The role of context in verbal humor processing in autism

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Humor plays a key role in human social communication and social interaction (e.g., Martin, 2001, 2006) and has been linked to children's developing abilities in social, cognitive, and linguistic domains (Semrud-Clikeman & Glass, 2008; Southam, 2005). Humor is thought to be a central factor in social bonding and in the maintenance of social relationships (McDougall, 1903; Panksepp, 2000). Although there are many forms of children's humor, including unresolvable 'nonsense' jokes (e.g., Geisel, 1957; see Ruch, 1992), a canonical form is the riddle (Zigler, Levine, & Gould, 1966), in which superficially incongruent information must be brought together and resolved in an unexpected or surprising manner, often – but not always – resulting in the resolver smiling, laughing, or at least reporting enjoyment of the riddle (Zigler et al., 1966; Whitt & Prentice, 1977).

This integration of information might be expected to pose particular problems for people with autism, whom Asperger (1944) characterized as lacking humor. Indeed, several studies have shown individuals with autism to have particular difficulty understanding humor (Emerich, Creaghead, Grether, Murray, & Grasha, 2003; Ricks & Wing, 1975; Samson & Hegenloh, 2010), especially for verbal humor relative to pictorial humor (Emerich et al., 2003). Despite these consistent findings of poorer comprehension of humor in autism, the evidence for appreciation of humor is more nuanced. This distinction is important, because it is possible to understand humor that one does not enjoy and vice versa.

Although there are other theories that have the potential to explain particular aspects of humor difficulties in autism, in both comprehension and appreciation, Happé and Frith's (2006) formulation of the Weak Central Coherence (WCC) account of the disorder, namely that there appears to be a detail-focused processing bias, has particularly strong empirical support and is also able to explain a broad range of behaviours associated with autism on a single principle (see Happé & Frith, 2006). Within this framework, impairments in humor processing would reflect poor integration of different parts of humorous utterances or materials, including context, not necessarily owing to an impairment in the ability to integrate information into a central processing stream (as in the original version of WCC; Frith, 1989), but because the individual may not have attended to all of the different information necessary for that processing, particularly by ignoring contextual information.

Parental reports show that children with autism laugh as often as typically developing children when being tickled or when viewing slapstick, but they do not respond in such a way when viewing jokes that include socially inappropriate situations (Reddy, Williams, & Vaughan, 2002). Yet, their responses were similar to those of children with Down syndrome (DS) matched on nonverbal mental age when viewing strange situations that did not include social aspects (Reddy et al., 2002), implying that the social aspects themselves might have posed a particular problem for children with autism in processing of humor. Questionnaire-based self-report studies of adults with autism have found consistent results for appreciation: individuals with autism reported lower appreciation of incongruity-resolution humor than controls did (Wu et al., 2014; Samson, Huber, & Ruch, 2013), but more enjoyment of nonsense jokes than controls, despite poorer comprehension of those same jokes relative to the controls (Wu et al., 2014). This raises an important point, namely that appreciation is not necessarily indicative of comprehension and, instead, may be somewhat independent from it (see Purser, Van Herwegen, & Thomas, 2020, for a discussion of this in relation to typically developing children). Consistent with this notion, Chan et al. (2013) discriminated separable processing streams for comprehension and appreciation using an fMRI technique in typically developing adults, relating comprehension to the cognition of humor, and appreciation to its emotional effects.

Implicit and explicit humor comprehension and appreciation in autism was investigated by Silva, Da Fonseca, Esteves, and Deruelle (2017), using an implicit item-item association task, in which participants were presented with neutral-humorous and neutral-

neutral pairings of images in an encoding phase. Subsequently, sequence recognition of the learned pairs was assessed, along with explicit measures of comprehension and appreciation of the humorous images. Although the participants with autism did not differ from performance IQ-matched typically developing controls in terms of either comprehension or appreciation, there were striking differences in terms of their implicit responses. The TD participants showed implicit effects to humorous stimuli involving socially-relevant human themes, whereas the participants with autism did not. However, this pattern was reversed with humorous stimuli themed around non-human animals: implicit processing effects were evident for participants with autism, but not the controls. The global processing and integrative demands of the human and animal conditions did not obviously differ, rendering a simple account based on local processing bias or central processing stream WCC problematic. Although Silva and colleagues (2017) suggested an account in terms of different levels of social motivation between people with autism and typically developing individuals (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012), this motivational explanatory framework is not universally supported, largely because a low level of social motivation does not appear to be defining or even highly prevalent in autism (see Jaswal & Akhtar, 2018, for a review), although there is robust evidence that the neurobiological processing underlying some social motivation is atypical in autism (see Clements et al., 2018, for a recent systematic review and meta-analysis). An alternative explanation might be that the animal themes were simply more interesting to participants than the human themes in this particular experiment.

A more systematic investigation into the ability of children with autism to take account of contextual information was undertaken by López and Leekam (2003) in a series of experiments. The authors found that under appropriate conditions, children with autism were just as able as controls to use supporting context to identify meanings (speak a written word after being cued with a single semantically related or unrelated word) and recall meanings (free immediate recall of a list of semantically related words). In one experiment, however, they found particular difficulties with using context to disambiguate homographs embedded within written sentences (from Happé, 1997; e.g., ‘The girls climbed over the hedge. Mary's dress was spotless, but in Lucy's dress there was a big tear.’), with the authors suggesting a specific difficulty with complex verbal stimuli and, in particular, with using sentence context to disambiguate meaning. Sentence comprehension may be understood as the incremental updating of a mental model of a situation described in text, which may be influenced by many other factors, including the nature and quality of representation of discourse and/or schema (see, e.g., Hemforth & Konieczny, 2006); its success depends not only on generating a mental model of some kind, but also on attending to and subsequently integrating many more types of information than does success in the identifying and recalling tasks used by López and Leekam (2003). Local processing bias, therefore, seems a plausible explanation for particular difficulties in the homophone task.

Given this finding that children with autism have a particular difficulty with using sentence context to disambiguate meaning, the possibility arises that increasing the salience of that context might, at least in part, overcome that difficulty. If children with autism can benefit from contextual support, this would pave the way to humor interventions based on training sensitivity to context, thereby improving social interactions by reducing confusions surrounding humor and perhaps other forms of communication. If, instead, humor processing differences in autism owe to an insurmountable local processing bias, facilitation of contextual cues should have no effect on humor processing. The current study investigated whether humor comprehension and appreciation could be augmented in children with autism, by providing contextual support that suggested humor was to be expected. Recent evidence has suggested that humor training can lead to increased use of humor in adolescents with autism (Wu, Liu, Kuo, Chen, & Chang, 2016).

Verbal homophone riddles were chosen for the current study as a form of humor that would be expected to be relatively poorly comprehended and appreciated in autism, and therefore one for which there was the potential for augmenting comprehension and appreciation. This choice was based on the self-reported low appreciation of incongruity-resolution humor in adults with autism relative to controls (Wu et al., 2014; Samson et al., 2013), along with relatively poor understanding of verbal humor (Emerich et al., 2003), Homophone riddles were presented with and without preceding contextual information in order to test the effects of that context on comprehension and appreciation, with measured taken of comprehension and both explicit and implicit appreciation, indexed by participant ratings and smiling/laughing, respectively.

Method

Participants

Ethical approval was obtained from [blinded for submission]. Seventeen children with autism and 21 typically developing (TD) children took part. Professional diagnosis of autism (e.g., by a pediatrician, other medical professional, educational psychologist, etc) was confirmed by all parents/guardians of the relevant participants when granting permission for participation. All participants were fully informed about the aims of the experiment, had parental consent, and also consented on the day of testing. In a preliminary test session, participants were tested on the Test of Receptive Grammar (TROG; Bishop, 2003), a measure of grammar comprehension in which participants are presented with four picture options per trial along with a verbally presented sentence; participants point to the picture that matches the sentence they heard. Participants were also assessed on Raven's Coloured Progressive

Matrices (RCPM; Raven, Raven, & Court, 1998), a test of nonverbal ability, in which participants select a picture that best completes a visual pattern or a logical series. Scores on these tests are summarized in Table 1. Owing to the uneven cognitive profile associated with autism (Mandy, Murin, & Skuse, 2015), the groups were matched on nonverbal ability with a view to equating the groups' ability on noncentral task demands (Jarrold & Brock, 2004): as noted by Jarrold and Brock (2004), matching participants with ASD on the basis of verbal ability will tend to result in the control group having poorer nonverbal ability, impacting on non-target correlates of task performance, such as understanding task instructions and responding appropriately during the task. Furthermore, language-matching in ASD research often results in comparisons to children of such markedly younger chronological ages as to make interpretation of results somewhat challenging. A series of independent samples *t* tests showed that the individuals with autism were significantly older than the TD group, t(36, Welch-corrected) = 4.03, $p < .001$, had reliably lower TROG raw scores, t(36, Welch-corrected) = 4.09, $p < .001$, but did not significantly differ in nonverbal ability, t(36, Welch-corrected) = 0.80, $p = .43$.

Table 1 about here

Procedure

Twenty-four video stimuli were created by filming silhouettes of adults telling riddles and riddle-like control stimuli, using a digital camera. The films were of silhouettes in order to eliminate any nonverbal cues from facial expressions or other bodily gestures, while providing a social attentional focus for participants (see Figure 1) and keeping participants focused on the task. The stimuli were spoken without obvious joking emphasis or prosody, in such a way that the riddles and control stimuli sounded similar to each other.

Figure 1 about here

Participants sat in front of a 15" laptop computer on a table top and wore headphones. Participants were told: "We are going to play a game where we watch some videos of people telling jokes from behind a curtain. Sometimes they're real jokes but sometimes the people just say things that sound like jokes. All you have to do is watch the videos and listen carefully to what the people say in the video. Then you have to let me know how funny you thought the video was by pointing to one of these pictures." At this point, participants were shown a visual scale including Very Funny, Funny, OK, Not Funny for rating their appreciation of the video (see Figure 2).

Figure 2 about here

The stimuli (Supplementary Materials 1), with a combination of video and auditory voiceover for each riddle, were presented using Microsoft PowerPoint software. There was a single practice trial including the following riddle: "What kind of room has no walls? A mushroom". When the video had finished playing, the PowerPoint presentation was moved on to the screen shown in Figure 2 and the participant was asked, "How funny was that video?". The experimenter noted the response on a score sheet. If the participant did not point to one of the four response options, the experimenter reminded the participant of each possible option by pointing to each and stating what each meant. If the participant still did not respond, they were asked to give their 'best guess'. At this point, if a child did not respond or did not appear to understand the requirements of the task, they were thanked and the experiment was ended.

Next, participants were presented 24 experimental trials, divided into two blocks of 12 separated by a short break (5 to 15 minutes, depending on the preference of the participant). Half of the trials were riddles and half were control stimuli (differing in the ending); half of each trial type had a preceding context and half did not.

Riddles and control stimuli were pseudorandomized into four orders, counterbalancing pairing of both context (context or none) and ending (joke or control) for each stimulus beginning.

Participants were filmed by the laptop's built-in camera during the experiment and recorded with MyCam software, so that their facial reactions to the stimuli could be subsequently coded (see 'Scoring' section below), with audio recorded via the laptop's built-in microphone.

After the experimental trials had been completed, participants were told, "Now we're going to watch some of the same videos again. I'll remind you of what you thought of the video and ask you to tell me why you thought it was funny or not funny, or just OK." Starting with the practice trial, participants were then shown the riddles, but not the control stimuli, in the same order that they had encountered them previously. Instead of rating each video, they were told the rating that they had given (e.g., "You thought this was just OK") and were asked, "Can you explain why? Why was it very funny/funny/just OK/not funny?" The experimenter transcribed these responses, which were categorized after the session.

Scoring of riddles task.

The video footage from the riddles task of each participant was edited using Apple iMovie. Clips of the experimental trials were edited to begin at the onset of each audio stimulus and ended with the initiation of the participant's verbal response. Each trial of the video footage was scored by the research assistant according to Pien and Rothbart's (1976) 4-point scale:

(0) serious/not laughing,

(1) faint-smile,

(2) smile,

(3) laughter

by a coder blind to whether each stimulus was a riddle or a control as no sound was played during the coding of the videos. At a later time, four randomly selected participants for each group were re-scored by another blind coder, with an inter-rater agreement of 85%. Explanations were scored according to whether or not the child had successfully explained the joke, pointing out the lexical ambiguity: this was scored very liberally, with any plausible allusion to the two different meanings inherent in the riddle being sufficient for a successful explanation. Here, the inter-rater agreement was 92%, again based on four participants from each group.

Results

Descriptive statistics are given in Table 2.

Table 2 about here

Subjective Ratings

The subjective ratings of riddles were analyzed with a multilevel ordinal regression model, with trial type (*joke/control*) and context (*context/no-context)* as within-participant factors, group (*typically-developing/autism*) as a between-participant factor, trial (i.e., the particular stimulus) as a random intercept. Analyses were performed in R (R Core Team, 2013), using ‘clmm’ from the ‘ordinal’ package (Christensen, 2019), with link = "logit" and threshold = "equidistant". Initial ordinal analyses flagged violation of the proportional odds assumption for all predictors aside from context. Analyses were also repeated with linear models and an identical pattern of results was obtained, lending some credence by this convergence. However, only where the proportional odds assumption was not violated (see below) were any of the following statistics used to support inferences in the Discussion section. The remainder are reported here for completeness.

Ratings were significantly higher for jokes than control trials, $Z = 6.07$, $p < .001$, with overall ratings of all stimuli higher for the ASD group than the TD group, $Z = 3.46$, $p < .001$, but there was no reliable difference in ratings of trials with context compared to those without it, $Z = 1.09$, $p = .278$. There was a significant two-way interaction of trial type and group, $Z = 5.02$, $p < .001$, but not of trial type and context, $Z = 1.31$, $p = .189$, nor of context and group, $Z = 1.16$, $p = .245$. There was no significant three-way interaction of trial type, context and group, $Z = 1.72$, $p = .085$.

Motivated by the interaction of trial type and group, the data were analyzed by group. For the TD group, ratings were significantly higher for jokes than those for control stimuli, $Z = 5.81$, $p < .001$, but the interaction of trial type and context was not reliable, $Z = 0.24$, $p = .811$. For the autism group, there was no significant effect of trial type, $Z = 0.25$, $p = .799$, but a reliable interaction of trial type and context, $Z = 2.09$, $p = .036$, reflecting higher ratings for jokes than control stimuli in the presence of context relative to in its absence. Importantly, there was no violation of the proportional odds assumption for this interaction of trial type and context for either group, which are the important results for the narrative of the article from this section.

Smiling/laughing

Due to violations of the assumption of the proportional odds assumption in the planned ordinal analyses, incidence of smiling/laughing was dichotomised (any smiling/laughing vs none) and analyzed with a multilevel logistic regression model, with trial type (*joke/control*) and context (*context/no-context*) as within-participant factors and group (*typically-developing/autism*) as a between-participant factor, again with participant and trial as random intercepts. Smiling/laughing was significantly more frequent for jokes than control trials, $Z = 4.35$, $p < .001$, but there was no reliable difference in smiling/laughing on trials with context compared to those without it, $Z = 0.30$, $p = .762$. There was a significant effect of group, $Z = 3.12$, $p < .001$, driven by more smiling/laughing for control stimuli in the autism group relative to the TD group.

There was a significant two-way interaction of trial type and group, $Z = 3.34$, $p < .001$, reflecting a larger smiling/laughing differential of jokes relative to control stimuli for the TD group than the autism group. The interactions of trial type and context, $Z = 0.39$, $p = .695$, context and group, $Z = 0.34$, $p = .731$, and the three-way interaction, $Z = 0.16$, $p = .869$, were not significant.

Comprehension

Comprehension of joke stimuli was analyzed with a multilevel logistic regression model, with context (*context/no-context*) as a within-participant factor and group (*typically-developing/autism*) as a between-participant factor, again with participant and trial as random intercepts. Context had no significant effect on comprehension, $Z = 0.93$, $p = .353$, but comprehension was reliably superior in the typically-developing group than the autism group, $Z = 3.43$, $p < .001$. There was no significant interaction of context and group, $Z = 0.62$, $p = .534$.

Bayesian analysis for subjective ratings

Given the very close mean subjective ratings given by both groups for riddles in context, a Bayesian between-subjects *t* test, using JASP (2018) and a scaled cauchy of 0.707 (given that very large effect sizes are rare, Wagenmakers et al., 2017) was conducted to assess whether these mean ratings could be considered the same: the analysis revealed that with the provision of context, subjective ratings of the autism and typically-developing groups were the same, indicated by a Bayes factor of 3.158 in favour of the null (indicating moderate evidence). Levene's test was not significant when comparing variances and so equal variances could be assumed across the groups; Q-Q plots revealed no marked departure from normality for the distribution of residuals.

Correlations

For these analyses, Q-Q plots revealed no marked departure from normality for the distribution of residuals. For the typically-developing group, comprehension was not significantly associated with age, $r(19) = .418$, $p = .060$, not reliably related to RCPM score, $r(19) = .335$, $p = .335$, but was significantly associated with TROG score, $r(19) = .736$, $p < .001$. For the autism group, comprehension was not reliably associated with age, $r(15) = .274$, $p = .287$, but was significantly related to both RCPM score, $r(15) = .548$, $p = .023$, and TROG score, $r(15) = .686$, $p = .002$.

Discussion

The aim of the current study was to investigate whether comprehension and appreciation of verbal riddles could be augmented in children with autism, by providing supporting verbal context. The results showed that for the children with autism the greater subjective appreciation of riddles than control stimuli was dependent on the provision of context, in line with experimental hypothesis that humor appreciation could be augmented in children with autism. This modulation of behaviour according to context demonstrated that children with autism are able to make use of supporting verbal context, necessarily reflecting successful integration of verbal context with verbal 'target' information. Furthermore, a Bayesian analysis indicated that when context was provided, the subjective ratings for riddles was equalized across the autism and typically developing groups. This is consistent with López and Leekam's (2003) finding that, in certain circumstances, individuals with autism can successfully utilize verbal context for verbal processing. One interpretation of the subjective rating results is that children with autism can derive as much pleasure as typically developing children when context signals the appearance of humor. A more conservative interpretation, making fewer assumptions, is that children with autism are able to evaluate the amusement-value of humorous material in a way that is congruent with the evaluations of typically developing children, when context signals the appearance of humor. This latter interpretation might be preferred, because no such contextual modulation was observed for smiling/laughing. In either case, however, there would be clear implications for the success or ease of social interactions between children with autism and their typically developing peers. Whether via a pathway involving emotional response or information processing, the extent to which individuals experience something in the same way would surely be expected to facilitate easier social interaction, not only because the shared nature of interpersonal humor forges and strengthens social bonds (e.g., Coser, 1959; Friedman & Friedman, 2006), with also as a result of the dual (but independent) mood-enhancing effects of the humor itself (e.g., Mobbs et al., 2003) and the fact that it is a *shared* experience (Jolly, Tamir, Buren, & Mitchell, 2019; Wagner et al., 2015).

Although a definitive explanation is not possible based on the current data, these results are consistent with the local processing bias account of weak central coherence (WCC; Happé & Frith, 2006), in which abnormal processing reflects a disposition rather than a lack of underlying ability. Under certain circumstances – in this case, where individuals have been instructed to attend carefully to verbal context – children with autism are able to make use of verbal context to interpret its meaning (even if only in the 'outer message' sense of recognising humor, rather than in the 'inner message' sense of the meaning of individual jokes). Thus, children with autism appear able to integrate target communications and context in the verbal domain, even if it is not something that they would be likely to do spontaneously in a real-world (see Leekam & Prior, 1994).

Although no contextual modulation was observed for smiling/laughing, the autism group did show a smaller difference in smiling/laughing between riddles and control stimuli than the typically developing group, along with more smiling/laughing by the autism group for control stimuli. This is consistent with previous findings that (younger) children with autism do not tend to laugh in expected contexts for laughter (Reddy et al., 2002) and that they appear to be more likely to express laughter in response to positive internal states, rather than using laughter in social interactions (Hudenko, Stone, & Bachorowski, 2009). However, this is the first experimental evidence that school-age children with autism show less difference in affect for humorous vs non-humorous material compared with typically developing controls. Both understanding (e.g., Eack, Mazefsky, & Minshew, 2014) and expression (Trevisan, Hoskyn, & Birmingham, 2018) of facial expression is atypical in autism, such that the higher rates of smiling/laughing by the autism group for control stimuli than the typically developing group might reflect this atypical expression rather than any greater amusement, or else reflect atypical development of the domain of facial expressions. Rates of smiling/laughing were generally low across all stimuli for both groups, but also relatively variable for the autism group, which limits interpretation of any lack of differences across conditions.

As with smiling/laughing, there was no evidence of an effect of context on comprehension for either the autism group or the typically developing group. One interpretation of the lack of a contextual effect on comprehension is that the explicit questioning itself served as a contextual cue to the material being humorous. In other words, if the mechanism of the contextual effect was via clarification that humor was indeed what was under consideration, then the act of being asked to explain a riddle would likely have served the same purpose, rendering any previous contextual support redundant. Whatever the case, the typically developing group was better able to explain the riddles than the autism group. This may reflect the superior verbal ability of the typically developing group, as indexed by TROG performance, despite similar levels of nonverbal ability across the groups. Alternatively, it could reflect pragmatic difficulties in the autism group (see Bishop, 2014, for a nuanced discussion), in the sense that they might have had difficulty in understanding what was meant by explaining why they had responded in the way they had or why a joke was funny. Successful comprehension was predicted by grammar comprehension in both groups and also by nonverbal ability in the autism group, as expected in a cross-sectional analysis, with disorder severity randomly associated to age.

As noted in the introduction, there is an important distinction between implicit and explicit processing in social cognition, with the current study involving explicit cues but eliciting a mixture of explicit (comprehension and subjective rating) and implicit (smiling/laughing) responses. Recent research has shown atypical behaviour in implicit, rather than explicit, social cognition in adolescents with autism, indexed by poorer spontaneous perspective taking and social awareness than controls (Callenmark et al., 2014), and also in implicit rather than explicit Theory of Mind abilities (Schuwerk, Vuori, & Sodian, 2014), and also in the finding that implicit social cognition is more predictive than explicit social cognition of social communication and interaction difficulties (Keifer at al,. 2020). In the current study, the finding that subjective ratings (explicit) but not smiling/laughing (implicit) was sensitive to explicit cuing could be seen as consistent with the literature above, in the sense that the absence of difficulty in explicit social cognition tasks might reflect compensation, or alternative solutions, that are effective, in spite of atypical implicit mechanisms. It is also consistent with neuroimaging data demonstrating that brain regions typically associated with social cognition, but not spontaneously activated in a typical manner in individuals with autism, can be activated by appropriate explicit cues (Wang et al., 2007).

As a small-scale exploratory experiment, there are some limitations that warrant mention. First, the sample sizes are not large. Although larger samples are always preferable, the experiment was funded by a small grant to support novel approaches to research and therefore its key strength is as a ‘proof of concept’ that children with autism can use verbal context to recognise verbal humour. Now, in the midst of the COVID-19 pandemic, it is unclear when any expansion or follow-up to this project will be possible, but it is a hope of the authors to attempt to expand on and reproduce this key finding when circumstances allow. Another limitation is the artificiality of the task itself, which is very far removed from a natural and spontaneous, ecologically valid humorous situation. This limitation is the flipside of a strength, namely the experimental control allowed by this method of research, with very closely matched experimental and control conditions. Finally, a limitation is the different levels of grammar comprehension observed between the autism and control groups. While matching on grammar in addition to nonverbal ability would afford even closer comparison, this limitation is not fatal to the interpretation of the *patterns* of results found for the autism group in terms of contextual effects, which are the key findings here. However, this difference in verbal ability does mean that any intergroup differences between the groups should be considered in that light. Relatedly, it is likely that there was some degree of learning difficulty in the autism group, given their older chronological age than the control group, such that any impact on intergroup differences of that learning difficulty rather than autism *per se* cannot be ruled out.

In sum, the current study provides novel evidence supporting the notion that children with autism can benefit from supporting context in terms of explicit appreciation (subjective rating), or at least in recognition of humor. However, there was no evidence of contextual effects on smiling/laughing or on explicit comprehension. The results of the current study demonstrate that children with autism are, even in the most conservative interpretation, able to use verbal context to recognize verbal humor – this is another novel finding that speaks not only to the topic of humor specifically, but also to the more general domain of verbal integration (cf. Leekam & Prior, 1994). As mentioned in the Introduction, recent research involving adolescents with autism has suggested that humor training can lead to increased use of humor (Wu et al., 2016). Given that children with autism can benefit from contextual support, this opens the door to possible interventions based on training sensitivity to context. These would, if successful, plausibly reduce confusions surrounding humor and perhaps other forms of communication, given that linguistic meaning is constrained and altered by context (e.g., Münster & Knoeferle, 2018; see Thomas, Purser, & Mareschal, 2012 for a computational mechanism) such that greater sensitivity to context would lead to improved overall language comprehension. As discussed above, the task used in the current study is far from representative of a ‘real world’ social situation and therefore investigations of contextual support in more ecologically valid conditions might be the next step, rather than moving to interventions prematurely. Nonetheless, it might be worth considering the focus of any eventual interventions: rather than intervening directly on individuals with autism, interventions in relation to verbal support might target peers, parents, guardians, teachers and other people in the social environments of individuals with autism. This brings with it the challenges of determining what factors would limit or facilitate the success of peer interventions – such exploration is beyond the scope of this report, but a recent systematic review of peer-mediated interventions for children with autism by Chang and Locke (2016) gives some reasons for being optimistic about this general approach. Here, we wish to close by amplifying one of their conclusions, namely the need to address more diverse populations of children with autism, especially those who have verbal difficulties.

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Table 1

Descriptive Statistics for Participant Characteristics

	TD		Autism	
	M	*SD*	*M*	*SD*
CA	6.0	0.5	9.2	1.6
TROG	14.1	3.6	7.6	6.0
RCPM	27.5	4.8	25.7	8.3

Note. TD = typically developing, CA = chronological age, TROG = Test for the Reception of Grammar (blocks passed, maximum = 20), RCPM = Raven's Coloured Progressive Matrices (raw score, maximum = 36)

Table 2

Descriptive Statistics

	Rating				Smiling/laughing				Comprehension			
	TD		Autism		TD		Autism		TD		Autism	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Riddle/no context	2.25	0.74	2.04	1.01	0.80	0.58	0.63	0.63	0.41	0.25	0.16	0.25
Riddle/context	2.30	0.75	2.31	0.98	0.97	0.63	0.78	0.85	0.48	0.27	0.17	0.30
Control/no context	1.48	0.73	2.15	1.05	0.19	0.25	0.50	0.46				
Control/context	1.54	0.68	1.89	1.05	0.17	0.25	0.46	0.46				

Note. TD = typically developing. Ratings are the average per trial (max=4), Smiling/laughing and Comprehension are proportions of all applicable trials.

Figure 1

Still Image of Example ‘Silhouette’ Video Shown to Participants

Figure 2

Funniness Scale