hinder ToM development (Dyck, Ferguson, & Shochet, 2001). Some ADHD researchers have pointed to impairment in specific social cognitive domains (e.g., empathy; Demurie, De Coral, & Roeyers, 2011; emotion recognition, prosody perception; Uekermann et al., 2010) as a basis for social dysfunction in ADHD. Others, explaining social deficits more generally (i.e., not specific to ADHD), have adopted a procedural model (i.e., Crick & Dodge, 1994) postulating disruption in a series of social-information processing steps that children go through when faced with social situations (i.e., encoding of cues, interpretation of cues, clarification of goal states, accessing/generating responses, response decision, and behavioral enactment). Indeed, compared to TD children, children with (or at risk for) ADHD tend to encode social information less accurately and, in turn, have difficulty integrating social cues and formulating appropriate responses (Coy, Speltz, DeKlyen, & Jones, 2001; Milch-Reich, Campbell, Pelham, Connelly, & Geva, 1999). Still other researchers have implicated biased or distorted social attribution as a causal factor underlying the social dysfunction in ADHD. For example, Andrade et al. (2012) reported that children with ADHD not only detected fewer social cues but also attributed more negative and less positive intent to peers and generated fewer positive responses compared to TD children.

Of course, there are multiple pathways to social difficulties and research employing more traditional ToM tasks has highlighted the potential of executive dysfunction (not ToM impairment) as a root cause of the social deficits of ADHD. While three studies (Charman, Carroll, & Struge, 2001; Happé & Frith, 1996; Perner, Kain, & Barchfeld, 2002) have reported no impairment on advanced ToM tests in school-aged children with (or at risk for) ADHD, findings are mixed and at least two

Table 1
Studies investigating ToM in individuals with ADHD and individuals with ASD.

Study	Sample	Theory of mind tasks	Results	Conclusions
Baribeau et al. (2015)	Youth less than 21 years of age with diagnoses of ASD ($n = 118$), ADHD ($n = 71$), OCD ($n = 42$) and TD controls ($n = 34$)	(3) The Reading the Mind in the Eyes Test (RMET; Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001)	When controlling for age and gender, youth with ASD and ADHD underperformed the other groups on the RMET. When also controlling for IQ, scores for the ASD group remained low but those for the ADHD group now matched controls	Social perception abilities in developmental disorders lies along a continuum and those with ASD have the greatest deficits. The deficits of ADHD are associated with impaired social perception and highlight overlapping cognitive and behavioral manifestations across disorders
Buitelaar et al. (1999)	20 with Autistic Disorder (ages 9–18 years), 20 with PDD-NOS (ages 8–18), 20 with Non-Autistic Psychiatric condition (ADHD, conduct disorder, or dysthymia, ages 8–18) & 20 TD participants (ages 8–12)	A series of commonly used first- and second-order ToM tasks and emotion recognition tasks	All three clinical groups performed worse than the TD group on 2nd order ToM and emotion recognition tasks. Only the autistic group performed worse than the TD group on 1st order ToM tasks. The best predictors of ToM was verbal memory, performance IQ, age, and gender	The non-autistic psychiatric group may be unable to apply social-emotional knowledge in real life. Social cognition "springs from a matrix of cognitive abilities" (p. 879) including verbal memory, visuospatial skills, verbal reasoning ability, and unspecified gender-associated features. The results challenge claims about the specificity and primacy of mentalizing and emotion recognition deficits in ASD
Buhler et al. (2011)	86 with ASD (ages 5–15 yrs.), 84 with ADHD (ages 4–22) & 52 with ASD + ADHD (ages 6–18)	(1) computer-based emotion recognition task (2) Social Attribution Task (Klin, 2000)	Results indicated differences in inhibitory control (ADHD < ASD) and in ToM performance among younger (ASD < ADHD) but not among older children	ToM deficits develop in clinical populations with age. Perhaps children with ASD lack a prerequisite or foundational ToM, while children with ADHD develop deficits in ToM over time
Demopoulos et al. (2013)	137 with ASD & 436 with ADHD, (ages 6–17 yrs.)	The Diagnostic Assessment of Nonverbal Accuracy-2 to assess facial and vocal affect, social judgment and problem solving (DANVA-2; Nowicki & Duke, 1994)	The ASD and ADHD groups performed significantly worse than the normative sample on all measures. "Although the ASD group had more severe deficits, the pattern of deficits was surprisingly similar between groups" (p. 1157)	The social-cognitive deficit patterns in ASD and ADHD may be more similar than previously thought. Results may indicate that persons with ASD and ADHD are similar in the early stages of social information processing (e.g., encoding social cures) but may differ in the latter stages (e.g., social responding and response evaluation)
Demurie et al. (2011)	13 with ASD, 13 with ADHD, & 18 TD participants (age range for groups was ~11–17 with a mean of ~14 yrs.)	(1) informant-ratings (self, parent) of empathy (2) a naturalistic test of empathic accuracy (3) The Reading the Mind in the Eyes Test (Baron-Cohen et al. 2001)	Adolescents with ASD had lower scores on all measures compared to the TD group. Adolescents with ADHD performed at an intermediate level (in between the ASD and TD samples at levels that did not achieve statistical significance). Finally, parents of adolescents with ADHD reported lower empathy scores than did parents of TD adolescents	Findings are consistent with the ToM hypothesis of ASD. Still, the mind-reading abilities of adolescents with ADHD (while not achieving significance) is not typical. Parents report empathy impairments in ADHD which is consistent with the idea of ADHD as an empathy disorder and challenges claims that ToM impairments are specific to ASD
Downs and Smith (2004)	10 males with ASD (ages 5–9 yrs.), 16 males with ADHD/ODD (ages 5–9), & 10 TD males (ages 6–9)	Several structured tasks (from Howlin, Baron-Cohen, & Hadwin, 1999) to assess emotion understanding across a range of situations	Children with ADHD/ODD displayed more social-emotional and behavioral deficits than the other groups, "including areas such as theory of mind that have been considered especially difficult or impossible for children with autism" (p. 631)	Previous studies have shown that children with ADHD/ODD generally perform as well as (or better than) those with ASD on ToM tasks. However, this study may indicate the presence of an ADHD-ODD specific ToM deficit in emotion understanding
Gonzalez-Gadea et al. (2013)	22 adults with ADHD, 23 adults with Asperger Syndrome, & 21 TD adults	(1) Reading in Mind in the Eyes test (Baron-Cohen, Wheelright, & Jolliffe, 1997) (2) The Faux Pas Test (Stone, Baron-Cohen, & Knight, 1998)	No significant differences were observed for the Reading the Mind in the Eyes Test, however, those with Asperger syndrome had significantly lower scores on	ADHD and Asperger syndrome groups have a heterogeneous ToM profile. Heterogeneity in executive functioning may serve as a link between ASD and

Table 1 (*Continued*)

Study	Sample	Theory of mind tasks	Results	Conclusions
			the Faux Pas Test compared to the ADHD and control groups	ADHD and ToM deficits appear to be unique to ASD
Yang et al. (2009)	20 with ASD (ages 3–15 years), 26 with ADHD (ages 3–8 years) & 30 TD children (ages 3–15)	(1) Appearance-reality task (2) False belief task (3) False contents task	The ASD group performed significantly worse on all ToM tasks compared to the other two groups. Inhibition was the only component of executive function that related to ToM	Children with ASD have a significant ToM impairment. Inhibition may be central to the relation between ToM and executive function

additional studies do report impaired performance on advanced ToM tasks (Buitelaar, van der Wees, Swaab-Barneveld, & van der Gaag, 1999; Papadopoulos, Panayiotou, Spanoudis, & Natsopoulos, 2005). In an attempt to reconcile the variable results, Sodian et al. (2003) noted that previous studies were "not motivated by analysis of possible interactions between conceptual content and inhibitory demands of the tasks" (p. 780). In their study, TD and ADHD children were no different on standard second-order tests but children with ADHD were delayed on a test of advanced understanding that required online representation of another's mental state. Sodian et al. (2003) concluded that inhibitory control is important for higher-order ToM but that the effects are more important for online mind-reading than for ToM reasoning in general.

1.1.3. ToM, ASD, & ADHD

Children with ADHD often experience social difficulties that are similar to those of children with ASD (Happé & Frith, 1996). Both groups may exhibit significant problems with peer functioning, demonstrate fewer neutral nonverbal behaviors (such as attending to other children or adults; Pelham & Bender, 1982) and show deficits in emotion understanding and social-cognitive aspects of interpersonal problem solving (Cook, Greenberg, & Kusche, 1994; Dodge & Price, 1994). Researchers have recently begun to consider whether, which, and to what degree the ToM impairments typical of ASD are common to ADHD. The research in this area, however, is sparse and mixed. To our knowledge, only eight studies have specifically compared the social cognition abilities of children with ASD and children with ADHD. A review of those studies is presented in Table 1.

Several findings are relevant in the studies reviewed as they highlight the likely competence deficits in individuals with ASD vs. the more typical performance deficits in individuals with ADHD. First, in six of the eight studies, individuals with ASD performed more poorly on ToM tasks than either individuals with ADHD or those who were TD (Baribeau et al., 2015; Buitelaar et al., 1999; Demopoulos, Hopkins, & Davis, 2013; Demurie et al., 2011; Gonzalez-Gadea et al., 2013; Yang, Zhou, Yao, Su, & McWhinnie, 2009) confirming what would be expected in our understanding of a core ToM deficit in persons with ASD. In the remaining two studies, however, some unique findings were reported. Downs and Smith (2004) found that children with ADHD combined with oppositional defiant disorder (ODD) exhibited more social-emotional and behavioral difficulties than TD children or children with ASD suggesting a specific ToM deficit in emotion understanding for children with ADHD-ODD. Buhler, Bachman, Goyert, Heinzel-Gutenbrunner, and Kamp-Becker (2011) found greater inhibitory control differences for children with ADHD than those with ASD, and ToM differences between the two groups were characteristic of younger vs. older children. Their findings suggested a more foundational and conceptual ToM deficit for children with ASD and a developing ToM deficit for older children with ADHD. In addition, ToM complexity appeared to be an influencing factor for ToM performance that differentiated persons with ASD from those with ADHD. Individuals with ASD often performed more poorly on first order ToM tasks (Buitelaar et al., 1999) and had more severe deficits (Demopoulos et al., 2013; Gonzalez-Gadea et al., 2013) than either those with ADHD or typical development, although the general patterns of ToM deficits in those with ASD and ADHD were similar. Finally, inhibition appeared to be tied to executive function and ToM performance. Individuals with ADHD appear to have greater challenges in inhibitory control and emotion recognition, which may influence ToM performance where individuals with ASD may have a more foundational ToM deficit (Buhler et al., 2011; Gonzalez-Gadea et al., 2013; Yang et al., 2009).

1.2. Explicit and applied ToM competence

First, it is noteworthy that while much education and psychological research speaks to explicit and applied competencies, it typically does so by employing different terminology to highlight slightly different contrasts, which in turn, encourages somewhat different discussions. In lieu of 'explicit' might be reference to 'basic' or 'conceptual knowledge' (Hiebert & Lefevre, 1986), the 'cognitive level' of functioning (Morton, 2004), or the notion of 'competence' more broadly (Chomsky, 1959) whereas 'skill', 'procedural knowledge', the 'behavioral level' of function, or the notion of 'performance' can act as stand-ins for 'applied'. The distinction between explicit and applied competence that we emphasize here is not synonymous with any of these distinctions, but it draws upon all of them. We employ the contrast between explicit and applied competence because it is precise, relatively circumscribed, and thus, has utility for describing two types of functioning relevant to our understanding of social communication impairments in developmental disorders. The mixing of terms 'explicit' and 'applied' (instead of 'explicit vs. tacit' or 'basic vs. applied') is also deliberate as the more traditional pairings span disciplines and carry theoretical baggage that might confuse the issues and frustrate attempts to link each competency to a reasonable operational definition. The explicit/applied distinction, however, is not atheoretical and its interest lies in the potential for these two competencies to converge or dissociate as described below. Finally, the distinction is practical as questions about how children fail to acquire ToM (and how they should be taught) often turn on speculations about which type of competency has the most developmental significance, how support in one might buttress or otherwise affect the other, or what might be an optimal balance between the two.

We define explicit ToM competence as ToM knowledge that is conceptual, operational, and logical. It is also calculable within a limited experimental context and, as such, can be readily accessed and verbalized. By contrast, we characterize applied ToM competence as the ability to deploy ToM knowledge to successfully address ToM dilemmas as they are presented in real-world samples of behavior. Applied ToM competence is revealed in day-to-day performance and it is ostensibly affected by a variety of endogenous (e.g., executive functioning, motivation, sensitivity) and exogenous (e.g., physical setting) factors.

As noted above, explicit and applied ToM competencies may dissociate: being able to compute the logic of mental states is no guarantee that one can or will apply the principles more broadly. To illustrate, Bowler (1992) reported that although adults with Asperger syndrome could pass explicit ToM tasks, their responses to justification questions lacked reference to mental states. Bowler suggested that persons with Asperger syndrome may use a logical rather than mentalistic process to compute the correct solution. He reasoned that this might explain good performance on ToM tasks in persons with persistent and significant social impairments. More recently, Senju, Southgate, White, and Frith (2009) reconfirmed this notion by demonstrating that although individuals with Asperger syndrome showed an explicit understanding of desires and beliefs, they nevertheless failed tasks designed to assess the spontaneous attribution of mental states.

Just as children may be conceptually competent but fail to perform, they may also succeed in practice without having the knowledge that explicit ToM tasks are intended to assess. This potential is rarely entertained in the developmental disabilities literature (primarily because performance is viewed as a downstream consequence of conceptual knowledge) and it seems counterintuitive: how can someone be competent in an applied way (e.g., doing well on a mathematics exam) without mastering the relevant underlying concepts (e.g., not understanding mathematical operations) ? Yet, ToM is only *sometimes* necessary but never sufficient for explaining social competence (Astington, 2003). “Rather than deploying a theory of mind constantly, people rely on social scripts, behavioral cues, and narratives to guide their actions in social situations” (Hughes & Devine, 2015, p. 151). Indeed, Senju (2012) showed that whereas high functioning adults with ASD could pass explicit tests of false belief while failing tests of spontaneous false belief, TD infants showed the opposite pattern and passed spontaneous false belief tests well before they could articulate their understanding. Of course, the latter finding is not surprising in light of Vygotskian theories that emphasize children’s interactions with the world as shapers of children’s cognitive development.

1.3. Statement of the problem

In designing interventions to support appropriate social interaction and communication, researchers and practitioners are increasingly invoking ToM in an effort to understand which (in) competencies are the putative causes of social dysfunction. One problem is that ToM competencies can dissociate and a window onto one cannot be assumed to be a window onto the other. Another problem is that conceptual complexity appears to moderate performance on ToM tasks yet few studies have systematically isolated its effects. The purpose of this study was to examine, in depth, the ToM profiles of children with ASD and children with ADHD, contrast their patterns of competency, and compare them to TD children. Our examinations were exploratory given the previous mixed findings on ToM competence in ADHD and the fact that this was the first study to specifically contrast indices of explicit and applied competencies in ASD, ADHD, and TD groups across various levels of complexity.

2. Materials and methods

2.1. Design

This study was a cross-sectional comparison of TD males, males with ASD, and males with ADHD. Groups were matched on age as well as carefully designed task control measures designed to assess memory and receptive language. Explicit and applied ToM competencies were compared using two different indices that were comparable across levels of ToM development.

2.2. Participants

Data for 22 individuals with ADHD (combined type) and their parents were drawn from an assessment clinic specializing in the identification of children with developmental disabilities.

Additional data were drawn from the archival data sets of three protocols examining different research questions. Data for seven individuals with ADHD-combined type and 13 individuals with ASD were drawn from a longitudinal study examining the benefits of exercise on parent-training to improve outcomes for children with ASD and ADHD. Data for 14 TD individuals and 13 individuals with ASD were drawn from a cross sectional study examining visual attention to face stimuli. Finally, data for 35 TD individuals and 41 individuals with ASD were drawn from a large normative study examining the psychometric properties of the tools used in this study (reported in Hutchins et al., 2012). Data were drawn solely from baseline measures so that they would not be affected by study-specific methods and procedures. Inclusion criteria for all participants and all studies required parent report of a formal diagnosis from a psychologist, psychiatrist, or developmental pediatrician with the singular exception of the seven individuals with ADHD in the exercise and parent-training study who were screened for ADHD as described immediately below. For each study, measures designed to confirm diagnosis were also administered. For the ASD samples, these were the Gilliam Autism Rating Scale—Second Edition (GARS-2; Gilliam, 2006) for which a minimum score of 70 was required for inclusion and the Social Responsiveness Scale (SRS; Constantino, 2005) for which a score minimum score of 60 was required for inclusion. For the ADHD sample, ADHD symptoms were measured by parent and teacher report using the ADHD Rating Scale—IV (DuPaul, Power, Anastopoulos, & Reid, 1998), a screening tool used to identify children with elevated ADHD symptoms and who may be best characterized as having either inattentive-type, hyperactive/impulsive-type, or combined type ADHD. For this measure, a score exceeding the 80th percentile was required for inclusion.

Exclusion criteria for the present study required that participants with ASD had no comorbid diagnosis of intellectual disability, ADHD, language disorder, or uncorrected visual or hearing impairment on the basis of parent report. Similarly, exclusion criteria required that participants with ADHD had no comorbid diagnosis of intellectual disability, ASD, language disorder, or uncorrected visual or hearing impairment on the basis of parent report.

Data were pooled from the above sources to create groups that were distribution-matched on age ($p = .16$). Specifically, the TD group consisted of 49 males (5.75–13.75 years; $\underline{M} = 8.82$; $SD = 2.09$), the ASD group consisted of 67 males (5.00–14.08 years; $\underline{M} = 9.77$; $SD = 2.32$), and the ADHD group consisted of 29 males (5.80–13.98 years; $\underline{M} = 9.02$; $SD = 2.52$). According to parent report, all participants with ASD were verbal and all used language in a flexible and functional way. As such, the ASD group was comprised of those who could be considered 'high functioning' and a large proportion (approximately 34%) had official diagnoses of Asperger syndrome. As would be expected, oppositional defiant disorder was also reported (or discovered as part of a comprehensive assessment process described above) in our ADHD-combined sample; the comorbidity rate was approximately 38%.

Although we attempted to minimize the effects of language and cognitive ability by examining groups who were all highly verbal, we recognize that children from clinical populations often have subclinical inter- and intra-group differences in language and cognition that are not adequately controlled by their status as 'verbal' individuals. Unfortunately, such variation is also not necessarily detected or adequately controlled with the use of standard measures. In fact, matching groups with different developmental disabilities (not to mention TD groups) on standard measures (e.g., non-central measures of language or verbal and nonverbal IQ) is fraught with practical, theoretical, and statistical problems so serious that some have advocated for alternate methods of control. As Jarrod and Brock (2004) explain:

> " . . . with careful task design one can ensure that groups are equated for these abilities. The most informative experimental designs are those that *build in* [italics in original] control conditions, resulting in versions of the task that are closely matched in most respects but differ in whether they require the target ability or not. If individuals with autism perform as well as comparison participants on the basic version of the task but are impaired when the target ability is required, then this is potentially strong evidence of a specific deficit in this area" (p. 82).

In line with this recommendation, we examined scores for a series of carefully designed memory and language comprehension control tasks that are 'built in' to a Theory of Mind Task Battery (described below). Our three groups were no different in their ability to correctly answer the 11 control questions that were embedded within the test ($p = .57$) and null effects were also obtained for each item when examined individually (p values range from .26 to .99 with a median value of .52). As such, all three groups were distribution-matched on tasks specifically designed to isolate memory and language comprehension while sharing as many of the non-central features of the experimental task as possible and which were presumably equally sensitive to variation in ability. It is also important to note that all three groups performed well on all test control questions (across items percent correct responses ranged from 65 to 100 in a severely negatively skewed distribution) as would be expected in TD children and what we consider to be clinical but high functioning ADHD and ASD groups.

2.3. Materials

Because "no one task offers a perfect window into children's minds" (Sophian, 1997, p. 286) and in light of the fact that ToM is broad and multifaceted, we needed measures of explicit and applied ToM competence that tapped a range of ToM content areas and varied in conceptual complexity. Two measures are particularly well-suited for this purpose. The *Theory of Mind Task Battery* (ToMTB; Hutchins, Prelock, & Chace, 2008; Hutchins & Prelock, 2014) is offered as a test of explicit ToM competence and the *Theory of Mind Inventory* (ToMI, Hutchins et al., 2008b, 2012) is offered as a measure of applied ToM competence. The ToMI (with 42 items) is, by design, more comprehensive in content compared to the ToMTB (with 15 items). Thus, the content tapped by the two measures is not identical but overlaps considerably and the tools were co-developed and co-normed so as to assess ToM across three general levels of development: both measures have an Early Subscale intended to capture those ToM abilities that emerge in typical development between 1 and 3 years of age, a Basic Subscale intended to tap those ToM abilities that emerge in the preschool years (ages 3–5.5 years), and an Advanced Subscale intended to tap those ToM abilities that emerge in later childhood ($\sim$ ages 5.5–8 years).

2.3.1. The Theory of Mind Task Battery

Since the development of the original measure (described in Hutchins et al., 2008b), the Theory of Mind Task Battery (ToMTB) has undergone revision to enhance the test content and the quality of the stimulus materials. In its current form, the ToMTB consists of 15 test questions within nine tasks (tasks A—I) that are arranged in order of ascending difficulty (order empirically determined). Tasks are presented as short vignettes that appear in a story-book format. Each page has color illustrations and accompanying text. For all tasks, children are presented with one correct response option and three plausible distracters, making the chance of correct responding in the absence of ToM knowledge equal to 25%. Eleven memory control questions are included which must be passed in order for credit to be given on the test questions. The control questions vary in linguistic complexity (e.g., from simple wh-questions like "Where is the book now?" to questions that include embedded clauses as in "What does Enrique think he is getting for his birthday?") and are designed to isolate ToM knowledge from working memory and receptive language. In situations where the child fails to respond, all test questions have two levels of prompting except the first four emotion recognition tasks for which the question is simply repeated a maximum of two times (see technical manual, Hutchins et al., 2014). The ToMTB has been favorably evaluated for test–retest reliability and construct validity (Hutchins et al., 2008b, 2014). Sample items from each subscale of the ToMTB are offered in Appendix.

2.3.2. The Theory of Mind Inventory

Each item on the ToMI was developed as a face valid indicator of a particular ToM dimension with the goal of producing a tool that could tap a wide range of ToM content and complexity. The ToMI is comprised of three empirically derived subscales identified on the basis of factor analysis. The Early Subscale consists of seven items intended to tap the earliest ToM abilities known to emerge in typical development during infancy and toddlerhood (e.g., social referencing, reading basic emotions). The Basic Subscale includes 19 items designed to tap ToM achievements characteristic of young TD school children (e.g., basic metarepresentation, seeing-leads-to-knowing, the mental-physical distinction). The Advanced Subscale consists of 16 items intended to assess more mature aspects of ToM that tend to emerge in typical development between approximately 5.5–8 years of age (e.g., making complex social judgments, inferring second-order false beliefs).

Each item on the ToMI takes the form of a statement. Examples of Early Subscale items are "My child understands that, when I show fear, the situation is unsafe or dangerous" (to tap social referencing) and "My child recognizes when others are happy" (to tap basic emotion recognition). Examples of Basic Subscale items are "If I showed my child a cereal box filled with cookies and asked 'What would someone who has not looked inside think is in the box?', my child would say that another person would think that there was cereal in the box" (to tap false belief) and "My child understands that if someone is afraid of the dark, they will not want to go into a dark room" (to tap belief-based behavior). Examples of Advanced Subscale items are "If it were raining and I said in a sarcastic voice 'Gee, looks like a really nice day outside' my child would understand that I didn't actually think it was a nice day" (to tap sarcasm) and "My child understands the difference between when a friend is teasing in a nice way and when a bully is making fun of someone in a mean way" (to tap complex social judgment). Each item is accompanied by a 20-unit continuum anchored by "Definitely Not" and "Definitely" with a center point of "Undecided" and respondents are asked to indicate their response by making a vertical hash mark along the point of the continuum that best reflects their attitude. Possible item, subscale, and composite scores range from 0 to 20 with higher values reflecting greater parental confidence that the child can perform particular ToM-relevant skills. ToMI scores are taken as indices of ToM performance in this study. Crucially, the rationale underlying the development of the ToMI was to develop a socially- and ecologically-valid index of ToM as it is applied in everyday interactions (Hutchins, Bonazinga, Prelock, & Taylor, 2008; Hutchins et al., 2012).

The ToMI has been extensively validated. The developers report excellent test-retest reliability (for both short and long intervals), internal consistency, and criterion-related validity (the ToMI correlates with other measures of ToM and language ability) for TD samples and samples with ASD. The ToMI also performs well under tests of contrasting-groups validity (it distinguishes ASD from TD groups and younger from older TD children) and statistical methods of validity (i.e., factor analysis) (Hutchins et al., 2008a, 2012; Lerner, Hutchins, & Prelock, 2011). Finally, although not intended for use in differential diagnoses, when children with ASD are examined, the ToMI demonstrates excellent sensitivity (.9) and specificity (.9) (Hutchins et al., 2014). The ToMI and the ToMTB, their accompanying technical manual, and four peer-reviewed articles reporting on the psychometric properties of the tools are available at Theoryofmindinventory.com.

3. Results

All ToMTB and ToMI data were analyzed on the level of composite, subscale, and item scores using a series of between-groups analyses of variance (ANOVAs). Due to the large number of comparisons and the exploratory nature of this study, we employed Fisher's least significant different (LSD) post hoc tests to protect against the likelihood of multiple Type II errors (O'Keefe, 2003a,b). Because not all measures were represented in all data sources, the comparisons reported below are sometimes based on samples sizes that are slightly different (as reflected in the reported degrees of freedom) from those reported in the participants section. Recall that scores for each ToMTB item are worth one point, scores for each ToMTB subscale (Early, Basic, Advanced) are worth five points, and the composite ToMTB test is worth a possible 15 points. By contrast, scores for the ToMI (whether they are item, subscale, or composite) are worth a possible 20 points (because subscale and composite scores are simple item averages).

3.1. Composite scores

A significant difference was found for the ToMTB omnibus ANOVA composite score, $F(2, 68) = 5.48$, $p < .01$ with post-hoc tests showing that the ASD group ($M = 9.46$; $SD = 3.75$) significantly underperformed both the ADHD group ($M = 11.94$; $SD = 2.22$, $p < .01$), and the TD group ($M = 12.67$, $SD = 2.0$, $p < .05$), who were not different from each other ($p = .31$). A significant difference was found for the ToMI omnibus ANOVA composite score, $F(2, 135) = 48.89$, $p < .01$, with post-hoc tests showing that the ASD group ($M = 11.51$; $SD = 3.65$) and the ADHD group ($M = 12.43$; $SD = 4.06$) were not different from each other ($p = .35$) although both significantly underperformed the TD group ($M = 17.61$, $SD = 1.85$) at the level of $p < .01$. These data are summarized in Fig. 1 in the form of percent possible correct that scores for each task may be interpreted on the same scale.

3.2. Subscale scores: ToMTB

No between-group differences were found for the ToMTB omnibus ANOVA Early Subscale score. This appears to be due to ceiling effects for all groups and is not surprising given that the participants in both clinical groups were older and high-functioning. A significant difference was found for the ToMTB omnibus ANOVA Basic Subscale score, $F(2, 136) = 4.43$, $p < .05$, with post-hoc tests showing that the ASD group ($M = 3.0$; $SD = 1.44$) significantly underperformed the ADHD group ($M = 3.60$; $SD = 1.10$, $p < .05$), and the TD group ($M = 3.85$, $SD = 1.35$, $p < .05$), who were no different from each other ($p = .45$). A significant difference was also found for the ToMTB omnibus ANOVA Advanced Subscale score, $F(2, 136) = 5.83$, $p < .05$, such that the ASD group ($M = 2.45$; $SD = 1.85$) significantly underperformed the ADHD group ($M = 3.30$; $SD = 1.51$, $p < .05$), and the TD group ($M = 3.45$, $SD = 1.72$, $p < .05$), who were not different from each other ($p = .48$). These data are summarized in Fig. 2 in the form of percent possible total score so they may be interpreted on the same scale as ToMI subscale data (described below).

3.3. Subscale scores: ToMI

A significant difference was found for the ToMI omnibus ANOVA Early Subscale score, $F(2, 136) = 37.32$, $p < .01$, with post-hoc tests showing that the TD group ($M = 17.86$, $SD = 1.75$) outperformed the ADHD group ($M = 14.90$, $SD = 4.31$, $p < .05$) who outperformed the ASD group ($M = 12.98$, $SD = 1.75$, $p < .05$). A significant difference was found for the ToMI omnibus ANOVA Basic Subscale score, $F(2, 136) = 4.43$, $p < .05$, such that the TD group ($M = 18.08$, $SD = 1.52$) outperformed the ADHD group ($M = 14.38$, $SD = 4.94$, $p < .05$) who outperformed the ASD group ($M = 12.78$; $SD = 3.66$, $p < .05$). A significant difference was also found for the ToMI omnibus ANOVA Advanced Subscale score, $F(2, 135) = 56.50$, $p < .01$, such that the TD group ($M = 17.25$ $SD = 2.36$) outperformed the ASD group ($M = 9.68$; $SD = 4.52$, $p < .01$) and the ADHD group ($M = 9.26$; $SD = 5.18$, $p < .01$) who were not different from each other ($p = .67$). These data are summarized in Fig. 3 in the form of percent possible total score for each index so that they may be interpreted on the same scale as previous data. A summary of all major results (which are raw score data) is also presented in Table 2.

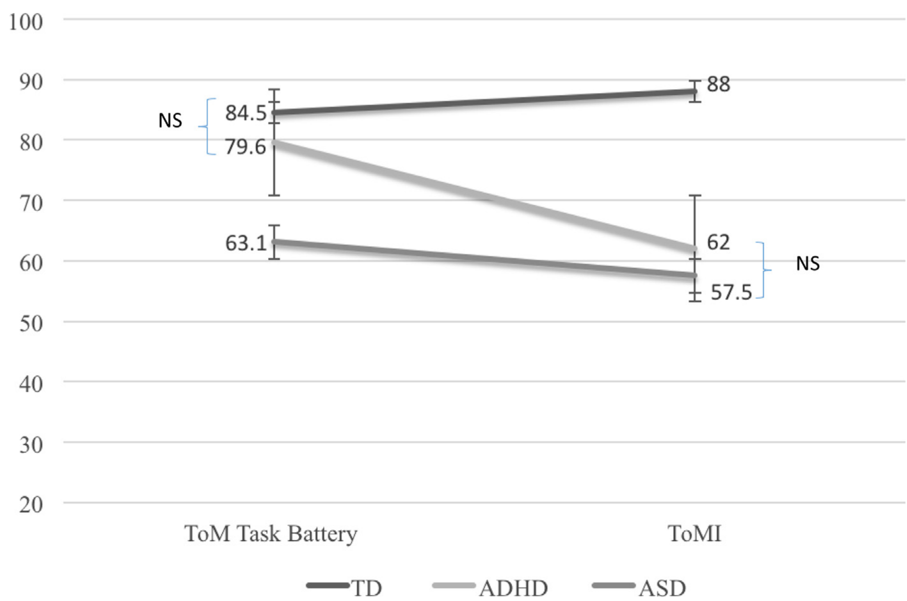

Fig. 1. Percent of possible total score for ToMTB and ToMI data for typically developing (TD) males, males with ADHD, and males with ASD. All differences are significant unless otherwise indicated as not significant (NS).

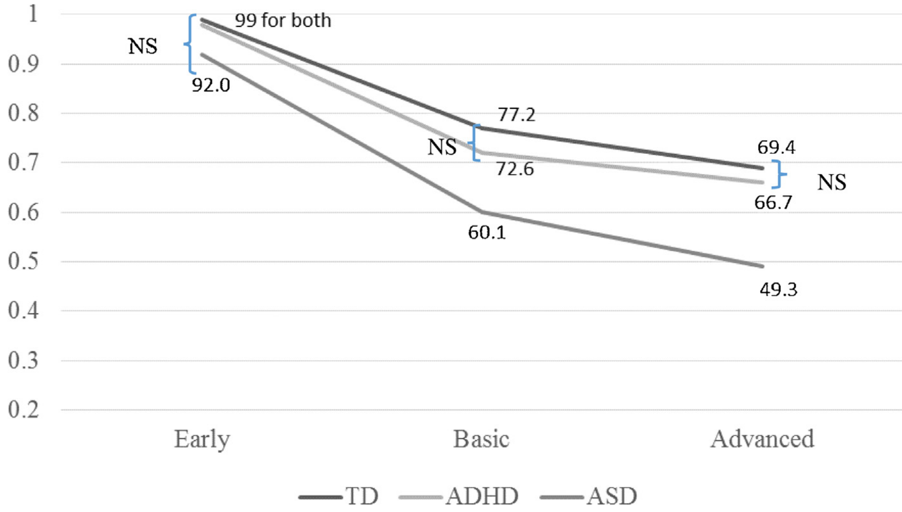

Fig. 2. Percent possible score for ToMTB by subscale (Early, Basic, Advanced) for typically developing (TD) males, males with ADHD, and males with ASD. All differences are significant ($p < .05$) unless otherwise indicated as not significant (NS).

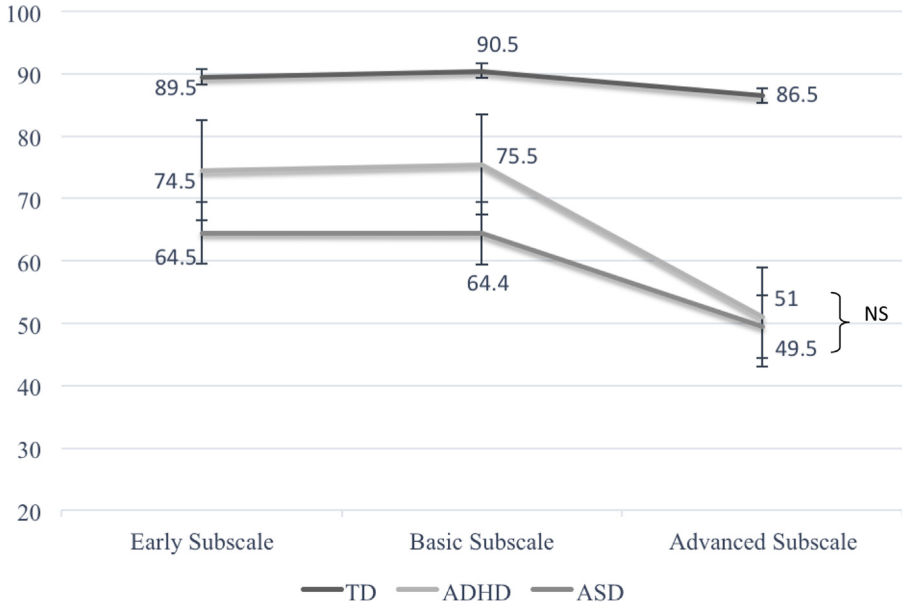

Fig. 3. Percept of possible score for ToMI subscale (Early, Basic, Advanced) scores for typically developing (TD) males, males with ADHD, and males with ASD. All differences are significant unless otherwise noted as not significant (NS).

3.4. Item level scores

As would be expected, item level scores for the ToMTB (15 comparisons) conformed to the results of ToMTB subscale analyses reported above. Inferential tests revealed that items from the Early Subscale did not distinguish groups ($p > .42$ for all comparisons) whereas items from the Basic and Advanced Subscales consistently distinguished the ASD group from the ADHD and TD groups ($p < .05$ for all comparisons), they never distinguished the ADHD from the TD group.

Similarly, item level ToMI scores (42 comparisons) generally conformed to the results of ToMI subscale analyses: Early and Basic subscale items generally distinguished groups (ASD < ADHD < TD) whereas Advanced Subscale items distinguished our TD group from our clinical groups but could not distinguish our ADHD from our ASD groups (i.e., ASD, ADHD < TD). Subscale analyses, however, may obscure a different pattern of findings for particular items. This was the case for our data and there are five items from the Early and Basic ToMI subscales where post-hoc tests showed significantly lower scores for the ASD group ($p < .01$ for all comparisons) compared to both of the ADHD and TD groups who were indistinguishable from each other (i.e., ASD < ADHD, TD). These items are of clinical interest and are listed below. The construct intended to be

Table 2
Summary statistics for omnibus group effects (mean, *SD*,*p* values, and partial Eta squared effect size).

DATA	GROUP *M* (*SD*)			*p*	η^2
	TD	ADHD	ASD		
ToMTB composite score (out of 15)	12.67 (2.0)	11.94 (2.22)	9.46 (3.75)	.006	13.39
ToMTB subscales (out of 5)					
-Early scale	4.93 (.25)	4.96 (.20)	4.58 (.92)	.12	–
-Basic scale	3.85 (1.35)	3.60 (1.10)	3.0 (1.44)	.04	8.90
-Advanced scale	3.45 (1.72)	3.30 (1.51)	2.45 (1.85)	.04	9.54
ToMI composite score (out of 20)	17.61(1.85)	12.43(4.06)	11.51(3.65)	.000	41.98
ToMI subscales (out of 20)					
-Early	17.86(1.75)	14.90(4.31)	12.98(1.75)	.000	35.44
-Basic	18.08(1.52)	14.38(4.94)	12.78(3.66)	.000	34.11
-Advanced	17.25(2.36)	9.26(5.18)	9.68(4.52)	.000	45.57

tapped by the item is given first (in bold) followed by the actual item and item means for each group in this order: ASD; ADHD; TD).

26. **Pretense**: My child can pretend that one object is a different object (for example, pretending a banana is a telephone). *M* = 11.1; 17.1; 15.7.

29. **Counterfactual reasoning**: My child understands the word 'if' when it is used hypothetically as in, "*If I had the money, I'd buy a new house*." *M* = 9.2; 13.4; 15.2.

32. **Play pragmatics**: My child understands that in a game of hide and seek, you don't want the person who is 'it' to see you. *M* = 9.2; 17.3; 15.7.

33. **Understanding performatives**: My child understands that when a person promises something, it means the person is supposed to do it. *M* = 14.2; 16.5; 17.8.

37. **Initiating joint attention**: My child is able to show me things. *M* = 16.4; 19.3; 19.5.

4. Discussion

The purpose of this study was to examine, in depth, the ToM profiles of children with ASD and children with ADHD, contrast their patterns of competency, and compare them to TD children. In support of the construct validity of the measures employed, the TD sample performed near ceiling levels on both the ToMTB (our explicit competence measure) and ToMI (our applied competence measure) for composite, subscale, and item scores. Relative to the expert conceptualization and utilization of ToM observed for the TD group, the composite score data suggests impaired explicit and applied ToM in children with ASD but intact explicit and impaired applied ToM competence in children with ADHD (see Fig. 1). The findings for the ASD group are not surprising given the decades of research citing pervasive deficits in the ability to infer a wide range of mental states. The results are also consistent with the Theory of Mind Hypothesis of autism (Baron-Cohen, 1995) and suggest a core conceptual deficit in metarepresentation that disrupts downstream applied ToM.

Nonetheless, there is no contradiction in stating that there are both broad ToM impairments in ASD and also islands of ToM competence for any given individual (Gonzalez-Gadea et al., 2013). In fact, inspection of our raw data showed that there were a few individuals in our ASD group who performed perfectly on the ToMTB while receiving scores on the ToMI that were well within the clinical range. Such performance patterns have been documented in previous research (Senju, 2012; Senju et al., 2009) and remind us not only is there great heterogeneity in ToM competencies within groups but some high-functioning individuals with ASD may be 'hacking out' the solution to laboratory-type ToM tasks in a non-mentalistic way. This raises a question of interpretation however. From a multiple ToM competencies framework, should 'hacking' (as the term connotes) be seen merely as a clever, if not roguish, maneuver as opposed to a genuine (although non-normative) ToM skill that demands its own special virtuosity? To understand cognitive development (even, no especially, in ASD), a more interactive conception of explicit and applied competencies will be necessary. Understanding good performance on explicit laboratory-type ToM tasks as 'hacking' may misconstrue or underestimate the degree to which ToM in ASD changes with development. Indeed, a theory of ToM development is needed that accounts for the many differences between high-functioning and verbal children ASD (and those who are able or unable to 'hack') as well as the commonalities between them.

The composite score results for the ADHD group are also consistent with previous research. Like most (meaning there are exceptions) earlier studies (Charman et al., 2001; Happé & Frith, 1996; Perner et al., 2002; Sodian et al., 2003), we found no ToM differences between our TD and ADHD groups when measured by laboratory-type indices. By contrast, our ecologically-valid measure of applied ToM competence distinguished our TD group from our two clinical groups but could not distinguish our two clinical groups from each other (again, reference Fig. 1). Research has documented that direct measures of ADHD often fail to predict scores on indirect (i.e., parent or peer ratings) assessment of functioning (Thomas, Shaprio, DuPaul, Lutz, & Kern, 2011) and our results support the speculation of Charman et al. (2001) who argued that "laboratory measures do not reflect [the] ability to access and utilize [ToM] competences in everyday interactions—perhaps due to the differences between the relatively controlled environment in the laboratory and more complex social information processing situations in real life" (p. 45). The fact that our explicit competence measure did not reveal differences between the TD and ADHD groups across levels of ToM complexity (see Fig. 2) also lends support to the notion that laboratory tasks are not sufficient measures of online ToM performance for those with ADHD (Charman et al., 2001; Happé & Frith, 1996). In like fashion, our results suggest that applied indices may not be accurate proxies of ToM conceptual competence in ADHD.

Of course, multiple routes to impaired ToM performance may entail different mechanisms and developmental processes and our different task results for the composite data suggest the presence of a moderating variable. One potential moderator for children with ADHD worthy of consideration is executive function (EF) level. Specifically, our applied ToM measure (intended to tap the ability to utilize ToM in everyday life) may have required greater raw EF resources than our explicit competence measure despite the fact that they were matched for level of conceptual complexity and equivalent with regard to their norms for mastery in typical development. From a social information processing perspective, it may be that real-life social dilemmas require more executive resources and carry more inhibitory demands than do laboratory tasks such that an individual's knowledge bank of social information cannot be efficiently or effectively recruited and utilized during naturally-occurring online interactions. Rather, irrelevant or inaccurate information may be accessed. The individual would then miscalculate the performance strategy for attaining the desired goal and the response would be ineffective. Thus, it may be that deficits in applied ToM in ADHD are a result of limited EF resources (attention deficits, impaired working memory, and/or impulsivity) which contribute to ineffective social behaviors.

An alternative (but not incompatible) interpretation focusing on type of EF resource might argue that it is not so much the quantity of available EF resources as it is their quality. Abelson (1963) originally described 'hot' cognitive processes as information processing under conditions of affective arousal which contrasts with the cool, rational processing of information under relaxed conditions. From this perspective, "whereas cool EF is more likely to be elicited by relatively abstract, decontextualized problems, hot EF is required for problems that involve the regulation of affect and motivation" (Zelazo, Qu, & Müller, 2005, p. 71). Our applied ToM measure relied on the observations of caregivers who observe children as they endeavor to solve social dilemmas in the real world. Such social dilemmas are almost always motivationally significant because success and failure are accompanied by different emotional consequences (Zelazo et al., 2005).

Inspection of ToMI subscale scores (see Fig. 3) reveals that the TD group outperformed the two clinical groups across levels of complexity but, whereas the ADHD group outperformed the ASD group on the Early and Basic Subscales, the ADHD and ASD groups were no different on the Advanced Subscale with both evidencing profoundly low scores. So what might account for the intermediate performance of the ADHD group on Early and Basic Subscales and worsened performance of the ADHD group on the Advanced subscale? In keeping with our earlier interpretation, it may be that the Early, Basic, and Advanced Subscales require variable thresholds of EF for success. It might also be that the Advanced Subscale included "hotter" items compared to the other subscales. Of course, both EF resources and EF type are likely operating. As noted above, hot cognition has been implicated as a key mechanism leading to disruptions in social information processing but hot cognition and cold cognition develop in parallel, are highly integrated, and are both parts of an interactive functional system (Zelazo et al., 2005). Perhaps physiological arousal increases the availability of cognitions that are consistent with that level of arousal (Dodge & Somberg, 1987). This, in turn, may affect speed of information processing and decrease attentional resources (Dodge & Somberg, 1987; Meichenbaum & Gilmore, 1984). Zajonc's (1980) notion of 'preemptive processing' (e.g., as seen in racial stereotypes) may also be relevant. "In preemption, a situational domain or a specific cue (such as another's violation of a dearly held value) leads a child to abandon processes of formal logic and adopt a less sophisticated, more impulsive response patterns. The child's attributional decisions become governed not by analyses of all information but by simple rules and associations acquired in socializations" (Dodge & Somberg, 1987, p. 222).

This interpretation is consistent with the notion that while affect and cognition are mechanistically linked, they can clearly dissociate in function. "Affective reactions can occur without extensive perceptual and cognitive encoding, are made with greater confidence than cognitive judgments, and can be made sooner" (Zajonc, 1980, p. 151). This fits with previous findings that persons with ADHD have an overall emotion processing deficit (Da Fonseca, Seguier, Sonaton, Poinso, & Deruelle, 2009; Downs & Smith, 2004), that they tend to overestimate their social abilities (i.e., they have a positive illusory bias, McQuade & Hoza, 2008), and that EF is linked to ToM in ADHD (Buhler et al., 2011; Gonzalez-Gadea et al., 2013; Papadopoulos et al., 2005). In contrast to hot and fast affective responses, cognitive reasoning is cold and slow which may explain why some people with high-functioning ASD are able to 'hack' advanced ToM tasks. In any event, the differences in hot and cold cognition seem central to the differences in explicit and applied ToM competence that we observed in children with ASD and ADHD in this study. We believe it is justified to extend the conclusions of Happé and Frith (1996) who examined the ToM and social impairments of children with conduct disorder. They argued that "where the carers of children with autism are helped by learning not to assume that the child is reading minds or attributing thoughts and feelings at all, the carers of children [at risk for ADHD] may need to consider the accuracy of these children's mental state attributions" (p. 396). In a related vein, experience suggests that both children with ASD and children with ADHD are assigned to social skills curricula designed to explicitly teach the content and cognitive principles (e.g., "People get frustrated when you interrupt them") that are the presumed deficit of social dysfunction. To the degree that the ToM conceptual competence of children with ADHD is intact, this approach is unresponsive to the processes underlying social behavior problems in children with ADHD. We suggest that children with ADHD may be better served through interventions that encourage introspection about the accuracy of one's own social attributions as they occur in motivationally relevant and real-world settings.

Our item level analyses remind us that assessment by a single subscale or composite score can obscure performance on individual items and is, therefore, not always as informative as more detailed assessments of ToM profiles. Although subscale ToMTB items conformed to the patterns observed for their subscales, five items on the ToMI deviated from their respective subscale results and point to specific challenge areas in ASD (and potential strength areas in ADHD) that can inform differential diagnosis. Three of these items (pretense, play pragmatics, initiating joint attention) represent deficits in ASD that are so well-documented that they are routinely considered emblematic of the disorder. The other two items reflect constructs (counterfactual reasoning, understanding performatives) that are less well-studied and warrant some elaboration. If ToM is a core deficit (or one of several core deficits) of ASD, then counterfactual reasoning may be uniquely disrupted in ASD. The few studies on this topic have carved and construed counterfactual reasoning in different ways but it can generally be described as the ability to reason about hypothetical events and worlds. Recent studies on this topic have documented specific deficits in counterfactual reasoning in ASD (Begeer, De Rosnay, Lunenburg, Stegge, & Terwogt, 2014) and some even suggested that impaired counterfactual reasoning is at the heart of impaired performance on standard false belief tasks (Grant, Riggs, & Boucher, 2004).

Similarly, very little research has been conducted on the understanding of performatives. Performatives are a specific kind of direct speech act: they are verbs whose action *is* a speech act (as in “I *apologize*”, “I *name* thee . . . ”, “I *bet* you money”). Their mastery requires awareness of the role that language plays in social interaction and the links between language and the inner mental states of oneself and others. The ToMI item designed to tap understanding of performatives employed the example of ‘promise’ which may be understood merely as a word (like any other word) or as a deed; one that obligates the speaker and forms a social contract with the listener. Thus, it makes sense that parents of children with ASD would report deficient understanding of performatives. To be clear, pragmatic deficits (e.g., turn-taking, interrupting, topic maintenance) are clearly evident in ADHD and can even include metalinguistic aspects (e.g., understanding idioms, Crespo, Manghi, Garcia, & Caceres, 2007; understanding irony, Caillies, Bertot, Motte, Raynaud, & Abely, 2014) but it may be that deficits in metalinguistics are restricted to understanding of non-literal indirect speech acts and that the understanding of performatives is one area that distinguishes these two populations. In summary, our item-level analyses suggest that pretense, play pragmatics, and initiation of joint attention are robust indicators of ASD that will be useful in differential diagnosis and we support further research in the area of counterfactual reasoning and the understanding of performatives for like purposes.

4.1. Limitations and directions for future research

Of course there are several limitations of our study that deserve mention. First, despite the fact that we matched groups on performance on ToMTB control questions (presumably an index of receptive language and working memory that is relevant to performance on ToMTB test questions), it is possible that group difference in intelligence may have influenced test scores. That is, it is conceivable that group differences in IQ (or variable IQ profiles) differentially impacted performance and so more thorough examination of cognitive competencies is warranted in future research. Another limitation involved the fact that the variables that we suggest moderate ToM functioning in ADHD were not assessed directly; hence, our conclusions are speculative at present. To evaluate the validity of our explanation, data for EF capacity as well as EF type (see Zelazo et al., 2005 for a discussion of hot and cold EF tasks that vary in complexity) are needed to complement our ToMTB and ToMI data. If our model for impaired ToM functioning in ADHD is correct, we would expect strong associations between cold EF and ToMTB scores and between hot EF and ToMI scores but weak associations between cold EF and ToMI scores and between hot EF and ToMTB scores. Future research should also examine the quality of justifications of parenting ratings on the ToMI. We strongly suspect that, although the ASD and ADHD groups achieve similar and low raw scores on the ToMI, the nature of ToM dysfunction is not only unique but reliably detectable with sensitive and targeted indices. Qualitative semi-structured interviews based on ToMI results should be employed to explore this possibility. Moreover, our analyses focused solely on males, the ADHD group was comprised solely of those who were identified as ADHD-combined type, and the ASD group was comprised solely of those identified as high-functioning. As such, generalizability of our findings is limited to these populations.

Another important direction for future research involves more systematic isolation of explicit and applied ToM competence in ASD and ADHD. Although our methods of measurement were advantageous in several respects (e.g., they were matched for complexity and represented a wide range of ToM content areas), it would be worthwhile to contrast explicit and applied ToM competence in ways that rely solely on direct assessments of child behavior. This would reduce methods variance, which could have affected the results of the present study. Future investigations of ToM competence should also examine children’s patterns of performance across tasks or conditions that differ in their conceptual demands as well as in the presence or absence of potentially disruptive task factors (Sophian, 1997, p. 285). Finally, while we commonly construe explicit competence as shaping applied ToM, the reverse is also true. A necessary next step entails observing children’s interactions with the world, which involves some kind of performance, to explain cognitive development.

4.2. Conclusions

Explicit and applied ToM competence can dissociate and a window onto one cannot always be assumed to be a window onto the other. It appears that children with ADHD can calculate the content of traditional laboratory ToM tasks. Nonetheless, this conceptual competence fails to be expressed in real world demonstrations of ToM (especially when performance of advanced ToM skills is required) which may be related to affective arousal and executive dysfunction. By contrast, the ToM difficulties of children with ASD seem to be attributable to a deeper metarepresentational deficit. To the degree that the ToM conceptual competence of children with ADHD is intact, social skills curricula that aim to explicitly teach social-cognitive principles will be unresponsive to the processes underlying social behavior problems in children with ADHD. In a related vein, counterfactual reasoning and the understanding of performative speech acts may be uniquely disrupted in ASD with implications for differential diagnosis.

Appendix. : Sample items from the Theory of Mind Task Battery

Tasks A and B comprise five test questions (items 1–5) and constitute the Early Subscale of the ToM Task Battery which is worth a total of five points. One example from the Early Subsacle is as follows:

TASK B: The *Desire-Based Emotion Task* is intended to assess children's understanding of desires. More specifically, this task is designed to tap the understanding that people are happy when desires are satisfied. One point is possible for this task. TASK TEXT: This is Brynn. Brynn wants a cookie to eat [CONTROL QUESTION: What does Brynn want?]. TEST QUESTION 5: How will Brynn feel if she gets a cookie? (response options: happy, sad, mad, scared)

Tasks C–F comprise five test questions (items 6–10) and constitute the Basic Subscale of the ToM Task Battery which is worth a total of five points. One example from the Basic Subscale is as follows:

TASK F: A *Standard False Belief Task* (Wimmer & Perner, 1983) is intended to assess children's ability to infer belief in the context of an unexpected location change. Like the Perception-Based Action Task, this task also includes an understanding of the knowing-looking connection; however, the Standard False Belief Task adds yet another layer of complexity because it must also include the understanding that people can have a belief that contradicts reality. One point is possible for this task. TASK TEXT: This is Anthony. Anthony is reading a book. When he is done, Anthony puts the book on the table. Anthony leaves to get something to eat in the kitchen. Look, Sonya comes in and moves the book from the table to a drawer. Then Sonya leaves. Look, Anthony comes back to read some more [CONTROL QUESTION: Where is the book now?] TEST QUESTION 10: Where will Anthony look for the book first? (response options: table, drawer, shelf, chair).

Tasks G–I comprise five test questions (items 11–15) and constitute the Advanced Subscale of the ToM Task Battery which is worth a total of five points. One example item from the Advanced Subscale is as follows:

TASK I: A Second-Order False Belief Task. TASK TEXT: This is Enrique and his Mom. It is Enrique's birthday. He is having a big party tonight. Enrique's Mom is surprising him with a new bike. Mom has hidden the bike in the closet. Enrique and his Mom are talking in the kitchen. Enrique says, "Mom, I really want a new bike for my birthday." Now remember, Mom wants the bike to be a surprise so she says "Sorry, I didn't get you that. I got you roller blades instead." Enrique thinks his Mom got him roller blades. Then Enrique waves goodbye to his Mom. Enrique says, "Ok. I am going to my friend's house. I'll be home later." On his way out, Enrique opens the closet to get a jacket and sees the new bike. Enrique is happy. He thinks to himself "Yes! Mom did not get me roller blades. She really got me a bike!" Mom does not see Enrique open the closet. Mom doesn't know that Enrique found the bike [CONTROL QUESTION: What does Enrique think he is getting for his birthday?] Later, Enrique's Grandfather comes over for his birthday. Grandfather asks Mom, "Does Enrique know what he is getting for his birthday?" TEST QUESTION 15: What does mom tell grandfather Enrique is getting for his birthday? (response options: rollerblades, bike, basketball, baseball glove).

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