

# Metaperception in Adolescents With and Without Autism Spectrum Disorder

Lauren V. Usher<sup>1,3</sup>  · Catherine A. Burrows<sup>1</sup> · Daniel S. Messinger<sup>1</sup> · Heather A. Henderson<sup>2</sup>

© Springer Science+Business Media, LLC 2017

**Abstract** This study compared how adolescents with and without autism spectrum disorder (ASD) evaluated unfamiliar peers (i.e., perceptions), as well as how adolescents believed they were evaluated by peers (i.e., metaperceptions). The Perceptions and Metaperceptions Questionnaire was designed to quantify perceptions and metaperceptions following a live interaction. For all adolescents, more positive perceptions of the peer were associated with more positive metaperceptions. Adolescents with ASD exhibited more accurate metaperceptions than did typically developing adolescents. More positive perceptions and metaperceptions were associated with higher levels of observed social competence across groups. Findings extend our understanding of typically and atypically developing adolescents' impressions of unfamiliar peers and their ability to discern what peers think of them.

**Keywords** Autism spectrum disorder · Adolescence · Social cognition · Metaperception · Perception · Social competence

## Introduction

As youth transition from childhood to adolescence, the way they are viewed by their peers becomes increasingly salient. Adolescents expand their self-identities as

perspective-taking skills develop (Somerville et al. 2013), and those who consider others' perspectives are more socially successful than those who do not (Fett et al. 2014). Researchers have investigated what people think about the way that peers evaluate them in the laboratory, in the classroom setting, and online (Malloy et al. 2007; Pozo et al. 1991; Sherman et al. 2001). However, little is known about the degree of accuracy between how adolescents, and particularly those with autism spectrum disorder (ASD), *think* peers evaluate them and how peers *actually* evaluate them, and how each of these factors relate to observed social competence when interacting with an unfamiliar peer.

During social interactions, people interpret behaviors in order to form perceptions of others. Metaperception is the ability to form ideas of what social partners think of us during social interactions (Laing et al. 1966). At the core of an ASD diagnosis are social-communication challenges (American Psychiatric Association 2013), which may be exacerbated during adolescence (Picci and Scherf 2015). Problems with metaperception may be associated with the social-communication problems evident in dyadic social interactions in ASD and may be especially evident during this critical developmental period. The purpose of this study was to quantify perception and metaperception abilities of adolescents with and without ASD in dyadic interactions with unfamiliar peers using a novel self-report measure, and to examine perceptions and metaperception in relation to observed social competence.

## Metaperception

Laing et al. (1966) coined the term *metaperception* to refer to a person's ability to consider another person's impressions. Metaperception, sometimes referred to as reflected self-appraisal (Pfeifer et al. 2009), involves the ability to

✉ Lauren V. Usher  
usher3@wisc.edu

<sup>1</sup> University of Miami, Coral Gables, FL, USA

<sup>2</sup> University of Waterloo, Waterloo, ON, Canada

<sup>3</sup> University of Wisconsin-Madison Waisman Center, 1500 Highland Avenue, Room 531A, Madison, WI 53705, USA

see oneself from another individual's perspective (Oltmanns et al. 2005), and is typically assessed in dyadic interactions (e.g., Cooper 2005). Although theory of mind, the ability to ascribe mental states such as beliefs and emotions to oneself and to others (Baron-Cohen 2001), is necessary for metaperception, metaperception is a more advanced skill involving the integration of self- and other-perceptions. Given that theory of mind does not account for all variation in social competence, other within-child characteristics must be involved (Cooper 2009; Klin 2000).

Early in development, children form mental representations that allow for interpretation of others' mental states (Siegel 2001). By middle childhood, children are able to form ideas about what other children think of them (Malloy et al. 2007). Further, the literature on reputation management suggests that children understand that they can influence the views that others have of them (Banerjee 2002). During adolescence, individuals are often highly focused on what peers think of them as they develop advanced concepts of the self (Somerville et al. 2013) and continue to develop their reputation management skills. Measurement of metaperceptions is not consistent across research studies, but examinations of convergent validity reveal that more positive metaperceptions are associated with higher levels of positive and even inflated self-views. Specifically, positive metaperceptions are associated with higher self-esteem (Pfeifer et al. 2009) and higher narcissism (Carlson et al. 2011), in typically developing adolescents and young adults.

Metaperception may aid people in responding appropriately during social interactions (Carlson and Kenny 2012; Hall and Andrzejewski 2008). Accurate metaperception may help individuals gain self-knowledge and make behavioral changes in response to social partners' cues (Carlson and Kenny 2012). Moreover, simply taking a peer's perspective can increase reciprocity in social interactions (Fett et al. 2014). It is unclear from previous literature whether metaperception *accuracy* is critical, or whether simply taking someone else's perspective is sufficient to impact social behavior. When accuracy, or the extent to which metaperceptions are congruent with a social partner's evaluations, is examined empirically, findings are mixed depending on the context, history with the social partner, types of characteristics evaluated, and whether accuracy is based on dyadic or group interactions (Carlson and Kenny 2012). In many situations, adolescents and adults are not accurate in predicting how others rate them, particularly when they are asked to predict specific people's impressions rather than the impressions of others in general (Kenny and DePaulo 1993; Ranta et al. 2016).

## Autism Spectrum Disorder

The study of metaperception in ASD may provide insight into mechanisms that support or hinder the development of social competence (Garfield et al. 2001). Although some individuals with ASD perform well on theory of mind measures, difficulty in social interactions persist, suggesting that the flexible implementation of social skills involves more complicated processes (Scheeren et al. 2013). During real-world interactions, individuals must quickly multitask by attending to social partners' cues, planning their own behaviors and responses serving as cues for others, imagining the perspectives of others, all while attending to conversational content (Gilbert et al. 1988). Because of the "busy" nature of a social interaction, individuals with ASD may form faulty or incomplete metaperceptions that are not in line with what the social partner is thinking.

However, the study of reputation management in the ASD literature reveals that individuals with ASD are not only able to understand that they have reputations in others' eyes, but also that they can change the way they represent themselves when being evaluated (Begeer et al. 2008; Cage et al. 2016a). For example, Scheeren et al. (2016, 2010) demonstrated that adolescents with ASD strategically used more positive words to describe themselves when told they were being evaluated, although to a lesser extent than TD adolescents. Given evidence that adolescents with ASD possess awareness of their reputations amongst peers, it is important to understand to what extent individuals with ASD may be accurate in their metaperceptions.

No previous studies have investigated the accuracy of metaperception in adolescents with ASD. Additionally, previous studies in both typical and atypical literature assessing components of metaperceptions are limited in their ecological validity and often use informants who have long social histories with the target individual. For example, in previous work, participants have considered hypothetical social interaction vignettes (e.g., Ranta et al. 2016), responded to one or two questions indexing perceptions and metaperceptions (e.g., Pozo et al. 1991), or assessed metaperceptions of familiar classmates' impressions that involve factors based on previous interaction history (Ranta et al. 2016). In contrast, in the present study, the examination of adolescents' perceptions and metaperceptions of unfamiliar peers will increase our understanding of these constructs following a brief social interaction with an unfamiliar peer.

## Present Study

There is a lack of research on metaperception in adolescents, and in those with ASD. To address this gap in research, we first examined the psychometrics of the novel Perceptions and Metaperceptions Questionnaire. We hypothesized that,

consistent with previous literature and supporting the validity of the measure, more positive metaperceptions would be positively correlated with measures of self-esteem and narcissism for all adolescents (with the opposite true for negative metaperceptions). We did not expect significant associations of perceptions with either self-esteem or narcissism. Second, we examined the relation between theory of mind and metaperception accuracy in adolescents with and without ASD, predicting moderate positive correlations. Third, we compared metaperception accuracy in adolescents with and without ASD. We hypothesized that adolescents with ASD would show greater discrepancy between their metaperceptions and their peers' actual ratings than would adolescents without ASD. Fourth, we examined associations between perceptions and metaperceptions and one's own social competence, hypothesizing that for all adolescents more positive metaperceptions would be associated with social competence as it may aid in the reciprocity and flow of the interaction.

**Method**

**Participants**

The sample consisted of 50 individuals (25 with ASD, 25 without ASD) between 12 and 16 years of age ( $M_{age} = 14.40$ ,  $SD = 1.41$ ) who participated in a study investigating social and behavioral functioning. See Table 1 for sample characteristics. Recruitment for participants with ASD was carried out through emails sent to families registered with the Center for Autism and Related Disabilities (CARD) at the University of Miami. Recruitment for adolescents without ASD, referred to as the typically developing (TD) group, was completed (1) using a commercially available list of

families in the community with children in the appropriate age range (12 to 16 years of age), and (2) through the Miami-Dade County Public Schools system, and (3) through community groups. Families who had previously participated in research at the University of Miami and consented to being contacted for future studies were also contacted.

Adolescents were included in the ASD group if they had a community diagnosis, met diagnostic criteria for ASD (score of 7 or above) on the Social Affect score of the Autism Diagnostic Observation Schedule-Second Edition (ADOS-2; Lord et al. 2012), and met diagnostic criteria for ASD on either or both the Social Communication Questionnaire (SCQ; Berument et al. 1999; clinical cutoff > 12) and Autism Spectrum Screening Questionnaire (ASSQ; Ehlers et al. 1999; clinical cutoff > 13). Participants in the TD group were excluded if they met the clinical cutoff on either the SCQ or the ASSQ.

Eighty-five individuals were ascertained for the study, and 81 completed one of two study visits. Seven participants were excluded for not meeting group diagnostic criteria. Twenty-four individuals did not complete the second study visit during which the social interaction paradigm was carried out, due to scheduling conflicts or lack of an age- and IQ-matched peer. The 50 participants in the final sample were ethnically-diverse—Hispanic (60%), non-Hispanic (40%), with racial categories of White/Caucasian (68%), Black/African American (16%), mixed or other (12%), and not reporting (2%). Parents had 4-year college degrees (33%), advanced or professional degrees (27%), some college (15%), high school degrees or less (14%) and 2-year college degrees (11%). Families' annual household incomes were \$50,000–74,000 (28%), greater than \$100,000 (28%), \$75,000–99,000 (14%), \$10,000–24,000 (10%), \$35,000–49,000 (10%), and less than \$10,000 (8%). Those who completed both visits did not differ from those

**Table 1** Sample characteristics

	Diagnostic group				Differences within dyads		Group differences	
	ASD		TD		t value	Cohen's d	F value	Cohen's d
	Mean (SD)	Range	Mean (SD)	Range				
Gender	17 M, 8 F	–	17 M, 8 F	–	–	–	–	–
Age (years)	14.66 (1.43)	12.13–17.67	14.21 (1.34)	12.05–16.71	3.30**	0.94	1.33	0.11
Verbal IQ	105.00 (14.79)	77–134	108.48 (13.83)	71–128	–1.32	–0.38	0.74	0.25
ADOS	12.00 (4.22)	7–20	–	–	–	–	–	–
SCQ	19.53 (7.47)	4–29	4.40 (3.49)	0–11	10.30***	2.94	82.39***	2.62
ASSQ	21.67 (8.62)	5–35	3.44 (3.18)	0–10	10.74***	3.10	98.07***	2.89

Differences within dyads refer to paired-samples analyses

ASD autism spectrum disorder, TD typically developing, ADOS autism diagnostic observation schedule, SCQ Social Communication Questionnaire, ASSQ Autism Spectrum Screening Questionnaire

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$

who completed one visit on age, gender, race/ethnicity, parent education, autism symptom severity, or theory of mind ( $ps > 0.05$ ). However, participants completing both visits had significantly higher verbal IQ ( $M = 106.74$ ,  $SD = 14.28$ ) than those who completed one visit ( $M = 96.90$ ,  $SD = 18.30$ ),  $t(79) = -2.70$ ,  $p = .01$ .

## Procedure

This study was approved by the University of Miami Institutional Review Board. Parents and adolescents completed written informed consent and assent, respectively, in the laboratory. A brief version of the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler 2003; described below), was administered. Adolescents with ASD were administered the Autism Diagnostic Observation Schedule (described below). Parents completed the SCQ and ASSQ. Participants completed a theory of mind assessment, described below, individually.

In a second visit in the laboratory, adolescents interacted with an unfamiliar peer (matched on gender, age, and verbal IQ). Dyads were composed of one adolescent with ASD and one adolescent without. Adolescents and parents were unaware of the diagnostic status of the other adolescent. All participants were informed that they might feel uncomfortable meeting someone for the first time and that they could take a break or stop any part of the study. After consent/assent, each dyad was seated at a table together in a quiet observation room and told that they had 5 min to “get to know each other.” Previously developed coding schemes from our laboratory were adapted to quantify social competence during the video-recorded interaction (Usher et al. 2015). Immediately following this five-minute task, each participant completed a questionnaire rating the social partner on several characteristics (perceptions) and how he/she believed the peer answered the same questions about him/herself (metaperceptions). Participants were separated to ensure privacy, and were informed that there were no right or wrong answers, that their responses would be confidential, and they were given the opportunity to ask questions. Following the questionnaires, dyads completed additional tasks not reported here.

## Measures

### Intelligence

A brief version of the WISC-IV (Wechsler 2003), comprised of the vocabulary and similarities subtests, was administered to all participants to obtain a verbal comprehension index (VCI). These scales have high loadings on the VCI factor, strong test-retest reliabilities, and good internal consistencies among the WISC-IV scales (Williams et al. 2003).

### Observed Autism Spectrum Disorder Symptoms

The Autism Diagnostic Observation Schedule-Second Edition (ADOS-2; Lord et al. 2012) consists of a series of semi-structured activities that elicit social-communicative and repetitive behaviors associated with ASD. For this study, participants received a Module 3 for verbally fluent children/adolescents. Items are scored from 0 (no concern) to 3 (indicative of ASD). Cronbach's  $\alpha$  for the ADOS in this study was 0.90.

### Parent-Reported Autism Spectrum Disorder Symptoms

The Autism Spectrum Screening Questionnaire (ASSQ; Ehlers et al. 1999) is a 27-item instrument intended to screen for symptoms of ASD. Raters are asked to indicate whether a child “stands out as different from other children of his/her age” on each item by choosing “no”, “somewhat”, or “yes.” Scores range from 0 to 54, with higher scores indicating more symptoms. For this study, a cutoff score of 13 was used, as suggested by the developers.

The Social Communication Questionnaire (SCQ; Berument et al. 1999; Rutter et al. 2007) is a parent report instrument for screening ASD symptoms. It was developed from 40 critical items of the autism diagnostic interview (Lord et al. 1994). Parents choose “yes” or “no” in response to questions regarding children's current behavior and behavior between 4 and 5 years of age. For this study, the Lifetime SCQ total score was used as a measure of individual differences in ASD symptoms, and a cutoff of 12 was used. The Cronbach's  $\alpha$  for the SCQ in this study was 0.74.

### Narcissism

A version of the narcissistic personality inventory (NPI; Raskin and Hall 1979) created for adolescents' reading and comprehension levels (Calhoun et al. 2000) was used to obtain a measure of symptoms of narcissism, or exaggerated favorable self-appraisal. Overall, the measure is designed to index individual differences in narcissism traits, and not narcissistic personality disorder (Raskin and Hall 1979). The questionnaire has 40 forced-choice items consisting of pairs of statements in which adolescents were asked to choose the statement with which they identified most. For example, “I am just as good as everybody else” versus “I am a really great person.” Of interest in this study was the total score, for which higher scores indicate more narcissism traits. Cronbach's  $\alpha$  for the NPI in this sample was 0.86.

### Self-Esteem

The 36-item self-perception profiles for children (Harter 1985) was used to obtain an index of adolescents' general

self-esteem. Of interest for this study was the global self-worth score, which consists of six items designed to assess how much individuals generally like themselves. Questionnaire items consist of two statements, and adolescents are first asked to choose which statement is more like them. For example, “Some kids like the kind of person they are BUT other kids often wish they were someone else.” Second, they are asked to identify whether the chosen statement is “really” like them or “sort of” like them. Each response was scored on a four-point scale from 1 to 4, where 1 indicates the lowest perceived competence at 4 indicates the highest level of competence. Cronbach’s  $\alpha$  in this sample was 0.93.

### Theory of Mind

The strange stories task (Happé 1994) consists of 12 vignettes that assess the ability to attribute mental states to others. Participants were asked a comprehension question to confirm understanding of story events (“Was it true, what \_\_ said?”), followed by an open-ended question about why events happened (“Why did \_\_ say that?”). Responses were recorded in writing and audiotaped for later coding as correct or incorrect. Approximately 30% of Strange Stories responses were double-coded by two undergraduate research assistants, supervised by a graduate student. Cohen’s Kappa scores ranged from 0.79 to 1.00. A summary score was computed by adding the number of correct responses on the comprehension and open-ended questions. Higher scores indicate more advanced theory of mind abilities.

The reading the mind in the eyes task (Baron-Cohen et al. 2001) assesses the ability to recognize facial affect in 28 photographs of the eye region of different adult faces. Participants were asked to pick which of four words best describes what the person in each photo is thinking or

feeling. Responses were scored as either correct or incorrect. Higher scores indicate more advanced theory of mind abilities.

### Observed Social Competence

Video-recorded interactions were coded for each participant’s proportion of time talking, latency to first utterance, latency to first spontaneous utterance, frequency of sharing ideas, and frequency of seeking information from the peer. Global eye contact, conversational efficacy (turn-taking, answering and asking questions), and social ease were coded on 5-point scales ranging from 1 (behaviors hindering the continuation of a social interaction) to 5 (behaviors supporting the continuation of a social interaction). See Table 2 for an abbreviated description of codes. All recorded interactions were double-coded by the first author and a trained research assistant who was blind to the diagnosis of participants and study hypotheses, and interrater reliability was achieved with average measures intraclass correlations ranging from 0.75 to 0.99. Composite scores were created for use in analyses (see page 14).

### Perceptions and Metaperceptions

The 52-item Perceptions and Metaperceptions Questionnaire was given to each participant immediately following the observed social interaction. Perceptions of the peer (e.g., “How happy is [name of partner]?”) and metaperceptions (e.g., “How happy does [name of partner] think you are?”) were assessed on a 5-point scale from 1 (not at all) to 5 (the most). Items were split between positively-valenced (e.g., polite) and negatively-valenced (e.g., uncool) items. In addition, two items not examined in the present study assessed

**Table 2** Abbreviated version of the Get to Know You Task

Get to Know You Task: 5 min
1. Record total time talking and total length of task time to compute <i>proportion of time talking</i>
2. Record <i>latency to first utterance</i> from start time
3. Record <i>latency to first spontaneous utterance</i> from start time. A spontaneous utterance is an utterance that is not a response to a seek and/or initiates a new idea or topic
4. Code each utterance as one of the following
a. Share, e.g., “ <i>I used to be in the football team at my last school.</i> ”
b. Seek, e.g., “ <i>Have you seen Mortal Combat?</i> ”
5. Rate <i>eye contact</i> on 5-point scale, based on flexibility and coordination with verbal communication (1 = not coordinated with other communication, 5 = well-coordinated with other communication)
6. Rate <i>conversational efficacy</i> on 5-point scale, based on social pragmatics, including taking turns, answering and asking questions, and not revealing overly friendly information (1 = conversational skills rarely maintain flow of interaction, 5 = conversational skills maintain flow of interaction)
7. Rate <i>social ease</i> on 5-point scale, based on behaviors indicate comfort versus discomfort during the interaction (1 = Appears uncomfortable during social interaction; displays anxious behavior most of the time; little to no spontaneous affect, 5 = Displays comfort during social interaction, including flexible affect and no anxious behaviors)

Each participant in a dyad receives codes for every item

each participant's global evaluation of the interaction ("How well did your interaction with [name of partner] go overall?" and "How much would you want to continue a friendship with [name of partner] outside of the lab?"). These items were excluded from the present study's analysis because they did not assess metaperceptions, which was the primary focus of this paper.

For clarity, we use the terms "liking" and "disliking" to differentiate positively- and negatively-valenced adjectives. For example, positively-valenced perceptions reflect a person's ratings of liking for the peer, while negatively-valenced perceptions reflect ratings of disliking for the peer. Positively-valenced metaperceptions reflect a person's prediction of the peer's liking rating, and negatively-valenced metaperceptions reflect predictions of the peer's rating of disliking. See the [Appendix](#) for specific items.

Sums were created for perceptions of liking, perceptions of disliking, metaperceptions of being liked, and metaperceptions of being disliked by summing the scores for each group of items. Specifically, positively-valenced perception items were summed, negatively-valenced perception items were summed, and the same was completed for positively-valenced metaperception items and negatively-valenced metaperception items.

### Analytic Approach

First, we present psychometrics for the novel Perceptions and Metaperceptions Questionnaire, including reliability and validity for perceptions and metaperceptions and examination of mean differences between adolescents with and without ASD on main constructs of interest. Second, we used Pearson correlations to examine the associations between theory of mind and both perceptions and metaperceptions within diagnostic group. Third, actor-partner interdependence model (APIM) analyses, described below, were used to examine the association of an adolescent's perception of the peer with his/her own metaperceptions (actor effect), as well as the association of the peer's perceptions with the adolescent's metaperceptions (partner effect, indexing accuracy). Fourth, APIM analyses were used to examine the association of one's own metaperceptions (actor effect) and one's partner's perceptions (partner effect) with one's own observed social competence.

The Actor-Partner Interdependence Model (Cook and Kenny 2005; Kashy and Kenny 2000; Kenny et al. 2006) uses multilevel modeling to examine associations between the two members of a dyad, accounting for the interdependent behavior of the two individuals. This method is less biased for dyadic analyses than statistical tests that assume independence of observations, such as hierarchical regression analysis (Kenny and Ledermann 2010). Analyses examine both a person's effects on their own behavior

(actor effects), and a partner's effects on the person's behavior (partner effects). Two separate models can be run for each APIM analysis (Kenny and Kashy 2011; Kenny et al. 2006). The first model tests for group differences between adolescents with and without ASD. If there are significant group differences, a follow up model is conducted to obtain coefficients for each group.

## Results

### Preliminary Analyses and Data Reduction

All analyses were conducted in IBM SPSS Version 22. See Table 3 for descriptive statistics for all primary variables. See Tables 4 and 5 for correlations between all primary variables within each diagnostic group.

#### *Observed Social Competence*

To reduce the number of variables in subsequent analyses, consistent with previous practices used in our laboratory (Usher et al. 2015), inter-relations among observed behavioral codes were examined using Principal Component Analysis (PCA; Abdi and Williams 2010). Variables were entered into a PCA using a Varimax rotation and a two-factor solution was specified. Proportion of time talking, latency to first utterance (reversed), latency to first spontaneous utterance (reversed), and sharing loaded onto the first factor, labeled *Social Initiative*. Seeking, eye contact, conversational efficacy, and social ease loaded onto the second factor, labeled *Social Reciprocity*. See Table 6 for eigenvalues and loadings. Composite scores were created by standardizing (subtracting the mean and dividing by the standard deviation) and averaging the standardized scores (Z-scores) that loaded onto each component.

### Perceptions and Metaperceptions Questionnaire Psychometrics

#### *Reliability*

Cronbach's  $\alpha$  reliability coefficients were examined to index participants' internal consistency in responding to the questionnaire items. Values for Cronbach's  $\alpha$  were as follows: 0.90 for liking of the peer, 0.70 for disliking of the peer, 0.93 for metaperception of being liked, and 0.81 for metaperception of being disliked.

#### *Validity*

Correlations with theoretically related measures were examined across the full sample to ascertain the validity

**Table 3** Descriptive statistics for primary measures of interest

Measure Name	ASD				TD				F-value	Cohen's <i>d</i>
	<i>n</i>	<i>M</i>	<i>SD</i>	Range	<i>n</i>	<i>M</i>	<i>SD</i>	Range		
Narcissism	21	13.48	5.27	6–26	23	16.30	8.03	4–35	1.87	0.42
Self-esteem	22	2.76	0.50	1.83–3.50	22	3.08	0.57	1.67–3.50	4.17*	0.62
Theory of mind										
Strange stories	22	20.50	3.00	14–24	22	21.36	2.17	15–24	1.19	0.34
Reading the mind in the eyes	24	19.08	3.54	12–24	25	20.04	2.61	14–26	1.17	0.32
Observed Social Reciprocity	25	−0.31	0.84	−1.91–1.62	25	0.31	0.55	−1.04–1.29	9.59**	0.89
Seeking	25	7.72	6.55	0–27.50	25	10.12	5.25	1.5–22.0	2.04	0.41
Eye contact	25	3.46	1.25	1–5	25	4.20	0.80	2.5–5.0	6.20*	0.72
Conversational efficacy	25	3.42	0.90	1.5–5	25	4.16	0.77	2–5	9.75**	0.90
Social ease	25	3.68	1.24	1–5	25	4.30	0.58	3–5	5.13*	0.65
Observed Social Initiative	25	0.03	0.79	−2.06–1.14	25	−0.03	0.56	−1.11–1.11	0.11	0.10
Proportion of time talking	25	0.30	0.13	0.09–0.56	25	0.23	0.10	0.06–0.49	4.03†	0.58
Latency to first utterance	25	3.14	4.95	0–26	25	2.04	1.38	0–6	1.15	0.31
Latency to first spontaneous utterance	25	16.76	35.90	0–179	25	8.88	17.40	0–64.50	0.98	0.29
Sharing	25	25.34	8.56	7–38	25	22.68	10.18	2–39	1.00	0.29
Perceptions										
Positively-valenced adjectives	24	45.50	10.27	31–65	25	44.12	8.56	29–65	0.26	0.15
Negatively-valenced adjectives	22	20.50	5.88	12–32	24	21.79	5.38	14–33	0.61	0.24
Metaperceptions										
Positively-valenced adjectives	24	41.67	12.27	17–64	25	44.44	9.36	24–61	0.80	0.26
Negatively-valenced adjectives	24	23.75	7.31	12–40	24	21.75	6.58	13–47	0.99	0.29

ASD autism spectrum disorder, TD typically developing

†*p* < .10; \**p* < .05; \*\**p* < .01; \*\*\**p* < .001

**Table 4** Correlations between primary variables and age, ASD symptoms, and verbal IQ for group with ASD

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	–											
2. ASD symptoms	−0.39†	–										
3. Verbal IQ	−0.08	0.15	–									
4. Narcissism	−0.39†	0.40†	−0.45*	–								
5. Self-esteem	0.14	0.07	−0.45*	0.18	–							
6. Reading the mind in the eyes	0.25	0.16	0.51*	−0.36	−0.36†	–						
7. Strange stories	0.17	−0.13	0.13	−0.44†	−0.08	0.04	–					
8. Social Reciprocity composite	0.19	−0.16	−0.27	0.02	0.36	−0.20	−0.03	–				
9. Social Initiative composite	0.20	0.12	−0.26	0.12	0.33	−0.32	−0.17	0.55**	–			
10. Positive perceptions	0.02	0.21	0.01	0.25	0.31	−0.30	−0.20	0.37†	−0.15	–		
11. Negative perceptions	−0.01	−0.11	−0.14	−0.07	−0.31	−0.03	0.11	−0.42†	−0.14	−0.66**	–	
12. Positive metaperceptions	0.05	0.22	−0.18	0.31	0.46*	−0.32	−0.30	0.60**	−0.22	0.62**	−0.38†	–
13. Negative metaperceptions	0.08	−0.28	0.18	−0.31	−0.32	0.12	0.25	−0.40†	0.18	−0.41*	0.70**	−0.59**

†*p* < .10; \**p* < .05; \*\**p* < .01

of the Perceptions and Metaperceptions Questionnaire. Metaperceptions of being liked were significantly associated with higher self-reported narcissism scores,  $r(44)=0.42, p=.005$ , and higher self-esteem,  $r(44)=0.45,$

$p=.002$ . Metaperceptions of being disliked were marginally associated with lower self-reported narcissism scores,  $r(43)=−0.28, p=.07$ , and lower self-esteem,  $r(43)=−0.28, p=.07$ . Fisher *r* to *z* transformations revealed that there

**Table 5** Correlations between primary variables and age, ASD symptoms, and verbal IQ for typically developing group

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	–											
2. ASD symptoms	0.01	–										
3. Verbal IQ	0.17	0.34	–									
4. Narcissism	0.13	0.38 <sup>†</sup>	0.15	–								
5. Self-Esteem	–0.22	0.06	0.12	0.30	–							
6. Reading the mind in the eyes	–0.03	–0.16	–0.14	–0.18	–0.04	–						
7. Strange stories	0.24	0.19	0.41 <sup>†</sup>	0.15	0.04	0.30	–					
8. Social Reciprocity composite	0.19	0.19	0.20	0.42*	–0.09	0.43*	0.50*	–				
9. Social Initiative composite	0.24	0.21	0.54**	0.28	0.21	0.26	0.33	0.20	–			
10. Positive perceptions	0.29	–0.42*	0.06	0.01	0.10	0.31	0.05	0.25	0.10	–		
11. Negative perceptions	–0.39 <sup>†</sup>	0.31	0.20	0.24	0.24	0.05	–0.02	–0.07	0.22	–0.68**	–	
12. Positive metaperceptions	0.37 <sup>†</sup>	–0.06	0.10	0.52*	0.40 <sup>†</sup>	0.29	0.21	0.41**	0.49*	0.62**	–0.20	–
13. Negative metaperceptions	–0.27	–0.24	0.12	–0.24	–0.17	–0.01	–0.17	–0.31	–0.07	–0.33	0.46*	–0.58**

<sup>†</sup> $p < .10$ ; \* $p < .05$ ; \*\* $p < .01$

**Table 6** Eigenvalues and loadings for peer social competence composite variables PCA

	Eigen values	
	Social Reciprocity	Social Initiative
	4.00	1.65
Coded variables	Loadings	
Proportion of time talking	0.16	<b>0.85</b>
Latency to first utterance	0.06	<b>–0.36</b>
Latency to first spontaneous utterance	–0.33	<b>–0.51</b>
Sharing	0.20	<b>0.83</b>
Seeking	<b>0.68</b>	–0.05
Eye contact	<b>0.73</b>	0.17
Conversational efficacy	<b>0.81</b>	0.30
Social ease	<b>0.82</b>	0.09

Bold values indicate variables that were included in each factor

were no significant differences between the magnitude of the correlations for adolescents with and without ASD,  $ps > 0.05$ . Additionally, perceptions of liking and perceptions of disliking were not associated with either narcissism or self-esteem, supporting the discriminant validity of the perceptions assessed by the Perceptions and Metaperceptions Questionnaire.

Mean scores on liking/disliking and metaperceptions of being liked/disliked were not significantly different for adolescents with and without ASD (See Table 3 for means, standard deviations, and group comparisons). A repeated measures ANOVA was conducted with domain (perception, metaperception) and valence (liking, disliking) as within-group factors and group (ASD, TD) as a between-group factor. Results revealed a significant effect of valence across diagnostic groups,  $F(1, 45) = 124.96$ ,  $p < .001$ . Adolescents

reported liking their social partners significantly more than they disliked them, and predicted that their social partners liked them significantly more than they predicted they disliked them. For all adolescents, ratings of liking and disliking were moderately and negatively correlated, as were ratings of metaperceptions of being liked and disliked, indicating that constructs were related but distinct. See Table 4.

For adolescents with ASD, raw perception and metaperception scores had acceptable values for skew and kurtosis (ranging from  $-1$  to  $1$ ). For TD adolescents, most scores had acceptable skew and kurtosis, but metaperceptions of being disliked were skewed (2.55) and kurtotic (9.18). Examination of the distribution of metaperceptions of being disliked revealed one participant in the TD group with a value of 47. Skew and kurtosis values calculated without this individual fell within an acceptable range. Analyses conducted with

and without this individual were comparable, and results are reported with the outlier retained.

**Hypothesis Testing**

*Associations Between Perceptions and Metaperceptions with Theory of Mind*

Bivariate correlation analyses were conducted within diagnostic group to examine the association between theory of mind and both perceptions and metaperceptions. There were no significant correlations between the theory of mind measures and perceptions or metaperceptions for adolescents in either diagnostic group. See Tables 4 and 5.

*Metaperception Accuracy*

The APIM was used to examine (1) the association between an adolescent’s perception of the peer and his/her own metaperceptions of being liked or disliked, controlling for the peer’s perception, and (2) the association between the peer’s perceptions and the adolescent’s metaperceptions, controlling for the adolescent’s own perception. We conceptualized this second association as “accuracy” in that it represents how closely an adolescent’s metaperceptions of being liked or disliked matched with the evaluation given by the peer. Predictors were grand mean centered Perceptions and Metaperceptions Questionnaire perception scores, and outcomes were metaperception scores. Separate models were conducted for liking and one for disliking.

*Liking* The APIM revealed a significant association of all adolescents’ ratings of liking with their own metaperceptions of being liked,  $b=0.66, \beta=0.57, t(28)=4.19, p < .001$ , indicating that overall, participants who liked their peers more predicted that their peers liked them more. This association was not moderated by diagnostic group,  $b=-0.10, \beta=-0.09, t(41)=-0.76, p = .45$ .

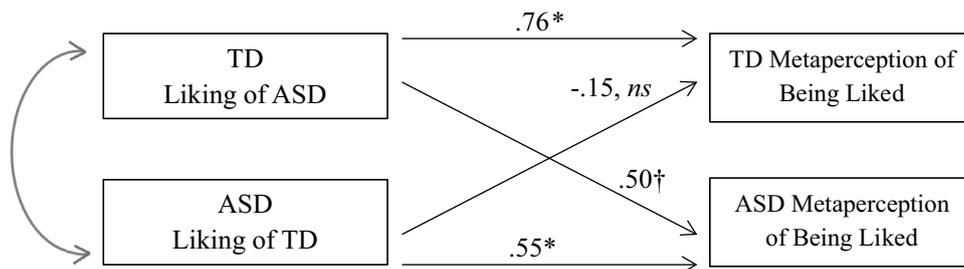
There was no overall association of the peer’s liking with adolescents’ metaperceptions of being liked,  $b=0.17, \beta=0.15, t(27)=1.08, p = .29$ . However, the association of the partner’s liking with adolescents’ metaperceptions of being liked differed by group,  $b=0.32, \beta=0.28, t(36)=2.34, p = .03$ . For TD adolescents, ratings of how much ASD peers liked TD adolescents did not relate to TD adolescents’ metaperceptions of being liked,  $b=-0.15, \beta=-0.13, t(21)=-0.87, p = .39$ , suggesting lack of accuracy. For adolescents with ASD, the association was also not significant. However, the more TD peers liked adolescents with ASD, the more adolescents with ASD tended to believe peers liked them,  $b=0.50, \beta=0.43, t(21)=2.02, p = .06$ . See Fig. 1.

*Disliking* Analyses revealed a significant association of adolescents’ disliking with their metaperceptions of being disliked,  $b=0.73, \beta=0.59, t(31)=4.40, p < .001$ . This suggests that the more adolescents disliked their peers, the more they thought peers disliked them. This association was not moderated by diagnostic group.

There was no significant association between peers’ disliking and adolescents’ metaperceptions of being disliked,  $b=0.04, \beta=0.03, t(32)=0.23, p = .82$ , indicating that across groups, adolescents were not accurate in their metaperceptions of being disliked. These findings did not differ by group.

*Associations of Perceptions and Metaperceptions with Social Competence*

Separate APIMs were conducted with perception and metaperception scores as predictors of Social Reciprocity and Social Initiative to examine the association between an adolescent’s metaperceptions and his/her own social competence, controlling for the peer’s perception, and the association between the peer’s perceptions and the adolescent’s social competence, controlling for the adolescent’s own perception.



**Fig. 1** Actor-partner interdependence model (APIM) illustrating dyadic perception and metaperception for liking. For TD adolescents, one’s liking of the peer has a stronger effect on metaperceptions (horizontal association) than does the partner’s liking rating (diag-

onal association). For adolescents with ASD, associations are similar, although the partner’s liking is marginally associated with metaperceptions. \* $p < .05$ , † $p < .10$ , ns non-significant. ASD autism spectrum disorder, TD typically developing

**Liking** Overall, adolescents who predicted that peers liked them more displayed higher Social Reciprocity,  $b=0.03$ ,  $\beta=0.37$ ,  $t(33)=3.13$ ,  $p=.004$ . In addition, there was no significant association between peers' liking and an adolescent's Social Reciprocity,  $b=0.02$ ,  $\beta=0.24$ ,  $t(32)=1.77$ ,  $p=.09$ . Similarly, a separate model revealed that adolescents who predicted that peers liked them more displayed significantly more Social Initiative,  $b=0.03$ ,  $\beta=0.43$ ,  $t(37)=3.09$ ,  $p<.01$ . However, there was no significant association between peers' liking and an adolescent's Social Initiative,  $b=0.02$ ,  $\beta=0.23$ ,  $t(33)=1.60$ ,  $p=.12$ . Associations did not differ by group,  $ps>0.05$ .

**Disliking** Across the full sample, adolescents who predicted peers to dislike them more displayed lower Social Reciprocity,  $b=0-.03$ ,  $\beta=-0.30$ ,  $t(34)=-2.40$ ,  $p=.02$ . However, there was no significant association between peers' disliking and adolescents' Social Reciprocity,  $b=-0.03$ ,  $\beta=-0.18$ ,  $t(35)=-1.39$ ,  $p=.17$ . There was also no significant association between adolescents' metaperceptions of being disliked and adolescents' own Social Initiative,  $b=-0.01$ ,  $\beta=-0.15$ ,  $t(35)=-1.18$ ,  $p=.25$ . Adolescents whose peers disliked them more displayed significantly less Social Initiative,  $b=-0.05$ ,  $\beta=-0.05$ ,  $t(36)=-0.02$ ,  $p<.01$ . Associations did not differ by group,  $ps>0.05$ .

## Discussion

This was the first study to quantify and compare metaperception abilities in adolescents with and without ASD following a dyadic social interaction using the novel Perceptions and Metaperceptions Questionnaire, and to evaluate how perceptions and metaperceptions related to theory of mind and observed social competence. Adolescents were generally not accurate in their metaperceptions following a brief interaction with an unfamiliar peer, consistent with previous research in adults (Carlson and Kenny 2012). Interestingly, adolescents with ASD displayed more accurate metaperceptions of being liked than did adolescents without ASD. Furthermore, social behavior during an interaction with an unfamiliar peer was related to how adolescents believed they were perceived by others, as well as how they were actually perceived by their peers.

### Perceptions and Metaperceptions Questionnaire

Results supported the reliability and validity of the Perceptions and Metaperceptions Questionnaire as an index of these constructs following a live social interaction. Consistent with previous research in typical development (Carlson et al. 2011; Pfeifer et al. 2009), metaperceptions of being liked were associated with higher narcissism and more

self-esteem. Adolescents may hold inflated metaperceptions in agreement with positive (self-esteem) or inflated (narcissism) self-views (Carlson et al. 2011; Pfeifer et al. 2009). Importantly, self-esteem and narcissism were not significantly associated within either diagnostic group, indicating that they are discrete constructs. It is also important to note that associations with narcissism and self-esteem were specific to metaperceptions—perceptions of others were not associated with narcissism or self-esteem. This suggests that the index of metaperceptions is not simply capturing a world view or general way that adolescents view their social interaction partners.

All adolescents reported liking peers more than disliking them, consistent with previous research suggesting that overall, typically developing children like, rather than dislike, peers (Hughes and Im 2016), but in contrast with previous research indicating that youth with disabilities are disliked by peers (Hinshaw and Melnick 1995; La Greca and Stone 1990). There is also evidence that youth and adults with ASD (Sasson et al. 2017) may be disliked by peers; however, these findings are based on very brief clips of audiovisual stimuli of individuals with ASD, in contrast to the naturalistic social interaction paradigm used in this study. In the present study, adolescents interacted with one other person, in contrast to the study conducted by Sasson et al. (2017), in which many individuals were rated during one session. In the present study, adolescents had a chance to modify behavior in response to a social partner over the course of the dyadic interaction. The five-minute interaction paradigm in this study undoubtedly provides a brief experience with peers; however, the initial moments of a social interaction provide important information about first impressions, which are critical for formation of relationships and friendships (Hall and Andrzejewski 2008). In contrast with previous studies demonstrating that children and young adolescents with disabilities *predicted* lower acceptance from their classmates than those without disabilities (La Greca and Stone 1990), all adolescents regardless of diagnostic group predicted higher mean liking than disliking ratings from peers. The adolescents in this study diagnosed with ASD had moderate to high levels of IQ, which limits generalizability of findings to the larger heterogeneous population of adolescents with ASD.

Neither perceptions nor metaperceptions were related to theory of mind for adolescents with or without ASD in this study. Supporting this finding, Ochsner and colleagues (2005) discuss the possibility that different types of metaperceptions may recruit neural regions separate from those recruited in theory of mind. Further research is needed to understand the associations between perceptions, metaperceptions, and theory of mind abilities. Measures beyond the traditional theory of mind assessments (e.g., Cauty et al. 2017) may provide additional information on what features

of perspective-taking are unique versus common to different social cognitive tasks.

### Metaperception Accuracy

Overall, adolescents were not accurate in their metaperceptions. Findings indicated that during this developmental stage, perceptions of the self and of one's social interaction partners are closely intertwined. The more adolescents liked (or disliked) their peers, the more they believed they were liked (or disliked), consistent with previous research demonstrating metaperceptions as relatively independent of others' evaluations (Kenny and DePaulo 1993; Sung et al. 2010; Zimmer-Gembeck et al. 2013). Adolescents may rely on their own views to determine what others may be thinking, perhaps following an "if I like you, then you must like me" logic. While this strategy can be useful, during adolescence when social contexts become more complex and salient, difficulties taking others' perspectives into account can worsen social challenges (Fett et al. 2014). It is also plausible that the direction of effects is reversed, with metaperceptions guiding perceptions (Pfeifer et al. 2009). Adolescents may form judgments of whether they are liked, and subsequently decide whether they like their peers. Future studies investigating direction of effects are needed.

Findings that, for adolescents with ASD, metaperceptions of being liked were marginally associated with peers' liking suggests that these adolescents detected social partners' cues and formed ideas about how they were perceived. Despite core social deficits in ASD, previous research has demonstrated that older adolescents and adults with ASD successfully detect changes in eye gaze (Fletcher-Watson et al. 2008), nonverbal social cues (Schwartz et al. 2014), and verbal social cues (Foxy et al. 2015) in social scenes, video, or audio, performing as well as their typically developing peers. Likewise, previous research on reputation management in ASD has demonstrated that adolescents with ASD have the ability to manage their reputations by strategically describing themselves in a more positive light when being evaluated (Cage et al. 2016a, 2013). Nevertheless, this finding must be interpreted with caution and examined in a larger sample. For typically developing adolescents, the lack of accuracy may suggest that cues displayed by adolescents with ASD may be difficult for adolescents without ASD to interpret (Brewer et al. 2015; Sheppard et al. 2016). Adolescents with ASD may demonstrate less synchrony of gestures with verbal communication than those without ASD (de Marchena and Eigsti 2010; Morett et al. 2016). It is important to consider the bidirectional nature of difficulties that people with and without ASD may have in understanding one another's perspectives, which has been studied empirically as the "double empathy problem" (Heasman and Gillespie 2017; Milton 2012).

### Associations of Perceptions and Metaperceptions with Social Competence

There were unique effects of perceptions and metaperceptions on observed social competence. For all adolescents, metaperceptions of being more liked and less disliked by peers, as well as being liked by peers, were associated with higher Social Reciprocity. For Social Initiative, associations were similar, as metaperceptions of being more liked and less disliked by peers were associated with higher Social Initiative. This indicates that the way that an adolescent believes he is perceived and the way that he is perceived are important factors relating to social competence. During adolescence, ratings of liking from peers have been associated with observed social competence in a summer camp setting (Englund et al. 2000). Adolescents' positive beliefs about how they are perceived may impact the way they interact socially (Burrows et al. 2016). Conversely, adolescents who have a history of reciprocal social interactions may develop positive ideas of how they are perceived. Unfortunately, previous research indicates that many individuals with ASD have negative social experiences and are likely to experience bullying (Maïano et al. 2016). Adolescents with ASD are often aware of their negative reputations (Cage et al. 2016b), which may contribute to negative self-views, internalizing problems, and avoidance of future social interactions (Burrows et al. 2016).

It is important to note that in this study, analyses were conducted using perceptions and metaperceptions as *predictors* of observed social competence, consistent with previous research demonstrating that an expectation of being liked by peers can lead to an increase in socially competent behavior (Parker et al. 2006). However, the directionality of effects involving perceptions, metaperceptions, and social competence should be further investigated in future studies. It would be informative to obtain perception and metaperception ratings from the Perceptions and Metaperceptions Questionnaire in one setting and relate them to outcomes in a different setting to assess whether these abilities generalize across contexts and over time.

### Strengths and Limitations

This study had several strengths, including its ethnically diverse sample, in-vivo observational design, and utilization of a novel questionnaire measure to index perception and metaperception abilities relating to a particular dyadic social interaction in adolescents with and without ASD. In addition, the unstructured unfamiliar peer interaction protocol provided a salient context upon which adolescents could base their initial impressions of peers. Finally, the APIM analyses provide unique perspectives on bidirectional

influences during dyadic interactions between unfamiliar adolescents.

These strengths should be considered in relation to relative weaknesses. One weakness was the study's relatively small sample size, with 25 participants in each diagnostic group. Future research would benefit from a larger sample, which would provide more power to detect statistically significant differences between groups. In addition, inclusion of mixed dyads in future studies could allow for a contrast between the ways that adolescents with and without ASD interact with typically and atypically developing peers. For instance, investigation into metaperception accuracy when adolescents with ASD interact with other adolescents with ASD, and comparing their abilities to dyads composed of typically developing peers, could shed light on contextual or dyad-level factors impacting accuracy. Finally, the sample was comprised of individuals without intellectual disability, limiting interpretability to this group of adolescents.

There are several constructs not measured in this study that could benefit future research in metaperception, such as social desirability and social motivation. In future research, these constructs would provide important information on individual differences in response patterns and social presentation of adolescents. There is evidence that temperamental dimensions relating to social desirability and social motivation, such as affiliation, relate to behavior similarly for individuals with and without ASD (Burrows et al. 2016). There was also a lack of information on co-occurring diagnoses of anxiety or depression, which could potentially impact adolescents' perceptions and metaperceptions (Pozo et al. 1991), as well as their observed social behavior (Usher et al. 2015). Examining these various potential sources of individual differences in metaperception abilities in both ASD and TD groups would strengthen future work in this area.

## Implications

Findings provide important information about typically and atypically developing adolescents' perceptions of peers and their dynamic abilities to discern what a social partner thinks of them. Overall, findings suggest that adolescents rely on their own perspectives of others to form metaperceptions of how they are perceived by others. Further, across diagnostic groups, adolescents liked their peers more when Social Reciprocity and Initiative were high. Research on metaperceptions may inform existing interventions targeting social skills and social pragmatics (Williams White et al. 2007). Metaperception is a trainable skill (Albright and Malloy 1999), and some current interventions for individuals with ASD utilize in-vivo feedback (Deitchman et al. 2010; State and Kern 2012); however, further research is needed to better understand the potential implications of manipulating metaperception abilities. The utility of the Perceptions and Metaperceptions Questionnaire should be further investigated to understand how it could be used to provide information on perception and metaperception in critical settings throughout development, such as the classroom and workplace.

## Appendix

*Perception and Metaperception Questionnaire.* Items containing positively-valenced adjectives have been marked \* for this paper, but are not marked on the administered questionnaire.

See Table 7.

**Table 7** Please answer the following questions about the person you just interacted with using the following scale: 1 = not at all, 2 = a little, 3 = in the middle, 4 = a lot, and 5 = the most

1. How happy is __?*	1—2—3—4—5
2. How outgoing is __?*	1—2—3—4—5
3. How relaxed is __?*	1—2—3—4—5
4. How talkative is __?*	1—2—3—4—5
5. How boring is __?	1—2—3—4—5
6. How insecure is __?	1—2—3—4—5
7. How positive is __?*	1—2—3—4—5
8. How quiet is __?	1—2—3—4—5
9. How anxious or nervous is __?	1—2—3—4—5
10. How negative is __?	1—2—3—4—5
11. How unhappy is __?	1—2—3—4—5
12. How cool is __?*	1—2—3—4—5
13. How polite is __?*	1—2—3—4—5
14. How mature is __?*	1—2—3—4—5
15. How annoying is __?	1—2—3—4—5

**Table 7** (continued)

16. How funny is __?*	1—2—3—4—5
17. How uncool is __?	1—2—3—4—5
18. How shy is __?	1—2—3—4—5
19. How serious is __?	1—2—3—4—5
20. How immature is __?	1—2—3—4—5
21. How helpful is __?*	1—2—3—4—5
22. How confident is __?*	1—2—3—4—5
23. How exciting is __?*	1—2—3—4—5
24. How impolite is __?	1—2—3—4—5
25. How entertaining is __?*	1—2—3—4—5
26. How uncool does __ think you are?	1—2—3—4—5
27. How outgoing does __ think you are?*	1—2—3—4—5
28. How negative does __ think you are?	1—2—3—4—5
29. How boring does __ think you are?	1—2—3—4—5
30. How anxious or nervous does __ think you are?	1—2—3—4—5
31. How relaxed does __ think you are? *	1—2—3—4—5
32. How funny does __ think you are?*	1—2—3—4—5
33. How talkative does __ think you are?*	1—2—3—4—5
34. How immature does __ think you are?	1—2—3—4—5
35. How cool does __ think you are?*	1—2—3—4—5
36. How positive does __ think you are?*	1—2—3—4—5
37. How happy does __ think you are?*	1—2—3—4—5
38. How polite does __ think you are?*	1—2—3—4—5
39. How quiet does __ think you are?	1—2—3—4—5
40. How annoying does __ think you are?	1—2—3—4—5
41. How shy does __ think you are?	1—2—3—4—5
42. How impolite does __ think you are?	1—2—3—4—5
43. How mature does __ think you are?*	1—2—3—4—5
44. How entertaining does __ think you are?*	1—2—3—4—5
45. How serious does __ think you are?	1—2—3—4—5
46. How helpful does __ think you are?*	1—2—3—4—5
47. How confident does __ think you are?*	1—2—3—4—5
48. How exciting does __ think you are?*	1—2—3—4—5
49. How unhappy does __ think you are?	1—2—3—4—5
50. How insecure does __ think you are?	1—2—3—4—5
51. How well did your interaction with __ go overall?	1—2—3—4—5
52. How much would you want to continue a friendship with __ outside of the lab?	1—2—3—4—5

**Funding** This work was supported by the Marino Autism Research Institute (“Peer Interactions in Children and Adolescents with and without Autism,” PI Henderson); the University of Miami Department of Psychology/Fred C. and Helen Donn Flipse Research Support Fund and Psychology Graduate Student Organization; and the University of Wisconsin-Madison Waisman Center (T32 HD07489 , PI Mailick).

**Author Contributions** LU obtained funding, conceived of the study, participated in its design and coordination, performed the measurement, performed the statistical analysis, participated in interpretation of the data, and drafted the manuscript; CB participated in the design, performed the measurement, and participated in interpretation of the data; DM participated in the design of the study and participated in interpretation of the data; HH obtained funding, participated in its

design and coordination, participated in interpretation of the data, and helped to draft the manuscript. All authors read and approved the final manuscript.

#### **Compliance with Ethical Standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

## References

- Abdi, H., & Williams, L. J. (2010). Principal component analysis. *Wiley Interdisciplinary Reviews: Computational Statistics*, 2(4), 433–459.
- Albright, L., & Malloy, T. E. (1999). Self-observation of social behavior and metaperception. *Journal of Personality And Social Psychology*, 77(4), 726–734.
- American Psychiatric Association (2013). *The Diagnostic and statistical manual of mental disorders: DSM 5*. London: American Psychiatric Publishing
- Banerjee, R. (2002). Children's understanding of self-presentational behavior: Links with mental-state reasoning and the attribution of embarrassment. *Merrill-Palmer Quarterly*, 48(4), 378–404. doi:10.1353/mpq.2002.0015.
- Baron-Cohen, S. (2001). Consciousness of the physical and the mental: Evidence from autism. In P. G. Grossenbacher (Ed.), *Finding consciousness in the brain: A neurocognitive approach* (pp. 61–76). Amsterdam: John Benjamins Publishing Company.
- Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The “reading the mind in the eyes” test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, 42(2), 241–251.
- Begeer, S., Banerjee, R., Lunenburg, P., Terwogt, M. M., Stegge, H., & Rieffe, C. (2008). Brief report: Self-presentation of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 38(6), 1187–1191. doi:10.1007/s10803-007-0503-0.
- Berument, S. K., Rutter, M., Lord, C., Pickles, A., & Bailey, A. (1999). Autism screening questionnaire: diagnostic validity. *The British Journal of Psychiatry*, 175(5), 444–451.
- Brewer, R., Biotti, F., Catmur, C., Press, C., Happé, F., Cook, R., & Bird, G. (2015). Can neurotypical individuals read autistic facial expressions? Atypical production of emotional facial expressions in autism spectrum disorders. *Autism Research*. doi:10.1002/aur.1508.
- Burrows, C. A., Usher, L. V., Mundy, P. C., & Henderson, H. A. (2016). The salience of the self: Self-referential processing and internalizing problems in children and adolescents with autism spectrum disorder. *Autism Research*. doi:10.1002/aur.1727.
- Cage, E., Bird, G., & Pellicano, E. (2016a). Reputation management in children on the autism spectrum. *Journal of Autism and Developmental Disorders*, 46(12), 3798–3811. doi:10.1007/s10803-016-2923-1.
- Cage, E., Bird, G., & Pellicano, L. (2016b). ‘I am who I am’: Reputation concerns in adolescents on the autism spectrum. *Research in Autism Spectrum Disorders*, 25, 12–23. doi:10.1016/j.rasd.2016.01.010.
- Cage, E., Pellicano, E., Shah, P., & Bird, G. (2013). Reputation management: Evidence for ability but reduced propensity in autism. *Autism Research*, 6(5), 433–442. doi:10.1002/aur.1313.
- Calhoun, G. B., Glaser, B. A., Stefurak, T., & Bradshaw, C. P. (2000). Preliminary validation of the narcissistic personality inventory—juvenile offender. *International Journal of Offender Therapy and Comparative Criminology*, 44(5), 564–580. doi:10.1177/0306624X00445004. doi.
- Canty, A. L., Neumann, D. L., Fleming, J., & Shum, D. H. K. (2017). Evaluation of a newly developed measure of theory of mind: The virtual assessment of mentalising ability. *Neuropsychological Rehabilitation*, 27(5), 834–870. doi:10.1080/09602011.2015.1052820.
- Carlson, E. N., & Kenny, D. A. (2012). Meta-accuracy: Do we know how others see us? In S. Vazire & T. D. Wilson (Eds.), *Handbook of self-knowledge* (pp. 242–257). New York: Guilford Press.
- Carlson, E. N., Vazire, S., & Oltmanns, T. F. (2011). You probably think this paper's about you: Narcissists' perceptions of their personality and reputation. *Journal of Personality And Social Psychology*, 101(1), 185–201. doi:10.1037/a0023781.
- Cook, W. L., & Kenny, D. A. (2005). The Actor-partner interdependence model: A model of bidirectional effects in developmental studies. *International Journal of Behavioral Development*, 29(2), 101–109.
- Cooper, M. (2005). The inter-experiential field: Perceptions and meta-perceptions in person-centered and experiential psychotherapy. *Person-Centered and Experiential Psychotherapies*, 4(1), 54–68.
- Cooper, M. (2009). Interpersonal perceptions and metaperceptions: Psychotherapeutic practice in the interexperiential realm. *Journal of Humanistic Psychology*, 49(1), 85–99. doi:10.1177/0022167808323152.
- de Marchena, A., & Eigsti, I.-M. (2010). Conversational gestures in autism spectrum disorders: Asynchrony but not decreased frequency. *Autism Research*, 3(6), 311–322. doi:10.1002/aur.159.
- Deitchman, C., Reeve, S. A., Reeve, K. F., & Progar, P. R. (2010). Incorporating video feedback into self-management training to promote generalization of social initiations by children with autism. *Education & Treatment of Children*, 33(3), 475–488. doi:10.1353/etc.0.0102.
- Ehlers, S., Gillberg, C., & Wing, L. (1999). A screening questionnaire for Asperger syndrome and other high-functioning autism spectrum disorders in school age children. *Journal of Autism and Developmental Disorders*, 29(2), 129–141.
- Englund, M. M., Levy, A. K., Hyson, D. M., & Sroufe, L. A. (2000). Adolescent social competence: Effectiveness in a group setting. *Child development*, 71(4), 1049–1060. doi:10.1111/1467-8624.00208.
- Fett, A.-K. J., Shergill, S. S., Gromann, P. M., Dumontheil, I., Blakemore, S.-J., Yakub, F., & Krabbendam, L. (2014). Trust and social reciprocity in adolescence—A matter of perspective-taking. *Journal of Adolescence*, 37(2), 175–184. doi:10.1016/j.adolescence.2013.11.011.
- Fletcher-Watson, S., Leekam, S. R., Findlay, J. M., & Stanton, E. C. (2008). Brief report: Young adults with autism spectrum disorder show normal attention to eye-gaze information—Evidence from a new change blindness paradigm. *Journal of Autism and Developmental Disorders*, 38(9), 1785–1790. doi:10.1007/s10803-008-0548-8.
- Foxe, J. J., Molholm, S., Bene, D., Frey, V. A., Russo, H.-P., Blanco, N. N., Ross, L.A., (2015). Severe multisensory speech integration deficits in high-functioning school-aged children with autism spectrum disorder (ASD) and their resolution during early adolescence. *Cerebral Cortex*, 25(2), 298–312. doi:10.1093/cercor/bht213.
- Garfield, J. L., Peterson, C. C., & Perry, T. (2001). Social cognition, language acquisition and the development of the theory of mind. *Mind & Language*, 16(5), 494–541. doi:10.1111/1468-0017.00180.
- Gilbert, D. T., Pelham, B. W., & Krull, D. S. (1988). On cognitive busyness: When person perceivers meet persons perceived. *Journal of personality and social psychology*, 54(5), 733–740. doi:10.1111/1468-0017.00180.
- Hall, J. A., & Andrzejewski, S. A. (2008). Who draws accurate first impressions?: Personal correlates of sensitivity to nonverbal cues. In N. Ambady, J. J. Skowronski, N. Ambady & J. J. Skowronski (Eds.), *First impressions* (pp. 87–105). New York: Guilford Publications.

- Happé, F. G. E. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Developmental Disorders*, 24(2), 129–154.
- Harter, S. (1985). *Manual for the self-perception profile for children: (revision of the perceived competence scale for children)*. Denver: University of Denver.
- Heasman, B., & Gillespie, A. (2017). Perspective-taking is two-sided: Misunderstandings between people with Asperger's syndrome and their family members. *Autism: The International Journal Of Research And Practice*, 3, 1362361317708287.
- Hinshaw, S. P., & Melnick, S. M. (1995). Peer relationships in boys with attention-deficit hyperactivity disorder with and without comorbid aggression. *Development and Psychopathology*, 7(4), 627–647. doi:10.1017/S0954579400006751.
- Hughes, J. N., & Im, M. H. (2016). Teacher–student relationship and peer disliking and liking across grades 1–4. *Child Development*. doi:10.1111/cdev.12477.
- Kenny, D. A., & DePaulo, B. M. (1993). Do people know how others view them? An empirical and theoretical account. *Psychological Bulletin*, 114(1), 145–161. doi:10.1037/0033-2909.114.1.145.
- Kashy, D. A., & Kenny, D. A. (2000). The analysis of data from dyads and groups. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 451–477). New York: Cambridge University Press.
- Kenny, D. A., & Kashy, D. A. (2011). Dyadic data analysis using multilevel modeling. In J. J. Hox & J. K. Roberts (Eds.), *Handbook for advanced multilevel analysis* (pp. 335–370). New York: Routledge/Taylor & Francis Group. (Chapter viii, 393 Pages).
- Kenny, D. A., Kashy, D. A., & Cook, W. L. (2006). *Dyadic data analysis*. New York: Guilford Press.
- Kenny, D. A., & Ledermann, T. (2010). Detecting, measuring, and testing dyadic patterns in the actor–partner interdependence model. *Journal of Family Psychology*, 24(3), 359–366. doi:10.1037/a0019651.
- Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: The Social Attribution Task. *Journal of Child Psychology and Psychiatry*, 41(7), 831–846.
- La Greca, A. M., & Stone, W. L. (1990). LD status and achievement: Confounding variables in the study of children's social status, self-esteem, and behavioral functioning. *Journal of Learning Disabilities*, 23(8), 483–490. doi:10.1177/002221949002300806.
- Laing, R. D., Phillipson, H., & Lee, A. R. (1966). *Interpersonal perception: A theory and a method of research*. Oxford: Springer.
- Lord, C., Rutter, M., DiLavore, P., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism Diagnostic Observation Schedule–2nd edition (ADOS-2)*. Los Angeles: Western Psychological Corporation.
- Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, 24(5), 659–685.
- Mañano, C., Normand, C. L., Salvat, M. C., Moullec, G., & Aimé, A. (2016). Prevalence of school bullying among youth with autism spectrum disorders: A systematic review and meta-analysis. *Autism Research*, 9(6), 601–615. doi:10.1002/aur.1568.
- Malloy, T. E., Albright, L., & Scarpati, S. (2007). Awareness of peers' judgments of oneself: Accuracy and process of metaperception. *International Journal of Behavioral Development*, 31(6), 603–610. doi:10.1177/0165025407080590.
- Milton, D. E. M. (2012). On the ontological status of autism: The 'double empathy problem'. *Disability & Society*, 27(6), 883–887. doi:10.1080/09687599.2012.710008.
- Morett, L. M., O'Hearn, K., Luna, B., & Ghuman, A. S. (2016). Altered gesture and speech production in ASD detract from in-person communicative quality. *Journal of Autism and Developmental Disorders*, 46(3), 998–1012. doi:10.1007/s10803-015-2645-9.
- Ochsner, K. N., Beer, J. S., Robertson, E. R., Cooper, J. C., Gabrieli, J. D. E., Kihlstrom, J. F., & D'Esposito, M. (2005). The neural correlates of direct and reflected self-knowledge. *NeuroImage*, 28(4), 797–814. doi:10.1016/j.neuroimage.2005.06.069.
- Oltmanns, T. F., Gleason, M. E. J., Klonsky, E. D., & Turkheimer, E. (2005). Meta-perception for pathological personality traits: Do we know when others think that we are difficult? *Consciousness and Cognition: An International Journal*, 14(4), 739–751. doi:10.1016/j.concog.2005.07.001.
- Parker, J. G., Rubin, K. H., Erath, S. A., Wojslawowicz, J. C., & Buskirk, A. A. (2006). Peer relationships, child development, and adjustment: A developmental psychopathology perspective. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental Psychopathology, Vol 1: Theory and method* (2nd edn., pp. 419–493). Hoboken, NJ: Wiley.
- Pfeifer, J. H., Masten, C. L., Borofsky, L. A., Dapretto, M., Fuligni, A. J., & Lieberman, M. D. (2009). Neural correlates of direct and reflected self-appraisals in adolescents and adults: When social perspective-taking informs self-perception. *Child Development*, 80(4), 1016–1038. doi:10.1111/j.1467-8624.2009.01314.x.
- Picci, G., & Scherf, K. S. (2015). A two-hit model of autism: Adolescence as the second hit. *Clinical Psychological Science*, 3(3), 349–371. doi:10.1177/2167702614540646.
- Pozo, C., Carver, C. S., Wellens, A. R., & Scheier, M. F. (1991). Social anxiety and social perception: Construing others' reactions to the self. *Personality and Social Psychology Bulletin*, 17(4), 355–362.
- Ranta, K., Laakkonen, E., & Niemi, P. M. (2016). Patterns of meta-perception in adolescents with social anxiety: Mind reading in the classroom. *Journal of Child and Family Studies*. doi:10.1007/s10826-016-0519-1.
- Raskin, R. N., & Hall, C. S. (1979). A narcissistic personality inventory. *Psychological Reports*, 45(2), 1–590. doi:10.2466/pr0.1979.45.2.590.
- Rutter, M., Bailey, A., Lord, C., Cianchetti, C., & Fancello, G. S. (2007). *SCQ: Social Communication Questionnaire: manuale*. Firenze: Giunti OS.
- Sasson, N. J., Faso, D. J., Nugent, J., Lovell, S., Kennedy, D. P., & Grossman, R. B. (2017). Neurotypical peers are less willing to interact with those with autism based on thin slice judgments. *Scientific Reports*, 7, 40700.
- Scheeren, A. M., Banerjee, R., Koot, H. M., & Begeer, S. (2016). Self-presentation and the role of perspective taking and social motivation in autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 46(2), 649–657. doi:10.1007/s10803-015-2610-7.
- Scheeren, A. M., Begeer, S., Banerjee, R., Terwogt, M. M., & Koot, H. M. (2010). Can you tell me something about yourself?: Self-presentation in children and adolescents with high functioning autism spectrum disorder in hypothetical and real life situations. *Autism: The International Journal Of Research And Practice*, 14(5), 457–473. doi:10.1177/1362361310366568.
- Scheeren, A. M., de Rosnay, M., Koot, H. M., & Begeer, S. (2013). Rethinking theory of mind in high-functioning autism spectrum disorder. *Journal of Child Psychology and Psychiatry*, 54(6), 628–635.
- Schwartz, C., Dratsch, T., Vogeley, K., & Bente, G. (2014). Brief report: Impression formation in high-functioning autism: Role of nonverbal behavior and stereotype activating information. *Journal of Autism and Developmental Disorders*, 44(7), 1759–1765. doi:10.1007/s10803-013-2021-6.
- Sheppard, E., Pillai, D., Wong, G. T. -L., Ropar, D., & Mitchell, P. (2016). How easy is it to read the minds of people with autism spectrum disorder? *Journal of Autism and Developmental Disorders*, 46(4), 1247–1254. doi:10.1007/s10803-015-2662-8.

- Sherman, R. C., End, C., Kraan, E., Cole, A., Campbell, J., Klausner, J., & Birchmeier, Z. (2001). Metaperception in cyberspace. *Cyber Psychology & Behavior*, 4(1), 123–129.
- Siegel D. J. (2001). Toward an interpersonal neurobiology of the developing mind: Attachment relationships, “mindsight,” and neural integration. *Infant Mental Health Journal*, 22(1–2), 67–94.
- Somerville, L. H., Jones, R. M., Ruberry, E. J., Dyke, J. P., Glover, G., & Casey, B. J. (2013). The medial prefrontal cortex and the emergence of self-conscious emotion in adolescence. *Psychological Science*, 24(8), 1554–1562. doi:10.1177/0956797613475633.
- State, T. M., & Kern, L. (2012). A comparison of video feedback and in vivo self-monitoring on the social interactions of an adolescent with Asperger syndrome. *Journal of Behavioral Education*, 21(1), 18–33. doi:10.1007/s10864-011-9133-x.
- Sung, Y.-T., Chang, K.-E., Chang, T.-H., & Yu, W.-C. (2010). How many heads are better than one? The reliability and validity of teenagers’ self- and peer assessments. *Journal of Adolescence*, 33(1), 135–145. doi:10.1016/j.adolescence.2009.04.004.
- Usher, L. V., Burrows, C. A., Schwartz, C. B., & Henderson, H. A. (2015). Social competence with an unfamiliar peer in children and adolescents with high functioning autism: Measurement and individual differences. *Research in Autism Spectrum Disorders*, 17, 25–39. doi:10.1016/j.rasd.2015.05.005.
- Wechsler, D. (2003). *Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV)*. San Antonio, TX: The Psychological Corporation.
- Williams, P. E., Weiss, L. G., & Rolfhus, E. (2003). Clinical validity (WISC–IV Technical Report No. 2). Retrieved June 15, 2003 from [http://images.pearsonassessments.com/images/tmrs/tmrs\\_rg/WISCIVTechReport2.pdf?WT.mc\\_id=TMRS\\_WISC\\_IV\\_Technical\\_Report\\_2\\_Psychometric](http://images.pearsonassessments.com/images/tmrs/tmrs_rg/WISCIVTechReport2.pdf?WT.mc_id=TMRS_WISC_IV_Technical_Report_2_Psychometric).
- Williams White, S., Keonig, K., & Scahill, L. (2007). Social skills development in children with autism spectrum disorders: A review of the intervention research. *Journal of Autism and Developmental Disorders*, 37(10), 1858–1868.
- Zimmer-Gembeck, M. J., Nesdale, D., McGregor, L., Mastro, S., Goodwin, B., & Downey, G. (2013). Comparing reports of peer rejection: Associations with rejection sensitivity, victimization, aggression, and friendship. *Journal of Adolescence*, 36(6), 1237–1246. doi:10.1016/j.adolescence.2013.10.002.