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Attributing Social Meaning to Ambiguous Visual Stimuli in Higher-functioning Autism and Asperger Syndrome: The Social Attribution Task

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More able individuals with autism and Asperger syndrome (AS) have been shown to pass relatively high level theory of mind (ToM) tasks without displaying commensurate levels of social adaptation in naturalistic settings. This paper presents a social cognitive procedure—the Social Attribution Task (SAT)—that reduces factors thought to facilitate ToM task performance without facilitating real-life social functioning. Sixty participants with autism ($N = 20$), AS ($N = 20$), and normally developing adolescents and adults ($N = 20$) with normative IQs were asked to provide narratives describing Heider and Simmel's (1944) silent cartoon animation in which geometric shapes enact a social plot. These narratives were coded in terms of the participants' abilities to attribute social meaning to the geometric cartoon. The SAT provides reliable and quantified scores on seven indices of social cognition. Results revealed marked deficits in both clinical groups across all indices. These deficits were not related to verbal IQ or level of metalinguistic skills. Individuals with autism and AS identified about a quarter of the social elements in the story, a third of their attributions were irrelevant to the social plot, and they used pertinent ToM terms very infrequently. They were also unable to derive psychologically based personality features from the shapes' movements. When provided with more explicit verbal information on the nature of the cartoon, individuals with AS improved their performance slightly more than those with autism, but not significantly so.

Keywords: Asperger syndrome, autistic disorder, social attribution, social cognition, theory of mind.

Abbreviations: ADI-R: Autism Diagnostic Interview-Revised; ADOS-G: Autism Diagnostic Observation Schedule-Generic; AS: Asperger syndrome; HFA: higher-functioning autism; NC: normal controls; PAT: Physical Attribution Task; SAT: Social Attribution Task; TLC: Test of Language Competence; ToM: theory of mind.

Introduction

The theory of mind (ToM) model of social development posits that being able to conceive of mental phenomena is the foundational base of human social interaction. This capacity is seen as a cognitive mechanism with neurofunctional localization, a developmental course of maturation, and, possibly, intergenerational transmission (Baron-Cohen, Tager-Flusberg, & Cohen, 1993, 1999). An insult to this mechanism has been proposed to be both universal and causative in autism in its various manifestations (Baron-Cohen, 1995). This paper addresses some limitations of current ToM methods in capturing clinical phenomena in autism, and offers a new procedure for social cognitive research called the Social Attribution Task.

ToM Skills in Individuals with Higher-functioning Autism and Asperger Syndrome

The most influential psychological hypothesis of autism—the ToM hypothesis—proposes that the social dysfunction characterizing this condition is the result of a very specific, and primarily cognitive, incapacity to impute mental states such as beliefs, intentions, desires, to others and to self (Leslie, 1987). This circumscribed but pervasive cognitive deficit is hypothesized to account for deficits in pragmatics, dearth of pretend play and imaginative activities, and impoverished empathy (Baron-Cohen, 1988) seen in autism. Individuals with autism are said to lack a "theory of mind," which is an implicit cognitive capacity involving the ability to postulate the existence of mental states and then using these to explain and predict another person's behavior. In this view, autism is seen as a disorder of "mind blindness" (Baron-Cohen, 1995). In the past few years, however, a series of questions have been raised regarding the ToM hypothesis of autism: (1) Children with autism were shown to exhibit social disabilities that probably precede even the earliest precursors of ToM skills such as joint attention (e.g., Adrien et al., 1993; Klin, 1991; Klin, Volkmar, & Sparrow, 1992; Osterling & Dawson, 1994), raising the possibility that ToM deficits may result from more basic and early emerging social disabilities; (2) since children with other developmental conditions such as profound deafness (Peterson & Siegal, 1995), schizophrenia (Corcoran, Mercer, & Frith, 1995), and some forms of mental retardation (Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998) also exhibit ToM deficits, the claim for specificity of ToM deficits in autism is controversial; and (3) given the brevity and the all-or-nothing nature of

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most ToM tasks, the test–retest reliability of some of these methods were called into question (Charman & Campbell, 1997; Mayes, Klin, Tercyak, Cicchetti, & Cohen, 1996).

Possibly the more interesting questions regarding the ToM hypothesis, however, have emerged from ToM studies of higher-functioning (i.e., not cognitively disabled) individuals with autism and related conditions such as Asperger syndrome. Despite their pronounced social disability, they have been shown to succeed on ToM tasks at different levels of complexity (e.g., Bowler, 1992; Dahlgren & Trillingsgaard, 1996). Clearly, there is a ceiling effect on most traditional ToM tasks, which were designed for use with children aged 4 to 6 years. New, more advanced tests of ToM (e.g., Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Happé, 1994) in fact appear to capture the ToM deficits in even these more able individuals, supporting the notion of universality of ToM deficits in the autistic population if developmentally appropriate tasks are utilized. However, the question remains as to whether those individuals who pass 4- to 6-year level ToM tasks possess the social skills displayed by typical children at that age. If these individuals' ToM capacities do not translate into commensurate social adaptation skills, one might have to qualify the ToM hypothesis of social development in terms of a *necessary but not sufficient* social cognitive faculty fostering social competence. This possibility is exemplified through two lines of evidence. The first relates to a possible discrepancy between ToM performance and level of spontaneous social adaptation. In a sample of individuals with higher-functioning autism (HFA) and Asperger syndrome (AS) followed in our Center, whose mean age is 16 years and whose IQs are in the normative range, the average age-equivalent score on the Interpersonal Relationships subdomain of the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984) is 3.9 years (Klin, Volkmar, Schultz, Pauls, & Cohen, 1997), which highlights the magnitude of their social disability. Given these individuals' relatively high standard scores (in the low 80s) on tests of higher language skills such as making inferences from social text, generating appropriate sentences in response to a picture of people interacting, and understanding figures of speech (as included in the Test of Language Competence; Wiig & Secord, 1989), it is likely that their ToM skills are even higher than the 4- to 6-year level focus of traditional ToM tasks, which, in most cases, they have no problem passing (see also Bauminger & Kasari, 1999). This would suggest that having ToM skills does not guarantee commensurate social adaptation skills. The second line of evidence relates to attempts to teach ToM skills to individuals with autism and then to measure the impact of their improved ToM performance on patterns of social behavior. Two studies focused on these issues showed that despite improvement in children's performance on experimental ToM tasks, there is little improvement in social competence (Ozonoff & Miller, 1995) or in communicative competence (Hadwin, Baron-Cohen, Howlin, & Hill, 1997). This suggests that learning ToM skills does not guarantee improvement in social adaptation skills.

The discrepancy between ToM performance and level of social development raises two important questions: first, what are the factors that promote performance on ToM tasks but do not necessarily promote social adaptation in naturalistic situations? and second, are there other social cognitive skills important for social adaptation that are not captured in current ToM paradigms? It should be noted that the focus of this discussion is on false belief tasks (Wimmer & Perner, 1983) and not on tasks tapping on earlier skills such as joint attention, given the general assumption that the false belief tasks are both a more stringent test of mentalizing capacities and the skills necessary to succeed on them emerge at a later point in development (e.g., Leslie, 1987).

Factors That Promote ToM Task Performance but That Do Not Necessarily Promote Naturalistic Social Adaptation

There are at least three aspects of ToM tasks that seem to help brighter individuals with autism and related conditions. The first one is the verbal nature of task presentation. A large number of studies have shown that ToM task performance is correlated with level of verbal skills (Bowler, 1992; Eisenmajer & Prior, 1991; Fombonne, Siddons, Achard, & Frith, 1994; Happé, 1995; Prior, Dahlstrom, & Squires, 1990; Yirmiya et al., 1998; Yirmiya & Shulman, 1996; Yirmiya, Solomonica-Levi, Shulman, & Pilowsky, 1996). These various studies have shown that individuals with autism are capable of using verbal scaffolding to improve their performance on ToM tasks. In a way, this is hardly surprising, given that in clinical practice most social skills training programs do include the rehearsal of verbal scripts to be used in social situations (e.g., Mesibov, 1986); unfortunately, there are major limitations to this approach, chief among which is the well-known lack of generalization, particularly in novel social situations, which, in turn, constitute most spontaneous social situations in real life (Klin & Volkmar, 2000). This observation is closely associated with the second aspect of ToM tasks that promotes performance on experiments but not social adaptation, namely their explicit nature. In most ToM paradigms, the problem to be solved is explicitly defined by the question posed (e.g., "Where will Sally look for her marble?"), creating the requirement to use knowledge about mental states (e.g., "Sally did not see what happened in her absence") and the implications of these to the situation at hand (e.g., "Sally believes that the marble is still where it was before she left"). Cognitively able individuals with autism appear to have little difficulty with such a problem-solving format. In real life, however, social situations seldom present themselves in this fashion. Not only are social demands in naturalistic settings not explicitly formulated as a problem-solving situation, they need to be created and defined as a "social demand" by the person. This typically results from an individual's spontaneous predisposition to perceive the relevant social elements of the situation, an interpretation of how the social elements create a given social context and how the context qualifies the behaviors of others toward that individual, and only then a decision is made as to the social adaptive behavior required in that situation (Gray, 1995). In sum, whereas ToM tasks are explicitly defined problem-solving situations, naturalistic social situations are not.

The third aspect of ToM tasks promoting performance on experimental situations but which is absent in real-life social situations is the dichotomous nature of the ToM measures. Typically, responses in experimental paradigms are classified as either a ToM response or a non-ToM response. It is very likely that individuals with autism exhibit variable degrees of ToM capacities

(Sigman, Yirmiya, & Capps, 1995; Yirmiya et al., 1998), and that the lack of quantification of these abilities in fact might mask their ToM disabilities by artificially classifying them as "ToM competent" on the basis of an explicitly defined, dichotomous measure. In naturalistic settings, we often witness a continuum of social dysfunction in individuals with autism (Wing, 2000); a shift of emphasis from an "all-or-nothing" approach to a dimensional approach of social cognitive abilities (such as is used with social adaptive behaviors; Volkmar, Sparrow, Goudreau, Cicchetti, & Cohen, 1987) might highlight the ToM delays in individuals with autism.

Social Skills That Are Required in Naturalist Social Situations but That Are Not Necessarily Required to Pass ToM Tasks

The recent focus of social development research in autism on mentalizing abilities has, to some extent, led to a neglect of other aspects of social skills that may play an important role in social adaptation (e.g., Mundy & Neal, in press; Sigman et al., 1995), and the attempt to subsume these under an all-encompassing ToM model of social development (e.g., Baron-Cohen, 1995) might not be warranted (e.g., Klin, Schultz, & Cohen, 1999). For example, it is an empirical question whether ToM-competent individuals with autism spontaneously seek social information in the environment, are capable of discerning central from peripheral social information and pertinent from tangential social responses, or are able to integrate social information into a social context defining the frame of the situation, among other social adaptive requirements (Bauminger & Kasari, 1999; Frith, Happé, & Siddons, 1994; Happé & Frith, 1995; Klin et al., 1999). As each one of these could potentially disrupt social adaptation, it would seem important to add measures of these social cognitive abilities to try and bridge the gap between ToM task performance and level of social adaptation.

Attributing Social Meaning to Ambiguous Visual Stimuli

One way to empirically explore the gap between ToM task performance and level of real-life social adaptation would be to minimize the factors that may be promoting the former but not necessarily the latter. This paper presents a social cognitive procedure intended to address this issue in the following ways: (1) to reduce the confound of verbal mediation of task presentation by minimizing verbal instructions; (2) to reduce explicit definitions of the task and to measure the relative salience of the social elements of the task, and the spontaneity with which participants employ their social cognitive capacities; and (3) to use stimuli that can be interpreted at different levels of social cognitive sophistication, from absence of social attributions, to attributions including mental states (e.g., intentions, beliefs, and feelings), as well as interactions thereof (e.g., social relationships). This would allow us to avoid the typical dichotomous response approach (ToM or non-ToM) in favor of a more dimensional approach. The paradigm we chose to satisfy these requirements focuses on people's ability to attribute social meaning to ambiguous visual stimuli. These stimuli are not explicitly or verbally defined to participants, nor are they people or people-like entities (such as dolls). Rather they are geometric shapes, which, however, act like people.

This paradigm was created by Heider and Simmel (1944) in their classic studies of social attribution. They presented a silent movie to college students in which geometric shapes moved in a contingent fashion. The movements of the shapes cannot be easily described without the use of anthropomorphic words because of the compelling impact on the viewer that human actions take place—e.g., the actors chase, fight, entrap, play with one another, get frightened or elated or frustrated. In the study, all but 1 of 34 students described the movie in human terms. Many of the scenes were interpreted in exactly the same way, suggesting that some perceptual configurations conveyed specific information that shaped social attributions in a predictable way. When the movie was shown in reverse, however, despite the students' interpretation of the movie as human actions (as in the previous condition), there was much more variability in interpretation, presumably because participants were struggling to "fit in" a plot that explained or brought together the "human movements" they saw. Based on their work, Heider and Simmel were able to define several perceptually based principles of social attribution: (1) if the shapes moved by themselves, they were likely to be people; if not, they were inanimate things or "props"; (2) when contact occurred between "people," they could be "aggressive" or "friendly" depending on the perceptual characteristics of the contact; however, if contact occurred between a shape that moved by itself with a shape that did not, the interaction was seen as the former operating the latter, never the other way around; (3) when movements of "people" were contingent but contact did not occur, causation was seen in psychological terms (e.g., a form of communication); and (4) perceptual configurations were not enough to explain social attribution: they became increasingly more dependent on the participants' perception of the invariances of the movie, namely the characters' attributes (e.g., to determine the origin of the action—aggressor vs. victim) and their needs and consequent intentions. Heider and Simmel (1944) concluded that although "perceptions give rise to anthropomorphic attributions … the movements become anchored in a field of objects and persons, and are interpreted as acts" (p. 256). Movement configurations are not interpreted arbitrarily but become "embedded in our picture of [physical and social] reality" (p. 256). And once we consider a movement as the action of a person, "perception of motive or need is [immediately] involved" (p. 257). But the cues for ascribing motivation or intention cannot be inferred from a movement in isolation (e.g., a small circle entering a large rectangle); preceding interactions with other actors offer cues for the determination of motives (e.g., a small child is trying to avoid confrontation with other children by hiding inside a house).

From the perspective of method development in social cognitive research, the most interesting aspect of Heider and Simmel's (1944) paradigm is that any social attribution made as a result of viewing the videotape is a mental phenomenon, and a very young child or a person with social disabilities might possibly fail to conceive the geometric shapes as social agents. In this way, the paradigm provides a rather unique window into a person's social cognitive abilities. The notion that certain kinds of perception elicit social attribution, but that causal attributions based on fundamental elements of social reality—needs and intentions—constrain the interpretation of percepts in predictable ways has become the staple of much current research in causal attribution (Sperber, Premack, & Premack, 1995; Thommen, Dumas, Erskine, & Reymond, 1998). Disappointingly, however, Heider and Simmel's paradigm has been used primarily to explore the *content* of social attributions (e.g., Greenberg & Strickland, 1973; Shor, 1957), not the *capacity* for making social attributions. The notable exception is the work of Thommen (1991, 1992), who has explored the emergence of skills required in attribution of causation and intentionality in typical children utilizing Heider and Simmel's paradigm and modifications thereof. This cartoon microcosm offers a compelling strategy to study social cognitive capacities, including the spontaneity with which a given perceiver makes use of whatever social understanding he or she has available to interpret the shapes' movements.

The Present Study

In order to address some of the previously outlined limitations of current ToM methods in the research of the social disability in autism and related conditions, a new social cognitive procedure based on Heider and Simmel's (1944) cartoon animation was developed. This procedure includes some adaptations required for presentation to developmentally disabled individuals, and a coding system to examine and quantify different aspects of the participant's social cognitive responses. This procedure was called the Social Attribution Task (SAT). The overarching goal of this study was to create an instrument capable of providing more comprehensive and quantified profiles of social cognitive abilities, with attention to some skills that have been relatively neglected in the ToM literature. We studied normative-IQ adolescents and adults with autism and Asperger syndrome, who despite having passed a second-order screening ToM task were nevertheless significantly socially disabled. We predicted that aspects of the SAT—specifically, the attempt to minimize factors that promote ToM task performance but that are absent in real-life social situations—would make this instrument more sensitive to social cognitive deficits, hence providing a social cognitive measure more commensurate with their (real-life) level of social adaptation. With regard to the content of the attributions made by participants, we predicted that individuals with autism and Asperger syndrome would tend to base their narratives more frequently on geometric or physical, rather than social, reasoning. This prediction stems from several lines of research showing that individuals with autism may use physical rather than social cues in order to perform social tasks (e.g., Weeks & Hobson, 1987), or that they may in fact treat social stimuli (e.g., faces) as physical stimuli (e.g., objects) (Schultz et al., 2000). These findings can be conceptualized in terms of the higher-level abilities of individuals with autism in "folk physics" in contrast to their deficits in "folk psychology" (Baron-Cohen, 1995).

Methods

Participants

Sixty adolescents and adults participated in this study: 20 with a diagnosis of autism unaccompanied by mental retardation, or higher-functioning autism (HFA), 20 with Asperger syndrome (AS), and 20 typically developing individuals or "normal controls" (NC). With the exception of five individuals with HFA and two individuals with AS, all of the participants were seen as part of a comprehensive $2\frac{1}{2}$-day research project on the neurobiology of autism, which includes completion of diagnostic, neuropsychological, neuroimaging, and genetic procedures. The seven nonparticipants in this project were recruited through a developmental disabilities clinic. With the exception of completion of the formal diagnostic instruments, all the background data required for this study were available. All participants completed a full intellectual battery (primarily the Wechsler Intelligence Scale for Children, Third Edition—WISC-III; Wechsler, 1992; or the Wechsler Adult Intelligence Scale-Revised—WAIS-R; Wechsler, 1981; a small number of adults ($N = 7$) completed the Wechsler Adult Intelligence Scale-Third Edition—WAIS-III; Wechsler, 1997). Data on social adaptive skills were collected with the Vineland Adaptive Behavior Scales, Expanded Edition (Sparrow et al., 1984). Language and communication assessment included a comprehensive measure of metalinguistic skills obtained with the Test of Language Competence, Levels 1 and 2 (TLC; Wiig & Secord, 1989). As only the Oral Expression; Recreating Speech Acts subtest of the TLC was used in the present study (see Control Test, below), only the results for this subtest are given here. Diagnostic characterization included the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994) and the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord, Rutter, & DiLavore, 1996). These various components of the assessment were conducted independently, by different clinicians. Diagnostic assignment followed DSM-IV criteria for autism and AS (American Psychiatric Association, 1994). In accordance with these criteria, none of the individuals assigned the diagnosis of AS had speech and language delays or marked deviance in the first 3 years of life (Klin & Volkmar, 1997; Volkmar et al., 1994). Although seven individuals assigned the diagnosis of autism or AS had not completed the ADI-R and the ADOS-G, they, like the remaining participants, were diagnosed following DSM-IV criteria by two experienced clinicians whose inter-reliability had been well documented (see also Klin, Lang, Cicchetti, & Volkmar, 2000). Table 1 summarizes the data on participants' characterization.

As can be appreciated from Table 1, the sample of individuals with HFA and AS represent a cognitively bright but severely socially disabled group, with a mean difference between Full Scale IQ and the Vineland Socialization scores of close to 3 *SD*s favoring the former. The AS and NC groups differed significantly in terms of their Performance IQ favoring the latter group. The HFA and AS groups differed significantly in terms of their current social disability (ADOS-G), with the HFA group being more impaired than the AS group. The overall ADOS-G scores for both groups are, nevertheless, quite high, suggesting, therefore, that all participants were severely socially disabled (Lord et al., 1996). The groups did not differ in terms of chronological age, Full Scale IQ, Verbal IQ, Vineland Socialization scores, parental report of social disability (in terms of early history at around ages 4 through 6 and current presentation; ADI-R), or on the test of language competence (see below). Nevertheless, there were trends of higher Verbal IQ in the AS group compared to the HFA group, Vineland Socialization scores were somewhat lower (i.e., more disabled) in the HFA group than in the AS group, and higher scores (i.e., more disabled) in the ADI-R Socialization scores in the HFA group than in the AS group.

All participants included in this study passed a second-order ToM screening task. This task was virtually identical to the set-up described in Baron-Cohen, Leslie, and Frith's (1985) Sally and Ann ToM procedure but was presented in a video (rather than live) version, and was enacted by people (rather than puppets). The specific set-up has been reported elsewhere (Mayes et al., 1996). The critical belief question—"Where will Sally look for her teddy bear?" (a first-order task)—was replaced by "Where does Ann think that Sally will look for her teddy bear?" (a second-order task).

Table 1
Participants' Characterization

	HFA	AS	NC	*F* and *t* and significance	Groups differing significantly
N	20	20	20		
Age	20.5	18.9	20.2	0.81	
(*SD*)	(10.8)	(11.8)	(7.4)		
Full Scale IQ[b]	95.5	98.1	103.1	0.63	
(*SD*)	(22.3)	(24.3)	(18.0)		
Verbal IQ[b]	97.2	106.4	101.2	0.36	
(*SD*)	(20.7)	(25.1)	(17.1)		
Performance IQ[b]	94.5	86.6	104.5	0.02*	AS & NC
(*SD*)	(19.6)	(20.8)	(19.0)		
Vineland					
Socialization[c]	48.6	58.4		0.28	
(*SD*)	(6.9)	(17.6)			
ADOS-G[a]					
Socialization[d]	20.8	15.5		0.02*	HFA & AS
(*SD*)	(4.8)	(4.2)			
ADI-R[a]					
Socialization[e]	18.2	14.2		0.17	
(*SD*)	(7.3)	(7.2)			
TLC OE[f]	8.2	8.6		0.86	
(*SD*)	(3.7)	(3.4)			

[a] $N = 15$ for HFA and 18 for AS.
[b] Mean = 100; $SD = 15$.
[c] Socialization domain of the Vineland (Mean = 100; $SD = 15$).
[d] Socialization section of the ADOS-G.
[e] Socialization section of the ADI-R.
[f] Oral Expression subtest (Mean = 10; $SD = 3$).
* Statistically significant.

Social Attribution Task (SAT): Overview

The SAT requires the participant's ability to recognize visual stimuli as social phenomena and then to extract visual cues from the display in order to create a social context (i.e., make social attributions). It utilizes Heider and Simmel's (1944) silent video display, which lasts 50 seconds. The "cast of characters" are a rectangle that has a small opening that opens and closes (like a "door"), a big triangle, a small triangle, and a small circle or dot (see Fig. 1). The movements of the shapes are contingent upon one another, in that they move in synchrony, against one another, or as a result of the action of the other shape.

Data obtained with this procedure are a series of narratives. The first narrative is obtained after the video sequence is shown twice (Narrative 1). The sequence is then broken down into six sequential, meaningful segments and presented one at a time. We found this necessary in order to avoid placing too much burden on memory and narrative organizational processes, two factors that could place unnecessary demands upon children and individuals with disabilities. In this way, the task is focused on the participants' ability to make attributions at varying levels of sophistication rather than on memory capacities. After each segment is shown, the participant is asked to state in as completely as possible fashion "what happened there" (Narratives 2 to 7). Narratives 1 through 7 represent spontaneous accounts of the visual display, with no explicit instruction as to the nature of the display. Once these various narratives are obtained, the participants are told (or reinforced) to see the shapes as people, and to answer the questions "What kind of a person is the big triangle/small triangle/small circle"? (Narratives 8, 9, and 10). The explicitness of these questions is limited to the presentation of the characters "as people"; otherwise, there are no additional details as to the nature of the characters' actions. Finally, four segments of the cartoon are re-presented to the participant, and explicit questions are posed including the explicit naming of objects (e.g., house) or events (e.g., fighting), or singling out specific interactions (e.g., "why did the big triangle break the house?"). Seven additional narratives are obtained in this way (Narratives 11 to 17). These narratives correspond to the participants' responses to specific questions defining somewhat more explicitly a given social situation in the cartoon. This section was used in order to present the participants with a more constrained problem-solving task than the more open-ended, preceding spontaneous narratives.

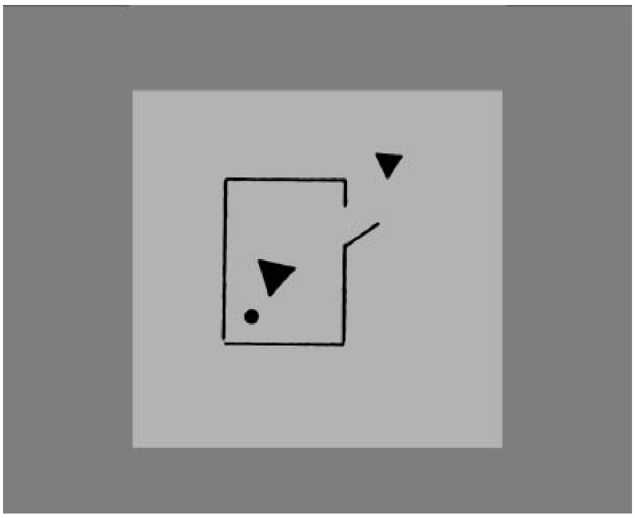

Figure 1. The "cast of characters" in the Heider and Simmel (1944) cartoon.

The SAT Coding System

Several narratives were initially obtained from a number of pilot cases of normally developing and normative-IQ socially disabled individuals. We were able to verify the compelling social nature of the video (as described by Heider and Simmel) in typically developing individuals, and were impressed with how socially impoverished the narratives we obtained for the individuals with autism were; many of these individuals described the video solely in geometric terms. Nevertheless, the narratives varied greatly in their content and quality.

In order to quantify the sophistication of social attributions contained in the narratives, we developed a detailed coding system, which emerged from a sample of pilot narratives obtained from both typical and socially disabled (normative-IQ) adolescents and adults. Seven index scores were derived from the narratives. A detailed description of, and rationale for, each index score is provided in the Appendix. These various indices were not meant to measure independent social cognitive capacities. Based on Heider and Simmel's (1944) work, these indices were likely to be fundamentally interrelated given that the presence (or absence) of an underlying social frame within which a viewer makes attributions to the ambiguous visual stimuli would probably result in higher (or lower) scores across these various indices. Nevertheless, as each index focuses on a different aspect of social attribution that has been given research and/or clinical attention in the literature of autism or early social development, the resultant profile provides a broader measure of social cognition.

The underlying capacity for imposing a social frame of reference on the movements of the geometric shapes is best summarized by the *Animation Index* score, which provides an overall summary of the participant's capacity for attributing social meaning to ambiguous visual stimuli, as scored in an ordinal scale of 0 to 6, where 0 indicates no social attribution and 6 represent a very high level of social attribution.

The *Theory of Mind indices* refer to the frequency of use of cognitive mental state terms (e.g., knowledge, desire, belief) or affective mental state terms (particularly the emphases on emotions that can only exist within a ToM framework such as jealousy, embarrassment). These indices provide a score corresponding to the percentage of propositions in the participants' narratives that contained a ToM term.

The *Salience Index* refers to the readiness with which a participant imposes a social interpretation to ambiguous visual stimuli. This index corresponds to the number of social elements (from a total of 20 items frequently mentioned by typically developing individuals) which the participant was able to identify in their spontaneous narratives.

The *Pertinence Index* refers not only to the capacity to adhere to an underlying social frame while imposing meaning on the visual display, but also to the ability to inhibit reasoning processes that are not relevant in social attribution. The inability to constrain one's utterances to what is relevant in a social interaction, and to refrain from introducing irrelevant information, are both related deficits often described as conversational skill deficits in bright individuals with autism and related conditions (e.g., Landa, 2000). This index score corresponds to the percentage of propositions contained in the participant's spontaneous narratives that were nonpertinent.

The *Person Index* refers to the normally developing young child's tendency to quickly create "personality" attributions (i.e., stable traits and dispositions) in relation to people (e.g., Eder, 1989, 1990) and then to often over-use this capacity by applying human attributes to a variety of not necessarily human phenomena (e.g., Inagaki & Hatano, 1987; Inagaki & Sugiyama, 1988; Piaget, 1960). This tendency to "anthropomorphize" reasoning about the world is thought to be pervasive in children (e.g., Carey, 1985), and may last into adulthood in many different forms (e.g., Kahneman & Tversky, 1973). To our knowledge, little is known about this interesting phenomenon in autism. This index is derived from Narratives 8 through 10, and corresponds to the level of sophistication in deriving personality features on an ordinal scale of 0 through 6, where 0 represents no personality attributions (e.g., describes shapes in physical terms only), and 6 represents high ability to impute psychological features to the shapes.

Finally, the *Problem-Solving Index* refers to the participants' ability to answer an explicit question about the cartoon "correctly", i.e., consistent with the responses obtained by typically developing adults. This index was created with the goal of assessing to what extent "correct" social attributions could be facilitated once the social "problem" was explicitly defined to the participant. The index is derived from Narratives 11 through 17, which include 10 items of information. The score refers to the percentage of the 10 items answered "correctly".

Scoring Algorithms for the SAT Index Scores

The various SAT Index Scores were obtained through the ratings of a participant's narratives according to the explicit criteria of each index score (see Appendix). The narrative unit for scoring was one proposition (verb + complement). Conversational words or sentences that were not part of social attributions were eliminated from transcripts (e.g., "I think that ... ", "You know, ... "). The first index score obtained was the Pertinence Index Score (Narratives 1 to 7). Propositions rated "nonpertinent" were eliminated from the ratings of the other Index Scores obtained from Narratives 1 to 7, namely Animation, Salience, and ToM Cognitive and Affective indices, as these did not refer to attributions made to the cartoon presented (e.g., a narrative offered about something not related to the cartoon). Consequently, the SAT does not measure the frequency of general use of mental state terms in spontaneous narratives; rather it measures the use of such terms as broadly pertinent to the cartoon presented to the participant. Once the individual propositions were rated, an algorithm for each index was completed.

Control Test

As the SAT involves generating social narratives from ambiguous visual stimuli, it was important to establish to what extent the participants were able to generate narratives from explicit social stimuli (e.g., pictures of people interacting). In order to ascertain that any poor results on the SAT were not due to a general failure to describe social situations using language, the Oral Expression, Recreating Speech Acts subtest of the TLC (Wiig & Secord, 1989) was administered. The TLC is a standardized test of metalinguistic skills (e.g., double meanings, figurative language, language in social context). The Oral Expression subtest of the TLC measures a person's ability to produce "speech acts" (or intentional statements or questions) that would be appropriate to one or more individuals depicted in a social situation presented as a drawing. As shown in Table 1, scores on this test were in the low average range (8.2 and 8.6, respectively, for the HFA and AS groups; Mean $= 10$; $SD = 3$). Therefore, the participants' ability to understand explicit social situations presented visually was somewhat lower than their Verbal IQs, but close to 2 *SD*s on average higher than their Socialization scores on the Vineland. These results indicate that these individuals could in fact reach a very high level of language performance in the explicit and structured context of this standardized test.

Procedure

The SAT was presented to participants as an individually administered procedure, in a quiet room. The participant sat about 2 feet away from the television screen where the cartoon was shown. The examiner operated a remote control to start and pause presentation of the video, and an audio recorder to record the participants' narratives. The initial instructions were as follows: "*You are going to watch a short videotape twice. The videotape lasts for less than a minute and it has no sound. If you have any questions please ask now. It is important that you pay attention while the videotape is showing. I will ask you a few questions about the videotape later. If you are ready we can start*".

After the complete animation is shown twice, the following instructions were given: "*Now, tell me what happened in the* *videotape. Please answer as completely as you can. There is no right or wrong answer. I will record your answer so that I can write it down later on. If you are ready, you can start*". Narrative 1 was obtained.

After the participant provided the first narrative, the following instructions were given: "*Now you will see clips of the videotape. They will be shown one at a time and only once, and then, after each one, I will ask you a question. Remember, please answer as completely as you can. If you are ready, we can start*". Six video segments, corresponding to six sequential, meaningful segments of the animation are then presented. After each segment, the participants were asked "*What happened here?*". Narratives 2 to 7 were obtained.

Once the participant provided the seventh narratives, the following instructions were given: "*Now let's say that the big triangle, the small triangle, and the circle are people* [if it was clear from the participant's narratives that he or she was clearly treating the shapes as people, this sentence was changed to "*As you have already been doing …*"]. *What kind of a person is the big triangle/small triangle/small circle?*". Narratives 8 to 10 were obtained.

Once the participant described the small circle, the following instructions are given: "*Now I will show some clips of the video again. After each showing, I will ask you some questions. When you answer these questions, please talk about what the people are doing, why they are doing it, and how they are feeling.*" After the video segment was presented, two questions were asked "*Why did the two triangles fight?*" and "*Why did the small circle go into the house?*". Narratives 11 and 12 were obtained. After another video segment was presented, two additional question were asked: "*What did the big triangle do and why?*" and "*What did the small circle do and why?*". Narratives 13 and 14 were obtained. After another video segment was presented the questions "*What happened to the big triangle?*" and "*What did the little triangle and the circle do?*" were asked and Narratives 15 and 16 were obtained. Finally, after the last clip is shown, the question "*Why did the big triangle break the house?*" was asked and Narrative 17 was obtained.

That completed the administration of the SAT. The recording of the participant's narratives was then transcribed for coding of the various indices.

The various other procedures (intelligence and language testing, Vineland, ADI-R, and ADOS-G) were administered by experienced clinicians, and the full protocol was approved by the appropriate Institutional Review Board.

Results

Reliability Issues

The written transcription of the recorded narratives was performed by a professional transcriber. Although inter-rater reliability of the transcriptions was not assessed, the transcriber was unaware of the purpose of the study or the identity of the participants.

Forty-five of the 60 protocols (75%) were rated by at least 2 raters of a total of 3 raters. In order to maximize inter-rater reliability (1) raters were trained together on the scoring of over 15 protocols before scoring the protocols included in this study, with a view to clarify frequent scoring issues and to learn explicit scoring guidelines, (2) SAT coding criteria and algorithms were very detailed (see Appendix), (3) ratings followed a procedural flowchart, and (4) an alphabetical glossary of frequent terms encountered in SAT narratives was produced with their corresponding SAT coding. Inter-rater reliability was computed for overall Index Scores. The intraclass correlation coefficients for each SAT Index Score are given in Table 2. As some of the indices depended on the number of propositions counted for each narrative (e.g., percentage of propositions in the narrative containing a ToM cognitive term), inter-rater reliability for number of propositions per protocol was also assessed. Only number of propositions in the spontaneous narratives (1 to 7) were included, as only these played an important role in the computation of other indices.

Table 2
Inter-rater Reliability Results for SAT Index Scores

SAT Index	*r*
Number of propositions per protocol	.87
Pertinence Index	.79
Salience Index	.90
ToM Cognitive Index	.76
ToM Affective Index	.82
Animation Index	.80
Person Index	.88
Problem-Solving Index	.91

Inter-rater reliability coefficients ranged from good to excellent (Cicchetti & Sparrow, 1981), with somewhat lower reliability for ratings of ToM cognitive terms and higher reliability for the more close-ended indices in which items of information had to be rated as "present" or "absent" only (Salience and Problem-Solving indices), or in which ratings involved terms used very frequently (Person Index). No reliability issues arose from identification of proposition units.

SAT Index Scores

Table 3 presents results for the six SAT Index Scores and number of propositions in the spontaneous narratives (1 to 7) for the three groups participating in this study. ANOVAs with Tukey post hoc comparisons were performed on each of the indices (and number of propositions) across the three clinical groups. Given the high number of comparisons (eight), Bonferroni corrections were adopted, setting the significance threshold at $p < .05$.

There were marked differences between the two clinical groups and the NC group in all measures obtained, although there were only minor differences between the HFA and AS groups. The number of propositions in the spontaneous narratives of the NC group was considerably larger (44.5) than in either the HFA group (21.5) or the AS group (29.5).

On the Pertinence Index, close to one third of the spontaneous propositions in the HFA and AS groups were scored as nonpertinent (i.e., tangential or nonrelated) to the social cartoon viewed, whereas only a small percentage of NC propositions were rated in this way, despite the fact that there was a considerably larger number of propositions in their narratives.

On the Salience Index, the HFA and AS groups were able to identify only about one quarter of the social elements typically described by normally developing adults when viewing the cartoon, contrasting to about three quarters of the social elements identified by the NC group.

On the ToM Cognitive and Affective indices, a significantly lower number of pertinent mental state terms, both cognitive and affective, were utilized by the HFA and AS participants in their narratives of the cartoon in comparison to results for the NC group.

On the Animation Index, the overall level of sophistication of the narratives in the HFA and AS groups was

Table 3
Number of Propositions per Protocol and Results of SAT Index Scores Obtained for the Three Groups

Number of propositions and SAT Index Scores	HFA	AS	NC	Sig.	Sig. post hoc group comparisons
No. of propositions[a]	21.5	29.5	44.5	.05*	Aut & NC
(*SD*)	(9.5)	(8.7)	(14.0)		AS & NC
Pertinence Index[b]	26.2%	36.0%	6.7%	.05*	Aut & NC
(*SD*)	(18.0)	(23.8)	(11.1)		AS & NC
Salience Index[c]	20.5%	23.5%	78.4%	.05*	Aut & NC
(*SD*)	(20.4)	(20.6)	(22.0)		AS & NC
ToM Cognitive Index[d]	4.3%	4.5%	13.6%	.05*	Aut & NC
(*SD*)	(3.1)	(2.9)	(10.7)		AS & NC
ToM Affective Index[e]	2.5%	2.9%	11.5%	.05*	Aut & NC
(*SD*)	(2.0)	(2.2)	(7.4)		AS & NC
Animation Index (0–6)[f]	1.6	1.9	3.5	.05*	Aut & NC
(*SD*)	(1.1)	(1.2)	(1.4)		AS & NC
Person Index (0–6)[g]	1.9	2.1	4.2	.05*	Aut & NC
(*SD*)	(1.0)	(1.2)	(1.5)		AS & NC
Problem-Solving Index[h]	29.2%	39.5%	79.3%	.05*	Aut & NC
(*SD*)	(24.2)	(27.0)	(22.0)		AS & NC

[a] Total number of propositions in Narratives 1 to 7.
[b] Percentage of nonpertinent propositions of the total number of propositions in Narratives 1 to 7.
[c] Percentage of the typical 20 social elements identified in Narratives 1 to 7.
[d] Percentage of pertinent propositions containing ToM cognitive terms in Narratives 1 to 7.
[e] Percentage of pertinent propositions containing ToM affective terms in Narratives 1 to 7.
[f] Level of social attribution on a scale of 0 to 6 in Narratives 1 to 7.
[g] Ability to attribute personality features to shapes in a scale of 0 to 6 in narratives 8 to 10.
[h] Percentage of questions answered correctly (Narratives 11 to 17).
* $p < .006$ (Bonferroni corrections set at the threshold of $p < .05$).

Table 4
Correlations between SAT Index Scores and Age, Verbal IQ, and Metalinguistic Skills for the HFA and AS Groups

SAT Index Score	Age	Verbal IQ	Oral Expression[a]
Pertinence Index	.27	−.25	−.17
Salience Index	−.02	.21	.10
ToM Cognitive Index	−.22	.00	−.03
ToM Affective Index	−.20	.03	.00
Animation Index	−.12	.29	.13
Person Index	.22	.18	.42*
Problem-Solving Index	−.09	.06	.26

[a] Oral Expression subtest of the TLC.
* $p < .05$.

markedly lower than in the NC group. Although there were several participants in the clinical group whose narratives did not include human agency at all (i.e., involved geometric or physical reasoning only), the majority did, albeit at a lower level of social attribution than the NC group.

Results on the Person Index were similar to those obtained for the Animation Index. Although there were marked differences between the HFA and AS groups on the one hand and the NC group on the other hand, the majority of HFA and AS participants were able to make at least one personality attribution based on the characters' actions.

Finally, results on the Problem-Solving Index indicate that in a more explicit question- and answer-situation, in which some social aspects of the cartoon were defined to the participants, there was some improvement relative to their spontaneous understanding (as indicated by the Salience Index). This improvement, however, was not significant: HFA and AS participants improved from 20.5% and 23.5% respectively in the Salience Index to 29.2% and 39.5% in the Problem-Solving Index. Of interest, there was virtually no improvement at all in NC group following the more explicit directions, as they appear to have understood just as much spontaneously (Salience Index) as they did after being given the more explicit directions (Problem-Solving), which speaks to their already high level of understanding in the spontaneous condition.

Associations between SAT Index Scores and Age, Verbal IQ, and Metalinguistic Skills

Table 4 examines the role of age, Verbal IQ, and the capacity for reproducing speech acts from a social situation presented as a drawing (TLC Oral Expression subtest) in the HFA and AS participants' performance on the SAT different Index Scores.

There were no significant correlations between age or Verbal IQ and any of the SAT Index Scores, suggesting no significant role to either of these two variables on SAT performance. And with one exception, SAT performance was also relatively dissociated from performance on a standardized test of social language use in which participants were asked to recreate speech acts—or, in a way, make social attributions—to the people depicted in the drawing presented to them. The exception to these results was the positive correlation between the TLC Oral Expression subtest and the SAT Person Index.

Discussion

This paper demonstrated the viability of a novel social cognitive procedure—the Social Attribution Task—intended to minimize some limitations identified in current ToM research in autism and related conditions, namely the facilitating effects of verbal skills, the explicitness in task presentation, and the typical dichotomous classification of participants' responses as either a ToM or a non-ToM response. By reducing these factors, it was hoped that the discrepancy between a relatively high ToM task performance in individuals with HFA and AS and the marked disabilities in social adaptation in naturalistic situations would also be reduced, bringing laboratory measures and clinical observations at a more even level. This new task was also intended to include measures of certain aspects of social skills that are often not included in ToM research, such as a person's spontaneous search for social meaning in visual stimuli, and the ability to constrain one's mental attributions to relevant aspects of a social situation.

The utility of the SAT was also demonstrated in that it was possible to reliably document marked deficits in social cognition in a very cognitively able, yet socially disabled, group of individuals with HFA and AS who had previously passed a screening second-order ToM task. Specifically, the clinical group's narratives were considerably shorter than those provided by NCs. A qualitative examination of these narratives indicated that the cartoon had been more meaningful to the NC group, allowing NC participants to generate fairly elaborated and lengthier social plots. The clinical groups also differed from the NC group on all SAT indices.

Pertinence. There were marked differences on the ability to provide relevant and pertinent narratives of the geometric cartoon; in fact, on average close to one third of their attributions were irrelevant or nonpertinent to the video presented to them. Considering that purely geometric accounts of the cartoon were not rated as "nonpertinent" because they described the stimuli faithfully (thought not socially), this result indicates that the search for meaning to the ambiguous visual stimuli was made by the clinical groups but these attributions were not related to the cartoon because they provided extraneous accounts (social, e.g., an unrelated story, or nonsocial, e.g., inanimate interactions between nonhuman entities; see below).

Salience. The clinical groups were sensitive to only one quarter of the social elements in the cartoon which are usually identified by normally developing adults. These results emphasize the insensitivity of the clinical participants to the social meaning of the shapes' movements.

Theory of mind cognitive and affective. The clinical participants used considerably fewer pertinent ToM cognitive and affective terms. This result is consistent with previous work (e.g., Tager-Flusberg, 1992). Qualitative examination of the protocols, however, suggested that several individuals among the HFA and AS groups utilized mental state terms more frequently in their spontaneous narratives, although many of these were excluded (i.e., nonpertinent) because they occurred in reference to stories or comments that could not be related to the cartoon. When the frequency of propositions containing a ToM cognitive term, regardless of whether the proposition was or was not pertinent, was compared across the three groups, the percentage scores rose from 4.3 %, 4.5 %, and 13.6 %, respectively for the HFA, AS, and NC groups, to 5.1 %, 8.5 %, and 14.0 %, suggesting, particularly, that individuals with AS in fact used ToM cognitive terms quite frequently, though still at a significantly lower frequency than NCs ($p < .01$). This finding was easily observed in their narratives, which at times described social situations that could not be related to the cartoon. In other words, in this group, the main issue was not the lower frequency of usage of ToM cognitive terms, but rather the pertinence of the attribution itself that was problematic. It is important to emphasize, however, that some mental state terms were used correctly by HFA and AS participants, albeit in only a very small percentage of propositions. A similar trend was observed in regards to ToM affective terms, but it was less pronounced (scores went from 2.5 %, 2.9 %, and 11.5 %, respectively for the HFA, AS, and NC groups, to 3.0 %, 4.1 %, and 11.9 %; $p < .01$).

Animation. The overall level of social sophistication in the understanding of the cartoon was markedly reduced in two clinical groups compared to controls. The Animation Score was designed to reflect the level that a given participant could reach in social attribution, regardless of the length of their narratives, frequency of usage of ToM terms, or completeness of their social understanding of the cartoon. In this way, this index reflects "capacity" more than "usage" of social attribution skills or "full understanding" of a social situation. It is interesting, therefore, that the HFA and AS participants could go as high as they did in the Animation Index while still being able to identify only one quarter of the SAT social elements (Salience Index) and offering such a large number of irrelevant attributions (Pertinence Index). This result speaks to the need to measure more than just capacity for mental state attribution in these individuals.

Person. The capacity for deriving personality features from the characters' actions was significantly reduced in the two clinical groups relative to the NC group. Nevertheless, some attributions were made by them. However, most of these attributions were specifically tied in to one or two behaviors portrayed in the cartoon, in contrast to NC participants who combined such action-based impressions into psychological features based on attributions of stable, psychologically derived features. This act of integration was only seldom seen in the clinical participants, resulting in much more simplistic attributions. In other words, although the capacity of at least some individuals with HFA and AS to see the cartoon characters as people could be demonstrated, their understanding was more concrete and less integrated.

Problem-Solving. Although there was a trend for some improvement in the AS group's understanding of the social situation when certain aspects of the task were made explicit to them, this result was not statistically significant. Even considering this improvement, however, there was still a major gap between their understanding and that of the NC group. Individuals with autism show little or no improvement. This trend suggests that verbal mediation and explicit definition of social situations might appear to be more beneficial to individuals with AS than those with autism, although this needs to be further studied. In other words, the AS group may have profited somewhat more than the HFA group from the explicit directions; still, they were able to answer "correctly" only half of the number of questions correctly answered by controls. The lack of a more substantial improvement was surprising, suggesting a substantial disability in making social attributions to ambiguous visual stimuli even in the more explicit presentation of the task.

Correlations between the SAT Index scores and age and Verbal IQ were not significant. Given the considerable variability in age and Verbal IQ in the HFA and AS groups on the one hand, and the comparability of age and Verbal IQ between the clinical groups and the NC group on the other (see Table 1), these results suggest that the SAT performance in this sample was capturing a phenomenon that was relatively independent of age and verbal intellectual skills. Another implication of this result is also the suggestion that the SAT may have succeeded in reducing the facilitating effects of language previously documented in more traditional ToM tasks. Of possibly more interest, however, was that, with one exception, SAT performance was also relatively dissociated from performance on a standardized test of social language use in which participants were asked to recreate speech acts—or, in a way, make social attributions—to the people depicted in the drawings presented to them. This dissociation suggests that the social skills required in such a task (the TCL Oral Expression subtest, on which HFA and AS participants did fairly well, scoring in the low average range), might be of a different nature than those required in the SAT, which builds on a person's ability to impose a pertinent social structure to the ambiguous visual stimuli. The exception was the positive correlation found between the TLC and the Person Index. This was the only index score in which what counted most was the person's ability to attribute psychological attributes to the explicitly defined social characters, whether or not these were appropriate given the overall context of the cartoon. This result suggests, therefore, that although higher ToM or metalinguistic capacity may have given the HFA and AS participants a higher vocabulary to use when questioned, it did not necessarily facilitate spontaneous understanding of the social plot depicted in the cartoon.

Although the SAT index scores provided a clear sense of the impoverished social attribution abilities in this clinical sample, it should be noted that the narratives themselves were probably a more striking indicator of their deficits. These narratives contrasted markedly with those obtained from normal controls. In this light, it is indeed striking that Heider and Simmel's (1944) paradigm elicits social attributions so effortlessly in normally developing individuals, who almost immediately are able to appreciate the social aspects of the movements of the geometric shapes, including scenes of "bravery", "elation", "outbursts of anger", "trapping", "threatening", and so forth. Here is one example of a narrative segment provided by a young normally developing adolescent with normative verbal IQ:

> What happened was that the larger triangle—which was like a *bigger kid* or a *bully*—and he had *isolated* himself from everything else until *two new kids* come along and the *little one* was a bit more *shy*, *scared*, and the smaller triangle more *like stood up for himself* and *protected the little one*. The big triangle got *jealous* of them, came out, and *started to pick on the smaller triangle*. The little triangle *got upset* and *said* like "what's up?" "Why are you doing this?" ...

Clearly, this adolescent was able to provide a coherent social story that was filled with social attributions (words in italic) of personality invariances (e.g., bully, shy), descriptions of relationships (e.g., stood up for himself, protected the other), and attributions of feelings (e.g., jealous, upset); these attributions built on his implied understanding of the characters' needs, intentions, and even beliefs about the acceptability of certain behaviors. In contrast, individuals with HFA and AS struggled greatly with the task of finding meaning in the cartoon. Here is one example of a narrative segment provided by a young adolescent with autism with a Verbal IQ comparable to the typical child above:

> The big triangle went into the rectangle. There were a small triangle and a circle. The big triangle went out. The shapes bounce off each other. The small circle went inside the rectangle. The big triangle was in the box with the circle. The small triangle and the circle went around each other a few times. *They were kind of oscillating around each other*, *maybe because of a magnetic field*. After that, they go off the screen. *The big triangle turned like a star—like a Star of David*—and broke the rectangle.

This adolescent was clearly unable to provide a social story. Mostly, the narrative was a geometric description of the movements he had seen. However, his narrative was not devoid of an attempt to ascribe some forms of interpretation ("like a Star of David") and even causation ("a magnetic field") to the display (words in italic). For example, in an apparent attempt to understand the contingent movements of the two little shapes (usually described by typical viewers as celebration or happy play, as the little circle had just escaped the pursuit of the larger triangle thanks to the small triangle's help), this person explained the interaction as governed by a physical form of causation, namely a magnetic field. Whereas the typical child was using the fundamentals of social relationships to attribute meaning to the ambiguous visual display, the child with autism was using the fundamentals of physical relationships to do the same. They were both viewing the same display, but their minds appeared to be searching for different kinds of principles, social and physical, respectively. This observation is consistent with Baron-Cohen's (1995) comments about deficits in "folk psychology" contrasting with maybe at times superior "folk physics" characterizing individuals with autism.

The above illustrative narratives also point to the need to explore the relative salience of social phenomena and the ability to constrain one's search for meaning to what is socially pertinent to the situation at hand. The SAT's focus on issues of salience and pertinence, among the other social cognitive skills addressed in the procedure, allows us to explore these factors, which may be of importance in naturalistic social situations, and which have not received adequate attention in the past. The fact that the HFA and AS participants were sensitive to only one quarter of the social elements of the cartoon could suggest that when coming face to face with a complex social situation—say, a high school cafeteria—they might be able to identify only a small number of important cues required for creating the social context of that setting. Failing to do so might place them at great disadvantage when having to predict other people's intentions and to select responses that will be appropriate to the social demands of that situation. This observation supports the emphasis placed by social skills training programs on promoting increased awareness of social cues in the environment by training individuals with autism to search for social information (e.g., Gray, 1995). The SAT Salience Index Score provides a laboratory measure of a person's capacity and inclination to search for social meaning in visual displays. Similarly, it was often the case that although the participants failed to attribute relevant social meaning to ambiguous visual stimuli, they still sought some form of meaning in the task they were asked to perform, hence providing quite often responses that were irrelevant or nonpertinent, or altogether focused on a different task, such as the adolescent who sought physical meaning—e.g., magnetic fields—in the cartoon display. Translated into a naturalistic setting, the fact that one third of the HFA and AS participants' narratives were irrelevant would very likely cause a series of communication breakdowns if these persons were, for example, conversing about the cartoon with another person. Pragmatic deficits of this kind are well known in autism and AS (Landa, 2000). The SAT offers a quantified indicator of the pertinence of a person's thoughts (as expressed in their verbal accounts) to the social situation presented to him or her. Given the apparent importance of both of these constructs (salience and pertinence) for social adaptation, it will be important to explore the extent to which the SAT indices can predict these abilities as evidenced in naturalistic settings.

This exploratory study has several limitations that deserve to be addressed in future studies. First, the cognitively able sample in the group with autism who participated in this study is not representative of the larger population of individuals with autism. The extent to which this procedure is viable in younger and more cognitively challenged samples needs to be ascertained.

Second, although the TLC Oral Expression test was thought to be a fairly strict control test, the fact that the clinical groups provided shorter narratives that contained fewer propositions than those of controls needs to be further studied. Although one may consider that the narratives were shorter because they were less meaningful to them, it is also possible that this was the result of a series of confounds not adequately controlled in this study, including linguistic factors (e.g., generativity, or the capacity for generating narratives; Hemphill, Picardi, & Tager-Flusberg, 1991; McAdams & de St. Aubin, 1992; Thommen, 1992), and more generalized imagination deficits. Similarly, despite the procedures introduced in the SAT in order to minimize memory effects, this is yet another possible confound, as are other neuropsychological constructs such as executive dysfunction. These various confounds will need to be more explicitly controlled for in future studies. That notwithstanding, the SAT coding system mitigates some of these shortcomings such as generativity by including several indices that are qualitative (i.e., what level of sophistication is achieved), rather than quantitative. It is also the case that analyses of individual narratives (see illustrations above) do suggest that the impoverished content of the clinical participants' narratives might not be simply the result of any of these confounds, although this is an empirical question. We are currently addressing these issues in the context of a new task in which the capacity for physical (not social) attributions is measured. This new task—the Physical Attribution Task (PAT)—has been developed to better explore the impact of generativity, memory, visual-spatial perception, imagination, integration, and other possible issues on the capacity to generate narratives about ambiguous visual stimuli. The PAT measures a person's ability to attribute physical meaning to a geometric cartoon depicting the launching of a "spaceship" to a moon and its return to "earth". In order to test whether or not individuals with autism and AS could provide higher-level physical attributions to a geometric cartoon depicting physical actions (than they were able to provide social attributions to the Heider and Simmel cartoon), similar coding procedures were developed so as to make possible a direct comparison between some of the SAT and the PAT scores (Salience, Pertinence, and Problem-Solving).

Third, the social attribution skills measured in the SAT probably result from the interplay of several social cognitive components, which were not addressed in the study. Although the primary purpose of the study was to reliably quantify different aspects of social cognition deemed to be clinically relevant, the unraveling of the multiple components contributing to high or low performance on the SAT needs to take place in the context of more controlled experimental designs.

If, however, the present results point to valid clinical phenomena, there are several implications to be pursued in future research. From the point of view of the ToM hypothesis of autism and related conditions (Baron-Cohen et al., 1999), the SAT results begin to address the issue of why mastery of ToM skills, as presented in the standard explicit or problem-solving format, is not sufficient for demonstrating social competence. If one does not naturally seek social meaning in the environment, one's ToM capacities are of little avail; in other words, there is a need for a theory of how ToM skills are put into action. Focusing on this question, Sigman and colleagues (1995) commented that " … the only children who achieve metarepresentation and social comprehension without recourse to the nearly automatic emotional understanding that most normal people possess are autistic children" (p. 174). A theory of ToM in action is required in order to bridge the gap between ToM capacity and competence. For such a theory to gain substance, it will be important for abilities such as sensitivity to social salience to be more actively researched (Klin et al., 1999; Mundy & Neal, in press). Clues from recent neuroimaging research has began to offer some interesting guidelines for such a model (Schultz et al., 2000; Schultz, Romanski, & Tsatsanis, 2000), which include integration of social reasoning with affective and motivational systems through highly interconnected regions of the mesial and orbital prefrontal cortex, medial regions of the temporal lobe, and the amygdala, bringing together ToM competencies with affective systems and more basic social orienting mechanisms such as sensitivity to gaze direction and facial emotions (Brothers, 1995; see also Frith & Frith, 1999). From an intervention standpoint, the search for adequate social skills training strategies that have a more substantial impact on spontaneous social adaptation of individuals with autism and AS should not be constrained to the teaching of ToM capacities (Klin & Volkmar, 2000). The active search for social cues and the constraining of thoughts to conventional social reasoning will also need to be addressed.

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Appendix: Description, Rationale, Scoring Criteria, and Algorithms for Each SAT Index

Pertinence Index (PI)/Narratives 1 to 7

From our pilot work, it was clear that there was a need to measure the extent to which narratives were pertinent to the task of making social attributions, and the extent to which attributions followed some underlying representation of social reality that related to the cartoon, however broadly. Accordingly, the Pertinence Index measures the percentage of propositions that are

(1) *vague references*: a proposition in which either the referent is undefined or an event occurs in the video but has little relevance to a reasonable social theme or the description of a discrete geometric event (e.g., "a lot of odd movements"; "some shapes spinning around");
(2) *misattributions*: a proposition in which the characters, setting, actions, or events are not possible within the broadly defined constraints of the video theme (e.g., "the rectangle is a table" rather than a human enclosure; "the shapes are playing tag" when typically the scene is seen as one character violently hitting another character);
(3) *irrelevant attributions*: a proposition that provides extraneous or tangential information (e.g., "the triangle made a star while falling"; "the triangle made a Star of David"; "the structure changed its design"); or
(4) *inconstant propositions*: a proposition that contradicts a previous proposition, or a referent (e.g., change of referent for a character or the setting).

Such propositions would likely result in communication breakdown in real life, and would reflect the participant's difficulties in interpreting stimuli meaningfully and in a situation-relevant fashion from a social standpoint. Scoring of this index is derived from the percentage of nonpertinent propositions out of the total number of propositions, and a proposition is defined as a verb plus its complement (Stein & Glenn, 1979).

Scoring: Number of Vague References + Misattributions + Irrelevant Attributions + Inconstant Propositions/Total number of propositions

Salience Index (SI)/Narratives 1 to 7

Based on Heider and Simmel's (1944) work, and our pilot work with normally developing adolescents and adults, a number of salient items of social attribution in the video segment which are typically included in the SAT narratives can be identified. Twenty high-frequency attributions could be identified in adult narratives. The Salience Index is calculated in terms of the percentage of such attributions included in the participant's narrative. The index is meant to capture the extent to which typical invariances in SAT attributions are detected by a given participant. There is no need for explicit use of the words describing a given element of the story; the item is scored as present or absent in terms of whether or not the idea is represented, explicitly or implied, in the participant's narratives. The 20 items are:

(1) Rectangle is human enclosure
(2) Recognition of three actors (rectangle not an actor, three agents throughout)
(3) Little triangle and circle are together (may be implicit)
(4) The big triangle and the small triangle fight
(5) Indication of the direction of hostility: The big triangle is the aggressor, the little triangle is resistant,
(6) The little triangle is overwhelmed by the big triangle (e.g., The big triangle wins, The big triangle scares off the little triangle)
(7) The little circle tries to avoid conflict (e.g., hides, cowers, seeks protection)
(8) The big triangle searches for the little circle (e.g., entraps, tries to catch)
(9) The little circle panics (e.g., is afraid, scared, terrified)
(10) Indication that the little triangle comes to the little circle's aid (e.g., save, rescue, help)
(11) The little circle escapes the big triangle (e.g., evades, flees, gets away from)
(12) The big triangle is trapped inside the enclosure
(13) The little circle and the little triangle celebrate (e.g., are happy, dance, rejoice)
(14) Proposition explaining the reason for celebration (e.g., escaped from the big triangle, are free)
(15) Indication that the big triangle chases the little triangle and the little circle (e.g., goes after, pursues them)
(16) Indication that the big triangle momentarily does not know where the little triangle and circle are (as a result of the big triangle's momentary search of the two other shapes inside the rectangle)
(17) The little triangle and the little circle are successful at evading the big triangle (e.g., they escape, ran away)
(18) The big triangle is frustrated (e.g., mad, angry)
(19) Proposition of explanation for the big triangle's anger (e.g., because he failed to catch them)
(20) The big triangle breaks the enclosure

Scoring: Number of elements of the story included in the participant's narration/20

Theory of Mind Index: Cognition (ToMC)/Narratives 1 to 7

This index corresponds to the percentage of pertinent propositions containing cognitive mental state terms (denoting desire, knowledge, thoughts, motivation/intention, or behaviors intended to alter another person's mental states) from the total number of pertinent propositions included in the participant's narratives. This index is derived from Tager-Flusberg's work (e.g., 1992) on the autistic children's use of psychological states in their spontaneous narratives. Cognitive mental states are defined as:

(1) Terms expressing one character's desire of knowledge
(2) Behaviors which not only implicitly indicate a shared cognition, thought, or plan between two characters but which cannot exist without it (e.g., trapping, rescuing, sneaking, hiding, spying)
(3) Terms expressing one character's belief, thought, imagination, intention, plan, motivation
(4) Behaviors which explicitly indicate a shared cognition, thought, or plan between two characters in which one character intentionally impacts on the other's cognitive state (e.g., intimidation, deception, trickery, bullying, arguing, joking, rebuffing)

Scoring: Number of cognitive mental state terms/Total number of propositions
(Notice that only the frequency of the terms, not their hierarchical value, is reflected in this Index.)

Theory of Mind Index: Affect (ToMA)/Narratives 1 to 7

This index corresponds to the percentage of propositions containing emotional terms (e.g., happy, sad, alarmed, envious, sulking) attributed to the characters of the video from the total number of propositions made. Guidelines for scoring were partially derived from the work of Bretherton and colleagues (e.g., 1986). Affective mental states are defined as:

(1) Emotional terms that may not be the result of social interaction or may not be uniquely human
(2) Behaviors which not only implicitly indicate a shared emotional state between two characters but which cannot exist without it (e.g., cheering, celebrating, hugging, high-fiving)
(3) Emotional terms which result only from a social situation (e.g., envious, jealous, sulking, bitter, mended his ways, expressing sour grapes, admiration)

Scoring: Number of affective mental state terms/Total number of propositions
(Notice that only the frequency of the terms, not their hierarchical value, is reflected in this Index.)

Animation Index (AI)/Narratives 1 to 7

This index corresponds to a summary measure of the narrative's general level of social attribution. It includes:

(1) *Behaviors (doing something)*:
A. Behaviors that necessitate actors or agents, but which are not uniquely or necessarily human behaviors, nor do they necessarily require any attribution of mental or feeling states (e.g., chasing, fighting, destroying).
B. Verbs or behaviors that do not involve an explicit mental state but are uniquely human (e.g., talking, says, or a quotation).
C. Behaviors that are uniquely human by virtue of implied indication of a shared mental state without which the behavior cannot occur (e.g., cheering, celebrating, trapping, hiding).
D. Behaviors that are uniquely human by virtue of direct indication of an awareness by one character of another's mental state, accompanied by an attempt to alter the second character's mental state (e.g., intimidation, deception, trickery, bullying, arguing, joking, rebuffing, taunting).
(2) *Perceptions*:
E. Sensory experiences or attention which are not uniquely human (e.g., look, watch, see, notice).
(3) *Emotions (feeling something)*:
F. Emotional terms that usually result from a behavior or an action, but which do not necessarily result from a social action, or which are not uniquely human (e.g., happy, sad, scared, mad, alarmed, panicked).
G. Emotional terms which result only from a social situation (e.g., envious, jealous, sulking, bitter, mended his ways, expressing sour grapes, admiration).
(4) *Cognition, intention, motivation (usually thinking something)*:
H. Lower developmental level: mental state terms expressing desire or knowledge (e.g., want to, know, mistake).
I. Higher developmental level: mental state terms expressing beliefs, thoughts, imagination, plans (e.g., pretending, remembering, decision).
(5) *Relationships or personality traits*:
J. Allusion to a person as constrained by his or her features (e.g., big guy, little guy, kid).
K. Allusion to a person as constrained by his or her relationship to another (e.g., is a daddy, mommy, or baby).
L. Allusion to a person as constrained by his or her actions or attribution of personality traits (e.g., to be a bully, friends, companions, curious, timid, shy).
(6) *Symbolic nature*:
M. An acknowledgement of the symbolic nature of an object or shape (e.g., represents, stands for, symbolizes, a home, domain).

This index is scored following an hierarchical procedure, based on level achieved within each category, rather than on frequency of scored categories or specific items. The index was intended to grade overall level of social cognitive sophistication without penalizing participants on the basis of the length of narrative provided. Scores are values in an ordinal scale of 0 to 6.

Scoring Algorithm:

Score	*Criteria*
0	No human agency; mechanistic; geometric reasoning only.
1	A or E or J
2	B or C or F or H or K or M
3	D or G or I or L
4	At least two of D or G or I or L, but not two of the same category
5	At least three of D or G or I or L, but not two of the same category
6	Four of D or G or I or L, but at least one of each.

Person Index (PI)/Narratives 8, 9, and 10

This index is derived from narratives 8 through 10 in which participants are explicitly instructed to see the shapes as people, and then to answer the question of what kind of a person they were. It was intended to measure the participant's ability to derive invariant or stable personality features from the shapes' actions in the video. This ability was graded in ascending level based on the participant's use of the characters';

Physical properties (*PP*): descriptions based on the shapes' form, e.g., big, small, skinny;
Relative properties (*RP*): descriptions of the interrelated social roles of the characters although still related to their relative shape, e.g., adult, dad, mother, grown-up, kid, boy, baby;
Behaviorally derived attributes (*BDA*): descriptions based on specific actions of the characters, e.g., protector, trapping kind of person;
Psychologically/derived features (*PDF*): these attributions reflect charactereological statements, e.g., curious, timid, i.e., features that the characters would carry with them beyond the specific events portrayed in the video.

Like the Animation Index, this index is scored hierarchically, in terms of level achieved, rather than frequency of attributes generated for each character. Ratings are used to measure the level of person attribution on an ordinal scale of 0 to 6.

Scoring Algorithm:

Score	Criteria
0	Don't know, or all PPs
1	One or more RPs
2	At least 1 BDA
3	At least 1 BDA for each character or at least 1 PDF
4	At least 3 PDFs
5	At least 1 PDF for each character
6	Four or more PDFs (i.e., more than 1 PDF for each character)

Problem-Solving Index (PSI)/Narratives 11 to 17

This index is derived from narratives 11 through 17, in which participants are instructed to answer specific questions after viewing segments of the cartoon. The index was intended to assess the participant's ability to answer correctly (i.e., consistent with the answers obtained by a pilot sample of adults) explicit questions about the cartoon. The index score indicates percentage of the items answered correctly. The index was also intended to measure the participant's ability to profit from the explicit verbal instruction to make social attributions describing a given clip from the animation story.

Narrative 11.

Item 1: Recognition that the large triangle and the small triangle (and/or circle) had antagonistic intentions, motivations, or beliefs that put them at odds (e.g., "they disagree", "they think differently", "they have a conflict of interest", "the big triangle wanted to take something away from the little triangle").

Narrative 12.

Item 2: Recognition that the small circle was trying to escape the conflict (e.g., "hiding", "seeks protection") (to say that it was scared is not sufficient).

Narrative 13.

Item 3: Indication that the big triangle wanted to catch, entrap the small circle (indication that the big triangle "notices the circle" or "finds the circle" are not sufficient).

Narrative 14.

Item 4: Indication that the small circle panics, is afraid, etc.
Item 5: Indication that the small circle is trying to escape.

Narrative 15.

Item 6: The big triangle was trapped inside the rectangle.

Narrative 16.

Item 7: The small triangle and circle celebrated, danced together because they were happy (it is important that the answer includes some form of celebration or happiness as a result of the event; simply saying that the two small shapes were playing together is not sufficient).
Item 8: An explanation of why the two shapes are happy, i.e., the small circle, which was in some peril, is now safe.

Narrative 17.

Item 9: The large triangle broke the house because it was angry, or a different negative (frustrating) emotion.
Item 10: Explanation for the large triangle's anger (e.g., it could not catch the other two shapes, or a different reason resulting from the story).

Scoring: Number of items answered correctly/10