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Limitations in social anticipation are independent of imaginative and Theory of Mind abilities in children with autism but not in typically developing children

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Abstract

Anticipating future interactions is characteristic of our everyday social experiences, yet has received limited empirical attention. Little is known about how children with autism spectrum disorder, known for their limitations in social interactive skills, engage in *social anticipation*. We asked children with autism spectrum disorder and their typically developing counterparts to consider an interaction with another person in the near future. Our results suggest that children with autism spectrum disorder and typically developing children performed similarly when anticipating the age, gender, and possible questions of another person, but children with autism spectrum disorder struggled more to anticipate what they would say in response to an anticipated interaction. Furthermore, such responses were robustly associated with imaginative capacities in typically developing children but not children with autism spectrum disorder. Our findings suggest that the cognitive mechanisms of social anticipation may differ between these groups.

Keywords

autism, children, imagination, pretence, social anticipation

Introduction

The imaginative capacity to anticipate future events facilitates a range of behaviors and phenomena in humans. By thinking through events that are yet to occur, we can make choices that lead to more desirable outcomes or imagine how things may have turned out differently (Harris, 2000; Harris et al., 1996). These capacities allow us to flexibly respond to an uncertain future environment, such as in domains of planning (McCormack and Atance, 2011), decision-making (Kahneman and Snell, 1990), and cooperative and competitive social interaction (Butler et al., 2011). The imagination thus brings future scenarios to life and makes them relevant to our own experience (Suddendorf and Corballis, 2007).

Individuals with autism spectrum disorder (ASD) are known for limitations in social interactions, which have been linked to poor imaginative and social cognitive abilities (Hudson et al., 2012; Yirmiya et al., 1998). Recent research with adults who have ASD suggests that they have a limited capacity to *pre-experience* future situations. They are less able to consider and rehearse future contingencies or actions, which may reduce planning and delay of gratification, and could underlie the behavioral inflexibility that is featured in ASD (Lind and Bowler, 2010; but see Crane et al., 2012 for a failure to replicate). Moreover, deficits in this domain are highly correlated with reduced imaginative thinking (Lind and Bowler, 2010). Children with ASD have also been shown to have problems with anticipating future actions; for instance, when asked to plan the order in which they would put on a costume (Jackson and Atance, 2008), imagining future events based on a given word (Terrett et al., 2013), and selecting objects that may be useful in a future context

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(Hanson and Atance, 2014). However, we know very little about how these limitations affect real-life interactive social behavior. In this study, therefore, we investigate the abilities of children with ASD and typically developing (TD) children to adaptively prepare themselves for a social interaction by anticipating its likely form and content. For the purpose of clarity and convenience—but not claims to domain specificity—we refer to this as *social anticipation* and posit that this activity is likely to be related to two overlapping capacities commonly assumed to be impaired in ASD children: imagination and Theory of Mind. We discuss the role of each below.

The practical deployment of imagination unfolds throughout childhood, but by 5 years of age, children appear to fluidly use their imaginative capacities in a range of situations (Atance, 2008). In particular, 4- and 5-year-old children are capable of planning in an anticipatory fashion and selecting objects in the present that will benefit them in an imagined future experience (Russell et al., 2010; Suddendorf and Busby, 2005). Findings such as these imply that children's imaginative capacities are used for much more than entry into imaginary worlds. Rather, these capacities are critical for their day-to-day understanding of the real world in which they live (Harris, 2000). Research on the productive imaginative abilities of ASD individuals has yielded inconsistent and at times puzzling findings. While some reports attest to normal abilities (e.g. idea generation) in ASD adults (Lind and Bowler, 2010), others have shown some deficits in these same abilities in children with ASD and normal intelligence relative to TD controls (Bishop and Norbury, 2005). On the basis of the current literature, it is not clear whether such children with ASD (1) show basic deficits in their imaginative behavior or (2) effectively use their imaginative abilities in a productive fashion to manage social situations. The latter remains an important possibility, given the social deficits in autism, and in light of those findings that do point to idiosyncratic patterns of imaginative behavior in this group. It is also possible that while children with ASD display comparable performance on tasks assessing imaginative abilities, they do not apply these to social reasoning, instead relying on relatively inflexible scripts and rules.

To anticipate and prepare for an interaction, it is also likely that understanding the goals and intentions of the other party is of particular salience. That is to say, social anticipation may represent a practical manifestation of more abstract and generalized abilities to see the world from the perspective of the other, also referred to as Theory of Mind. In otherwise cognitively able children with ASD, the ability to distinguish their own goals, intentions, and perspectives from those of another person is atypical, evidenced by a wide literature on autism-related limitations on Theory of Mind (Yirmiya et al., 1998). Across a range of different perspective taking contexts—situations involving the unprompted prediction of action (Senju et al., 2010), pictorial and verbal story tasks, and tasks involving the observed deception of another person (Yirmiya et al., 1998)—participants with autism are observed to have a self-centered approach.

Furthermore, impairments in the planning and executive control abilities of children and adults with ASD appear to be most striking in socially mediated contexts (Kenworthy et al., 2008), which is consistent with reported and observed difficulties managing social interactions in the context of ASD. In this study, therefore, we examined the anticipation of a social interaction in intellectually able children with ASD and their TD counterparts. We created an ecologically valid situation in which children genuinely anticipated an interview and questioned them about their expectations in a casual but structured manner prior to the supposed interaction. The initial questions were related to features of the interviewer (gender and age), for which there was no basis to expect systematic group differences in responding. The final questions were related to the content of the interview, asking children to describe ways in which they expected the interview to unfold. In response to these final questions, we predicted that children with ASD would be poor at generating ideas about the anticipated interaction compared to TD children.

To explore whether social anticipation is associated with global indices of imaginative production, we also measured individual differences in children's general imaginative capacities. In TD children, we expected that greater imaginative abilities would be associated with increased likelihood of specifying how the anticipated interaction could unfold. This prediction turns on the assumption, discussed above, that TD children actively use their imagination in a productive fashion to construe social situations in comprehensible terms. This activity also likely draws on children's Theory of Mind, which was studied as an additional factor associated with social anticipation. It is unclear whether productive imaginative abilities are specific to the social domain, so we utilized two measures of imagination tapping social and non-social topics: *ideational fluency*, which provides an inference of general, non-social imaginative skills (e.g. "What objects can fit in your pocket?"), and *storytelling*, which is inherently socially oriented (Bleichrodt et al., 1984). In contrast to TD children, we were uncertain whether these general indices of imaginative capacity would in fact underpin genuine social anticipation in children with autism. Thus, we compared associations between imaginative capacities and social anticipation separately in TD children and children with ASD, and examined whether relations between these factors differed either quantitatively or qualitatively, controlling for individual differences in IQ.

Table 1. Age and full-scale IQ measures for TD and ASD children.

	TD (n = 71)			ASD (n = 64)			$t(133)$	d
	M	SD	Range	M	SD	Range		
Age	9.3	1.7	6.5–12.2	9.3	1.8	6.2–12.8	< 0.01	0
FIQ	104.0	14.7	70–139	103.6	14.9	75–145	0.14	0.03
ToM	0.8	0.4	0–1	0.6	0.5	0–1	2.26	0.44*
Fluency	49.7	17.5	21–99	44.9	18.7	8–87	1.54	0.27
Storytelling	55.5	17.2	21–105	54.4	14.9	22–102	0.41	0.07

TD: typically developing; ASD: autism spectrum disorder; FIQ: full-scale IQ; SD: standard deviation; ToM: Theory of Mind.
Cohen's d is included as an index of effect size.
*$p < 0.05$.

Method

Participants

Participants were 77 intellectually able children with ASD (69 boys) and 72 TD children (68 boys). Of the participants, 1 TD child and 13 children with ASD were excluded from the analysis due to missing data, resulting in a sample of 64 ASD (59 boys) and 71 TD (67 boys) children. No differences were found between the ASD children with or without missing data in terms of age, verbal IQ, or total IQ. After obtaining parental consent, children with ASD were recruited from specialized schools for children with ASD. School admission criteria included a normal IQ (> 70) and a clinical diagnosis of ASD. The clinical diagnoses of all children with ASD were thus established prior to the current project, by independent psychiatrists and psychologists, according to *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; DSM-IV-TR; American Psychiatric Association, 2000) criteria. The diagnostic process included extensive psychiatric and neuropsychological examinations by multiple informants, including psychiatrists and psychologists. Children from the TD comparison group were recruited via public primary schools in the vicinity of Amsterdam. Children were matched group-wise on chronological age and intelligence measures (Table 1). Intelligence measures were obtained by administering an abbreviated version of the Wechsler Intelligence Scale for Children III (WISC-III) (Kort et al., 2002). The medical ethical committee of the VU University Medical Center approved the project (project number 05/138).

Materials

Theory of Mind. Children completed a widely used second-order false-belief (FB) task derived from Sullivan et al. (1994). The task included a description of a child who was to receive a gift from a parent and when the child by mistake finds out what the gift is. A series of probe and control questions were asked to ensure children followed the story. After each probe or control question was answered, feedback or correction was provided to the child. Finally, the second-order FB question was asked on second-order ignorance, belief and justification, aiming to assess participant's abilities to acknowledge what the parent thought/knew about what the child thought/knew. Children were prompted to justify their response. Children who provided an incorrect answer to one or both second-order questions received a score of zero, while children who answered both correctly—displaying better second-order reasoning—received a score of one.

Ideational fluency. Ideational fluency was derived from Bleichrodt et al. (1984). In this task, children were first asked a practice question ("Have you ever had something in your pocket?") and prompted to name as many objects that could go in their pocket within 120 s. Following the practice item, children asked a further five questions (e.g. "What can you drink?"; "What can you lift?") and were instructed to generate as many items as possible that were consistent with that category. For instance, "try to name as many things that you can put in your pocket." Children had a time limit of 60 s to respond to each item (Bleichrodt et al., 1984). The minimum possible score was zero, with no fixed maximum. Larger scores indicate greater fluency.

Storytelling. The storytelling task captures several facets of imagination within the context of a prompted but child-generated narrative (Bleichrodt et al., 1984). In the storytelling task, children were presented with two pictorial scenes, a garden and a kitchen, that represent a series of events that are about to unfold (e.g. a cat being chased by a dog that is on a lead attached to a ladder with a child standing on it). The pictures featured various objects and individuals, and participants were required to generate a story about what may happen next. Children's scores on this task were comprised of the following: (1) the number of units (single words referring to objects like a tree or a dog, ranging between 0 and beyond) children provided for each scene, (2) the number of relations between units (e.g.

the dog is pulling the robe, ranging between 0 and beyond), and (3) the complexity of the plot, composed of qualitative measures reflecting whether the participant was told a comprehensive story, including two or more relations, using adequate structure and grasping the central meaning of the story reflected in the picture (scores ranging from 4 (incomplete plot without a core) to 12 (complete plot with core). Larger scores indicate greater storytelling ability.

Social anticipation. In this novel task, the experimenter informed the child of the following:

> In a moment I'll just leave the room and then someone else will come in to talk to you. The person wants to know more about the children who participate in this study. We'll just wait here, it will take a few minutes. Just stay seated, I need to check some paperwork in the meantime.

After 60 s, the experimenter asked the child a series of questions in a relaxed but structured manner regarding the other person and the interaction the child expected to have with him/her. First, children were asked a question requiring them to provide a spontaneous and non-prompted response: "What were you thinking about just now?" Children who did not mention the interviewer were told "Now think about this person that is coming to talk to you" and given 15 s before being asked the test questions (below). For children who did mention the interview or the interviewer, the test questioned followed directly after the prompt.

The test questions, which were given in a fixed order and designed to be delivered in a conversational manner, consisted of two questions about features of the interviewer ("What were you thinking about that person, have you figured out if the person will be a man or woman?"; "Have you thought about how old or young the person will be?") and two about the imagined content of the interaction ("Have you thought about what that person might ask you?"; "Have you thought about what you might say?"). For simplicity, we refer to these questions, respectively, as *gender, age, what-ask*, and *what-say*. When children provided information about features of the interviewer or the content of the interview, they were asked clarification questions: "What gender?"; "What age?"; "What then?"; and "What else?"

Following questioning, the experimenter went outside to collect the interviewer. After a moment, the experimenter returned and informed the child that the interviewer was, unfortunately, unable to attend and that they would just continue to the next task.

Procedure

Children were tested individually in a quiet part of their school, during a 20-min session. The WISC-III was administered in a separate session within 2 weeks before or after the imagination and social anticipation tasks. All sessions were audiotaped and transcribed. Transcriptions were scored by two independent coders (graduate students).

Scoring

Theory of Mind. Children were scored as passing the second-order FB task when they showed second-order reasoning (e.g. "Mother does not know that the child knows what he will get for his birthday"), which included a response that revealed an understanding of the embedded thoughts of the protagonist on the thoughts of another story character, and included an appropriate justification according to the taxonomy of Sullivan et al. (1994). Inter-rater reliability for the second-order FB task was excellent (Cohen's kappa = 0.99).

Ideational fluency. Children's score on this task was the total number of unique and meaningful objects generated for each of the five prompted categories. Reliability across these five items was good (α = 0.85) and consistent with past research (α = 0.86; Verschueren and Marcoen, 1999).

Storytelling. As per Bleichrodt et al. (1984), the participant has to tell as much as possible about a picture and about what could happen to the persons or objects in the picture. The total score of the child is composed of both quantitative and quantitative measures described above. Reliability across the storytelling measures was moderate (α = 0.66), consistent with previous research with Dutch children (α = 0.68; te Nijenhuis et al., 2004).

Social anticipation. Children's responses to the non-prompted question and each of the four questions in this task were categorized as follows. Responses to the gender question were coded as either *man* or *woman*. In instances where children replied that they had not considered the gender of the interviewer, their response was coded as *don't know*. Responses to the age question were coded as *old, young, in-between*, or *don't know*. The what-ask and what-say questions were coded in a trichotomous fashion, scoring 2 for any response regarding what the interviewer would ask (e.g. "what I have done today") or what the children would say (e.g. "that we have been working on math") that was specific to the interview context, 1 for non-specific statements (e.g. "Anything and everything," "the things they ask"), and 0 for failing to report the anticipated content. Inter-rater reliability based on two raters who rated all children, but were blind to the diagnostic categories of the participants, was satisfactory (Cohen's kappa ranged from 0.76 to 0.95). All disagreements were resolved by discussion.

Results

Table 1 shows the background characteristics (age and full-scale IQ (FIQ)) by *group* (children with ASD vs TD

children) and confirms that the groups were closely matched. Table 1 also confirms that ASD children were, relative to TD children, poorer at Theory of Mind, a finding well replicated in the literature. Finally, Table 1 shows that on the formal, structured tests of imagination, there were no significant differences between TD children and their ASD counterparts. Subsequent results are presented in three sections. First, we examine children's social anticipation and compare the performance of children with ASD to their TD counterparts. Second, using correlational analyses separated by group, we examine whether social anticipation is related to imaginative abilities and Theory of Mind, and the nature of the association between other study variables in children with ASD and TD children. Finally, we use separate ordinal logistic regression models to evaluate the contribution of imaginative abilities and Theory of Mind to children's social anticipation in children with ASD and TD children.

Between–diagnosis group comparisons

For the question intended to elicit a spontaneous, largely unprompted response ("What were you thinking about just now?"), the majority of children (57.5%) either said that they did not know or that they were thinking about nothing, while only 11.2% expressly mentioned the interview or the interviewer (11.3% of TD children and 11.1% of children with ASD). The remaining children reported some other topic. A chi-square analysis confirmed that there was no systematic bias in reporting by diagnosis group, $\chi^2_{(3, N = 134)} = 4.09$, $p = 0.252$.

For the first two questions, relating to features of the interviewer, a high proportion of children said that they did not know whether the interviewer was male or female (38.5%), or how old the interviewer was (27.4%). When analyzed by group, most TD children (47.9%) and children with ASD (42.2%) indicated that the interviewer was likely to be a woman, and there was no difference in the prediction of gender by group, $\chi^2_{(2, N = 135)} = 0.70$, $p = 0.704$. Similarly, group was unrelated to age predictions, $\chi^2_{(3, N = 135)} = 5.61$, $p = 0.132$.

For the second two questions about the imagined content of the interaction, children's reluctance to provide a response was more marked, with 53.3% and 61.5% of children saying they did not know in response to the what-ask and what-say questions, respectively. A small proportion of children provided non-specific responses to what-ask (8.9%) and what-say (11.1%) questions, while the remainder gave specific responses to what-say (37.8%) and what-ask (27.4%). Chi-square tests did not reveal any significant group differences in response patterns for what-ask or what-say questions. Owing to the small number of children who provided non-specific responses to what-ask and what-say, we decided to re-code responses in a dichotomous fashion, such that both specific and non-specific

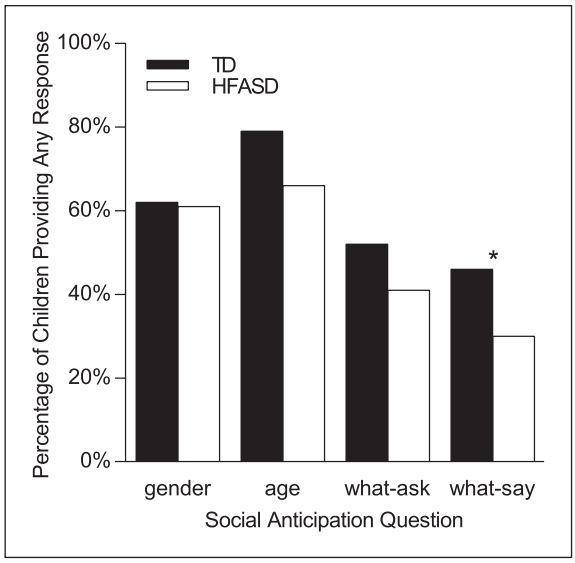

Figure 1. Percentage of children with HFASD or TD who responded to the four social anticipation questions.
HFASD: high-functioning autism spectrum disorder; TD: typically developing.
*$p < 0.05$.

responses were coded as 1.[1] Chi-square analysis confirmed that there was no significant group difference in TD (52.1%) and ASD (40.6%) children's tendency to provide a response about what they would ask, $\chi^2_{(1, N = 135)} = 1.79$, $p = 0.182$. However, there was a small, but systematic, difference in the tendency of TD (46.4%) and ASD (29.6%) children to provide a response to what they would say, $\chi^2_{(1, N = 135)} = 4.01$, $p = 0.045$, $\varphi = 0.17$.

Thus, across the four questions, a basic distinction emerged between children who produced answers—whether features of the imagined interviewer or imagined interview content —and those who did not. Figure 1 shows the percentage of children producing answers to each of the four questions by group. For subsequent analyses, we generated a 0–4 *total response* score by summing the four questions, and we generated two 0–2 sub-total response scores, one each for *features* (gender + age) and *content* (what-ask + what-say). Each single unit increase on these scores indicated that a response was made, such that 0 indicated no response. A one-way analysis of variance (ANOVA) was used to examine between group differences in the total response score. Overall, TD children ($M = 2.3$; standard deviation (SD) = 1.20) were more likely to generate any response than their ASD counterparts ($M = 1.8$; SD = 1.30), and this difference, while small, was significant, $F_{(1,132)} = 4.98$, $p = 0.027$, $\eta^2 = 0.04$.

Bivariate correlations

Table 2 shows bivariate correlations between background (age and FIQ) and task (Theory of Mind, ideational

Table 2. Bivariate correlations for individual differences measures and social anticipation responses.[a]

Study variables	1	2	3	4	5	Social anticipation					
						TD			ASD		
						Features	Content	Total[b]	Features	Content	Total[b]
1. Age	–	0.28*	0.38**	0.59**	0.5**	−0.07	0.12	0.06	0.20	0.31*	0.31*
2. FIQ	0.06	–	0.36**	0.28*	0.43**	−0.13	0.14	0.01	−0.08	0.06	−0.02
3. ToM	0.36**	0.44**	–	0.29*	0.45**	0.09	0.29*	0.23	0.00	0.02	0.06
4. Fluency	0.49**	0.26*	0.25*	–	0.47**	0.00	0.31**	0.27*	0.18	0.27*	0.24
5. Storytelling	0.31*	0.31**	0.16	0.17	–	0.04	0.36**	0.31**	0.28*	0.09	0.21

TD: typically developing; ASD: autism spectrum disorder; FIQ: full-scale IQ; ToM: Theory of Mind.
[a]Children with ASD appear below the diagonal.
[b]Total scores represent the sum of children's responses to the features questions (gender + age) and the content questions (what-ask + what-say). Spearman's rho was used for the above correlations.
* $p < 0.05$; ** $p < 0.01$.

fluency, and storytelling) variables and the relations between these variables and social anticipation for TD children and children with ASD separately. Spearman's rho was used due to the ordinal properties of the social anticipation scores. Regarding correlations between independent variables, a number of findings are of note. First, there was a robust correlation between background characteristics (age and FIQ) and imagination measures (ideational fluency and storytelling) for both groups. However, whereas Theory of Mind was related to fluency in a similar fashion for both groups, the correlation between Theory of Mind and storytelling, which taps social imagination, was only significant for TD children. Regarding correlations with social anticipation, Table 2 shows that Theory of Mind, fluency, and storytelling were all modestly, positively correlated with TD children's responses to the content questions (what-ask and what-say), as predicted. For children with ASD, however, the pattern of correlations was very inconsistent. Fluency and age were both correlated with children's responses to content questions, while storytelling was correlated with feature responses. Only age was correlated with the sum of children's responses.

Regression models

In order to determine the unique contribution of children's imaginative abilities to their social anticipation (*content*: what-ask + what-say), a series of ordinal logistic regression models were run, separately for TD children and children with ASD but including the same independent variables. In the first model (see Table 3), we examined the influence of the background characteristics (age and FIQ[2]) on social anticipation. For TD children, the model was not significant, $\chi^2_{(2,\ N=71)} = 2.25$, $p = 0.324$, and neither age nor FIQ contributed significantly to children's social anticipation. For children with ASD, the model was marginally significant, $\chi^2_{(2,\ N=64)} = 5.98$, $p = 0.050$, and the Nagelkerke pseudo-R^2 indicated that the overall model explained 10.4% of the variance in children's social anticipation. Only age emerged as a significant predictor of social anticipation.

In the second model, we examined the influences of Theory of Mind and imaginative abilities (i.e. ideational fluency and storytelling) once background variables were controlled for. For TD children, the model was significant, $\chi^2_{(2,\ N=71)} = 21.46$, $p = 0.001$, Nagelkerke pseudo-R^2 = 0.30. Table 3 shows that both fluency and storytelling were robust independent predictors of social anticipation. Also, as TD children got older, controlling for other variables, there was a tendency for them to generate fewer responses. By contrast, for children with ASD, the model was not significant, $\chi^2_{(2,\ N=64)} = 8.32$, $p = 0.140$. Furthermore, with the other variables in the model, the influence of age on social anticipation in children with ASD became only marginally significant.

Discussion

Although previous studies have reported that children and adults with ASD may have deficits in cognitive aspects of future orientated thinking (Lind and Bowler, 2010; Terrett et al., 2013), this study is the first to test these skills in a genuine social context. Using a novel and ecologically valid task, we found that intellectually able children with ASD did not systematically differ from TD children in their tendency to report on either the anticipated features (gender, age) of a person who will interview them in the near future or on what this person might ask them. However, they were less likely to state *their* response, that is, what they would say to the other person. When all questions in the social anticipation task were considered together, children with ASD were less likely to provide responses than TD children. Furthermore, consistent with previous research (Lind and Bowler, 2010), this study showed that imaginative abilities of children with ASD did not differ from those of TD children when measured using a structured laboratory-style task.

Table 3. Summary of ordinal logistic regression analysis for background and imagination variables predicting responses to content questions for TD and ASD children.

Model	Predictor	TD			ASD		
		β (SE)	Wald's χ^2	e^{β} (95% CI)	β (SE)	Wald's χ^2	e^{β} (95% CI)
1	Age	0.08	0.37	1.09	0.34	5.31*	1.41
		(0.14)		(0.83–1.43)	(0.15)		(1.05–1.88)
	FIQ	0.02	1.28	1.02	0.01	0.09	1.01
		(0.02)		(0.99–1.05)	(0.02)		(0.97–1.04)
2	Age	−0.43	4.44*	0.65	0.33	3.09***	1.39
		(0.20)		(0.44–0.97)	(0.19)		(0.96–2.00)
	FIQ	−0.01	0.24	0.99	0.01	0.14	1.01
		(0.02)		(0.95–1.03)	(0.02)		(0.97–1.05)
	ToM	0.76	1.41	2.13	−0.65	1.08	0.52
		(0.64)		(0.61–7.43)	(0.62)		(0.15–1.77)
	Fluency	0.05	6.76**	1.05	0.02	1.31	1.02
		(0.02)		(1.01–1.08)	(0.02)		(0.99–1.05)
	Storytelling	0.05	6.74**	1.05	0.00	<0.01	1.00
		(0.02)		(1.01–1.09)	(0.02)		(0.96–1.04)

TD: typically developing; ASD: autism spectrum disorder; FIQ: full-scale IQ; ToM: Theory of Mind; SE: standard error; CI: confidence interval.
df = 1 for all predictors.
* $p < 0.05$; ** $p < 0.01$; *** $p = 0.08$.

The abilities predicting performance on the social anticipation task varied between groups. The likelihood that children with ASD would generate examples of the interaction appeared unrelated to generative and storytelling aspects of their imaginative abilities. Although generative ability was positively correlated with the generation of content for anticipated interaction, it did not predict social anticipation performance while controlling for age. Conversely, these same domains of imagination were found to be strong predictors for whether or not TD children would provide responses to the questions. These findings highlight that it is critical to study *how* children generate a particular form of response, rather than focusing exclusively on idiosyncrasies in the response itself. Despite performing equivalently on tasks assessing basic imaginative abilities, TD children and children with ASD may differ in the relation between these abilities and their navigation of social interactions. For TD children, two overlapping domains of imaginative thinking, ideational fluency and storytelling, appear to be related to social anticipation task performance. We speculate that for TD children, anticipating a social encounter may involve actively imagining how the interaction could unfold, and that this "pre-experiencing" (Lind and Bowler, 2010) at least partially guides their behavior in the present. By contrast, laboratory tasks designed to assess imagination did not predict social anticipation performance in children with ASD.

Given that age was a significant positive predictor of social anticipation performance for the ASD group, it is possible that children with ASD are relying on analytical strategies that are effortful, but improve with the accumulation of social experience. For example, older children in this group may have developed increasingly complex scripts, guided by the diverse range of social encounters they have previously experienced. Relatively deprived of such experiences, the scripts of younger children would be expected to be considerably less comprehensive and consequently less able to guide their responding during an anticipated social interaction. While increases in age-predicted responsiveness in children with ASD, this relation was reversed in TD children. We suspect that this inverse relationship may be an artifact that occurred because the predictors that improve with age *and* predict social anticipation performance in TD children are included in the model and controlled for.

Theory of Mind did not uniquely predict social anticipation performance, but was correlated for TD participants. This may be because the task used to assess Theory of Mind reflects a different—and only partially overlapping—facet of social cognition than used in the social anticipation task, and when imaginative abilities are controlled for, it is not associated with performance. The Theory of Mind task used in this study presented children with a largely complete depiction of fictional events and required them to adopt a second-order perspective to correctly determine the possible intentions or actions of someone in the series of events. This differed from the social anticipation task which required children to first adopt—and infer—the intentions and possible goals of someone they know very little about and then to rapidly model their own response. The preparation for an *actual* social encounter may differ from anticipating on the actions and intentions of a hypothetical character, and the former may not

require the skills associated with the latter. That is, anticipating the dialogue of a real social interaction may rely more on imaginative abilities that facilitate such forward modeling than the social cognitive skills inferred by the Theory of Mind task used in this study.

We note, however, that the preceding interpretation assumes a specific causal direction between imaginative abilities and the anticipation of social interactions, in which imagination facilitates social interactions. This assumption may be incorrect, insomuch as the development of children's social skills—including what we have referred to as social anticipation—may facilitate the acquisition of imaginative abilities. This is a distinction that requires further investigation.

The difficulty of children with ASD in anticipating their own responses may be due to limitations in switching between an *egocentric* stance—in which the perspective of another person is understood only relative to the self—and an allocentric stance—in which the other person's perspective is abstract and unrelated to the self (see Frith and De Vignemont, 2005). The children in our study may have been able to adopt an allocentric stance with respect to the hypothetical interviewer's perspective, irrespective of ASD diagnosis; children with ASD were equally able as their TD peers to anticipate what the interviewer might ask. However, children with ASD found it more difficult to re-adopt their own position in order to generate an exemplar of what *they* would. Similar limitations have been observed in the practical use of episodic future thinking. Jackson and Atance (2008) report that children with autism performed poorly on tasks reliant on imagining the self in the immediate future (e.g. correctly stating the order they would put a costume on), relative to ability to imagine the consequences of mechanical processes (e.g. selecting a ball that would knock over a domino). Lind and Bowler (2010) argue that autism is associated with a difficulty in adopting a "field perspective" in which the child imagines and anticipates events from their own point of view. Instead, they appear to remember the past and imagine the future from the perspective of an outside observer, an allocentric, rather than egocentric, stance. However, such an explanation for this study is tentative, as the above literature focuses either on non-social activities or social behaviors that are not explicitly anticipatory in nature.

The results of these findings should be considered with the following limitations in mind. First, over half of all TD and ASD children were non-responsive to the social anticipation task. However, because non-responses were factored into the logistic regression models, it is possible to draw some tentative conclusions about the mechanisms that distinguish children who will generate responses from those who do not. Second, the wording of the first feature question (man–woman) differs from subsequent questions. Rather than asking children whether they had *thought* about the features of the anticipated interviewer or the content of the interview, the man–woman question asked children whether they had *figured out* the interviewers' gender. The difference in phrasing between *thought* and *figured out* may have been interpreted by children as asking about different aspects of their thoughts. Third, although both content questions (what-ask and what-say) were designed to be open ended, it is possible that children's responses were directed by the content and context of an interview. It is unclear to what extent children—particularly those with ASD—would display similar patterns of behavior in a less constrained and directed context. Fourth, we did not investigate children's behavior when the anticipated interview transpired, precluding any conclusions about the relation between children's anticipation of social interactions and subsequent behavior. In addition to the clarification of causality with respect to imagination and social anticipation, describing how children's anticipation of social encounters maps to their actual behavior is an important direction for future research. Fifth, the order of social anticipation questions was not counter-balanced across participants. Sixth, this study did not control for social engagement motivation. Given that past research has reported that ASDs are associated with reduced sensitivity to reward in social contexts (Scott-Van Zeeland et al., 2010), it is possible that ASD children in this study were less motivated than TD children to anticipate the interaction or to engage with the experimenter. Moreover, lack of motivation to participate—or anxiety—may have been a systematic confound regardless of diagnosis. Furthermore, this study did not include a measure of children's episodic memory abilities, which has been argued to provide, "… the vocabulary for constructing mental representations of the future" (D'Argembeau et al., 2010: 810) and is highly correlated with episodic future thinking, particularly in individuals with ASD (Lind and Bowler, 2010; Terrett et al., 2013). Finally, this study is limited by the absence of standardized diagnostic instruments. Despite these limitations, however, this study has a considerably larger sample of children with ASD than previous research in related domains, and all children received a clinical diagnosis of ASD based on extensive diagnostic assessments.

Anticipating the form that future events may take allows humans to modulate their behavior in a flexible and adaptive—rather than reactive—fashion. In this study, we found that intellectually able children with ASD are atypical in how they anticipate social interactions. Unlike TD children, who appear to use their imagination to navigate an expected interaction, children with ASD are less likely to reflect on their own contribution to the future interaction, and moreover, they do not seem to draw on the imaginative abilities they reveal in laboratory-style tasks of imagination. These findings suggest that far from being inherently impaired in their ability to anticipate social interactions, children with ASD are atypical in *how* they go about this activity.

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Notes

1. While there may be characteristics that distinguish children who provided non-specific responses from those who either did not respond or offered specific statements, the limited number of children who did the former—as low as 4 children in one group—precludes interpretable statistical analysis.
2. Substituting full-scale IQ (FIQ) for verbal IQ did not alter any of the reported effects. Therefore, we report only the results of the regression models using FIQ.

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