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Readers with Autism Can Produce Inferences, but they Cannot Answer Inferential Questions

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Abstract Readers with autism (ASD), poor comprehension (PC), and typical development (TD) took part in three reading experiments requiring the production of inferences. In Experiments 1 and 2 reading times for target phrases—placed immediately after text implicitly indicating the emotion of a protagonist or after a number of filler sentences, respectively—were used as measures of inferencing. In Experiment 3, participants were explicitly asked to identify the protagonist's emotion. There were no significant differences among groups in Experiment 1. Compared to TD readers, the PC group performed poorly in Experiments 2 and 3. ASD readers performed worse than PC participants only in the explicit-question task. Although ASD readers can produce inferences, they respond to questions about them with difficulty.

Keywords Autism · Inferences · Poor comprehension · Reading comprehension

Introduction

Readers with autism spectrum disorder (ASD) tend to show a discrepancy between comparatively good word reading and poor reading comprehension (e.g., Castles et al. 2010; Flores and Ganz 2009; Huemer and Mann 2010; Jones et al. 2009; St Clair et al. 2010). Although they are not all good word readers with respect to age-appropriate levels, their accuracy scores in word reading tasks are in many cases superior to their ability to respond in reading comprehension tests, showing what has been called a hyperlexic or poor comprehender profile (Brown et al. 2013; Nation 2005).

The inability to adequately process inferences is one of the deficits that has been most related to poor comprehension in autism. The original studies by Frith and Snowling (1983) and Happé (1997) showed that people with autism have difficulties inferring the adequate meaning of a homograph, because of their problems in placing themselves in the context of a story (but see Brock and Bzishvili 2013, for critical analysis of this task).

Later, Jolliffe and Baron-Cohen (1999a, b) also found that adult readers with ASD have problems in using context and making appropriate inferences in a series of experiments systematically exploring different levels of local and global text processing. For example, their readers with ASD had significantly greater difficulties than an age-matched control group in a multiple-choice task evaluating the ability to produce bridging inferences (1999a). In another one of their studies, they analysed if the participants were capable of offering context appropriate inferential answers in short mentalistic and nonmentalistic texts (1999b). The groups differed significantly in the accuracy and nature of the inferential explanations they offered for the mentalistic texts.

Norbury and Nation (2011) more recently also evaluated the ability of adolescents with autism to respond to inferential questions. Their analyses determined that, although oral language was largely responsible for differences among individuals, a diagnosis of autism predicted 10 % of the variance in inferencing scores in their participants.

All these studies have included tasks that rely on the capacity to make off-line inferences after reading a text:

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readers are presented with a story and then asked to respond to questions about what they have just read. This requires a conscious management of information and later reflection on the part of the reader.

An exception to this method is the study of Saldaña and Frith (2007). They evaluated automatic bridging inferences in texts with nonsocial and social content. Following a paradigm by Singer and Halldorson (1996), readers (aged between 12 and 19 years) were presented with questions of real-world knowledge that were primed or not by bridging inferences necessary for the comprehension of two-phrase stories. Shorter response times to world-knowledge questions in the primed condition indicated activation of this knowledge by a bridging inference. Both participants with ASD and age-matched controls showed this effect in both the nonsocial and social content stories. Based on these results, it seems plausible that readers with autism activate the necessary knowledge and produce pertinent inferences automatically. These results have been replicated recently by Sansosti et al. (2013). They used the same paradigm, adding eye tracking measures. They found that although children with ASD, aged 11–17 years old, made more and longer fixations and showed more regressions than the control group, they were able to produce the bridging inferences necessary for comprehension.

At a sentence level, Brock et al. (2008) had also found evidence for automatic on-line production of inferences. Using a visual-world paradigm, they registered the eye movements of a group of 24 adolescents with ASD between the ages of 12 and 17, who anticipated a target word predictable from the prior context of a phrase, just like age-matched controls.

However, results of these on-line studies may be a consequence of the shorter length of their stories. Norbury and Nation (2011) found that readers with autism and language delay were more accurate in tasks that demanded local coherence, instead of globally coherent decision making. This was consistent with the results of Jolliffe and Baron-Cohen (2000), who had also found problems in global inferencing in adults. It could be the case that on-line inferencing does not appear in longer texts and at the level of global inferencing necessary to understand the gist of a story or follow it from beginning to end. Our study will begin by exploring whether children, adolescents, and young adults with ASD are able to produce inferences in longer texts, automatically generating a mental model coherent with what is occurring in them. We shall then explicitly compare the ability of readers with ASD to respond to inference-related multiple-choice questions, like previous studies, and their on-line automatic production of those inferences, in the *same stories*.

Another aim of this study is to compare reading comprehension problems in individuals with and without autism. Most poor comprehenders do not have autism. The word to text comprehension discrepancy is also found in otherwise typically developing children with *specific comprehension difficulties* (Nation et al. 2010). As opposed to dyslexic readers, they tend to show adequate phonological abilities and representations, but poor vocabulary, verbal working memory, and oral language (Cornoldi and Oakhill 1996; Charles et al. 2011; Oakhill et al. 2005). Just like readers with autism, they also have limitations in responding to questions that require inferencing from text (Cain et al. 2003, 2004; Nash and Heath 2011; Oakhill et al. 2005; Yuill and Oakhill 1988; Yuill et al. 1989).

The question arises then as to whether their limitations are of the same nature and profile as the readers with autism. Up to now, no study has explicitly compared both groups in an inferencing task that taps on-line or off-line inferencing abilities. Our study includes a control group of poor comprehenders in order to do so.

Three experiments follow with the overall objective to determine the ability of readers with autism to produce automatic inferences in narrative text. We expected participants with ASD and poor comprehenders to have greater difficulties making automatic and off-line inferences in long texts with social and emotional content than typically developing participants. However, we also expected, in the case of readers with autism, to find greater problems in off-line that in on-line inferences.

The second of the experiments specifically explores the impact of memory load on the production of inferences. Some studies have shown that the distance between the text information required for an inference and inconsistent information provided subsequently affects readers' ability to detect the inconsistencies (Ackerman 1984a, b; Zabrucky and Ratner 1986). There are also studies supporting the idea that readers with poor comprehension experience greater difficulties in making inferences when memory demands are increased (Cain et al. 2003, 2004; Oakhill et al. 2005; Yuill and Oakhill 1988; Yuill et al. 1989). However, in the case of autism, evidence on working memory limitations is contradictory (Foley-Nicpon et al. 2012; Mayes and Calhoun 2008) and their impact on reading comprehension unclear. We therefore predicted that increased memory load would negatively impact poor comprehenders' ability to produce inferences more than it would in the case of typically developing participants and readers with ASD.

Experiment 1

In this first experiment, we examined the ability of participants with autism, poor comprehension and typical development to adopt the perspective of the main character

of a story by producing inferences relative to his or her emotions. In the case of autism, there is a special interest in examining emotions, because of the difficulties of individuals with autism in this area (e.g., Baron-Cohen et al. 2001) and because of the lack of data on the representation of emotion during reading. Following the paradigm developed by Gernsbacher et al. (1992) and de Vega et al. (1996), we designed a task to analyse the ability of the participants to detect the coherence or incoherence of an emotion, given the state or the perspective of the main character. In their studies, undergraduate students were asked to read texts in which the emotions of the character changed from the first to the second half. The story usually implied that the characters' feelings would evolve to an opposite emotion in response to the events in the narrative (i.e. from sadness to happiness). At no point was the emotion explicitly mentioned, with the exception of a target phrase, placed at the end of these sections, which could be coherent with one or the other. Inferencing and updating the representation of the characters' emotions was indicated by increased target reading times when the target phrase was incoherent with the section where it was placed, since target consistency was the only difference among versions of each story. Although reading times do not indicate the degree of specificity with which the emotions are identified by the readers (see, for example, Gygax et al. 2004, who claim that these kind of representations are not identified with precision by readers), they do, however, reliably point to the detection of an inconsistency that is related to inferring of the characters' emotions. We predicted that poor comprehenders and readers with autism would not show this effect due to an inability to adequately produce these inferences.

Method

Participants

Participants included 61 Spanish children, adolescents, and young adults in three groups of typically developing individuals, poor comprehenders and persons with autism, respectively. The typically developing group had age-appropriate text reading speed, reading comprehension accuracy scores, nonverbal IQ, and working memory (typically developing, TD, $n = 21$, ages 11–18 years). Poor comprehenders were otherwise typically developing individuals with nonverbal IQ and working memory scores within the normal range and age-appropriate word reading skills, but with difficulties in reading comprehension (poor comprehender group, PC, $n = 19$, ages 11–20 years). The autism group included children, adolescents, and young adults with a clinical diagnosis of Asperger syndrome or high-functioning autism (autism spectrum disorder, ASD, $n = 21$, ages 11–20 years).

The groups' distributions were matched on age, working memory, and reading speed (see Table 1). The mean nonverbal IQ of the PC group was lower than the ASD group, $t(38) = 3.83$, $p = .010$, $d = 0.88$. The ASD and PC groups both had lower reading comprehension accuracy scores than the TD group, $U\ (n = 42) = 98.00$, $p = .002$, $r = 0.50$ and $U\ (n = 40) = 0.00$, $p < .001$, $r = 0.86$, respectively. All individuals in the PC group in this and the next experiments scored at or below the 20th percentile on the standardized reading assessment instrument. All those in the CN group scored at or above percentile 55.

Materials and Procedure

Following de Vega et al. (1996), and using a self-paced phrase-by-phrase reading paradigm, participants were presented with 24 newly developed two-section texts on a computer screen. Fifteen filler texts of the same structure were also included. The approximate average completion time was 40 min. This and the following experiments were programmed in E-Prime 2.0 (Schneider et al. 2007).

A first seven-phrase section in each story described circumstances leading to a specific emotion in the main character of the narrative, without explicitly naming his or her feelings. The second half of the story, which included five phrases, described a change in circumstances that would normally make this character experience different feelings, usually an opposite emotion. The separation between sections was not made visible to the readers. All of the texts included a target sentence which explicitly mentioned the main character's emotion. This sentence could appear either after the first part (Locus 1 position) or after the second (Locus 2 position). Likewise, the target could either be coherent (Version 1) or incoherent (Version 2) with the first section, and therefore respectively incoherent and coherent with the second. A Version × Locus interaction, with faster reading times for target phrases coherent with the section that preceded them, would show an activation of the corresponding inferences for the character's emotions in each section of the text. Every story ended with a filler phrase and a true-or-false comprehension question. These questions were mostly related to specific details apparent in the text, and therefore not useful for assessing inferencing. Feedback was provided for the comprehension question. Table 2 shows an example of one of the texts.

In the case of participants with autism, we used the autism-spectrum quotient (AQ: Baron-Cohen et al. 2006) as a background test for autistic symptomatology. We administered the Magellan Scales of reading and writing

Table 1 Background data (mean scores and standard deviations) of participants

Variable	Typically developing		Poor comprehension		Autism spectrum disorder	
Experiment 1						
n	21		19		21	
Age (years)	14.86	(1.83)	15.01	(2.60)	15.00	(2.81)
Text reading speed (words per minute)	136.65	(24.03)	131.53	(26.02)	129.29	(34.34)
Nonverbal IQ (standard scores)	$100.29_{a,b}$	(10.52)	93.05_{a}	(8.50)	103.10_{b}	(14.05)
Working memory (standard scores)	105.71	(10.60)	101.26	(9.16)	106.62	(13.41)
Reading comprehension (percent correct)	79.70_{a}	(7.07)	46.71_{b}	(13.20)	58.35_{b}	(25.86)
Autism quotient (raw scores)	–		–		35.90	(6.76)
Experiment 2						
n	22		22		22	
Age (years)	15.48	(2.86)	15.49	(2.73)	16.64	(2.87)
Text reading speed (words per minute)	148.56	(19.07)	141.52	(28.06)	132.94	(33.36)
Nonverbal IQ (standard scores)	102.86	(8.78)	98.41	(11.09)	104.32	(15.11)
Working memory (standard scores)	$105.68_{a,b}$	(10.56)	97.68_{a}	(10.91)	106.95_{b}	(13.18)
Reading comprehension (percent correct)	83.44_{a}	(4.06)	43.18_{b}	(7.47)	56.88_{b}	(25.93)
Autism quotient (raw scores)	–		–		35.86	(6.58)
Experiment 3						
n	22		22		22	
Age (years)	15.83	(2.84)	15.48	(2.74)	16.64	(2.87)
Text reading speed (words per minute)	147.71	(15.64)	142.29	(26.80)	132.94	(33.36)
Nonverbal IQ (standard scores)	103.05	(10.38)	98.50	(11.02)	104.32	(15.11)
Working memory (standard scores)	$105.23_{a,b}$	(10.17)	97.55_{a}	(11.06)	106.95_{b}	(13.18)
Reading comprehension (percent correct)	82.14_{a}	(5.73)	43.18_{b}	(7.47)	56.88_{b}	(25.93)
Autism quotient (raw scores)	–		–		35.86	(6.58)

Means with different subscripts differ significantly at $p < .05$ (corrected) for working memory, at $p = .01$ (corrected) for nonverbal IQ and at $p < .001$ (corrected) for reading comprehension

Table 2 Example of a text from Experiments 1 and 3, with targets for different conditions of Experiment 1

Section 1	Fátima is going to work as a waitress this weekend. His sister is sick and she is going to replace her. When Fátima was a child she sat all her dolls and pretended to be a waitress, bringing glasses of water. Also, when asked what she wanted to be when she grew up, she always replied "a waitress". On top of it, she is going to earn some money in a proper job.
Target	Fátima was feeling excited. [*Locus 1 Version 1*]
	Fátima was feeling disappointed. [*Locus 1 Version 2*]
Section 2	But everything went wrong. Two people started screaming and fighting among themselves and she called the police. One customer was angry because she did not give him the change. In addition, Fatima stumbled and dropped the tray with a whole lot of glasses.
Target	Fátima was feeling excited. [*Locus 2 Version 1*]
	Fátima was feeling disappointed. [*Locus 2 Version 2*]
Filler phrase	Sometimes people even insult the waiters.
Question	Did Fatima call her sister when the fight started?
Correct answer	No

Target and filler phrases were not included in Experiment 3

(ELME TALE-2000: Toro et al. 2002) to test reading speed and comprehension, and the Spanish version of the Wechler Adult Intelligence Scales (WAIS-III: Wechsler 2002) and the Wechler Intelligence Scales for children (WISC-IV: Wechsler 2005) for nonverbal IQ and working memory. The EMLE TALE is widely used in Spain for the assessment of writing, decoding and reading comprehension. We only used the text reading fluency and

comprehension subtests. Reading speed and fluency have been shown to be strong indicators of reading difficulties in Spanish (Davies et al. 2007; Serrano and Defior 2005). For reading speed and fluency the children are asked to read out loud one of three age-appropriate texts and types of decoding errors and reading time are registered. Reading comprehension is assessed with multiple-choice questions presented after reading an age-appropriate text. Participants can read the text as many times as necessary and return to it if they wish. Test–retest reliability of the EMLE TALE ranges from .76 to .85 for the different ages involved in the study. It has a 98 % agreement with teacher ratings in the identification of poor comprehenders, and a Kappa of .68 for overall classification of readers into poor and good comprehenders.

Results

Shapiro and Wilks' W statistic was used to test for normality of variable distribution within each group. Due to excessive positive skew in the data, we performed a square-root transformation. This kind of transformation has a moderate effect on distribution shape and allows the use of parametric analyses for the study of main and interaction effects. A mixed-effects ANOVA on target reading times, with version and locus as the within-subjects factors and group (TD, PC, and ASD) as the between-subjects factor was carried out.

A main effect for version was found. Target reading times in Version 2 (coherent emotion in the second text portion and incoherent in the first) were significantly faster than those in Version 1, in the by-subjects analysis, F_1 (1, 58) = 6.93, $MCE = 11.77$, $p = .011$, $\eta_p^2 = .11$, mean difference 121 ms, CI 95 % (33, 209), but not in the by-items analysis, F_2 (1, 23) = 0.06, $MCE = 80.13$, $p = .810$, $\eta_p^2 = .003$. The expected interaction effect of locus and coherence variables was found: F_1 (1, 58) = 11.40, $MCE = 16.48$, $p = .001$, $\eta_p^2 = .16$ and F_2 (1, 23) = 8.46, $MCE = 32.08$, $p = .008$, $\eta_p^2 = .27$. However, as can be seen in Fig. 1, the third-order interaction of Locus × Version x Group was not significant: F_1 (2, 58) = 0.30, $MCE = 16.48$, $p = .743$, $\eta_p^2 = .01$. All other effects were nonsignificant, $F < 1$.

Although irrelevant to the study's aims, accuracy on the final question was compared across groups and no differences found, F_1 (2, 59) = 0.58, $MCE = 0.01$, $p = .561$, $\eta_p^2 = .02$.

Discussion

The results from our study replicate those of de Vega et al. (1996) with respect to the ability of readers to infer characters' emotions. These results were found for all groups,

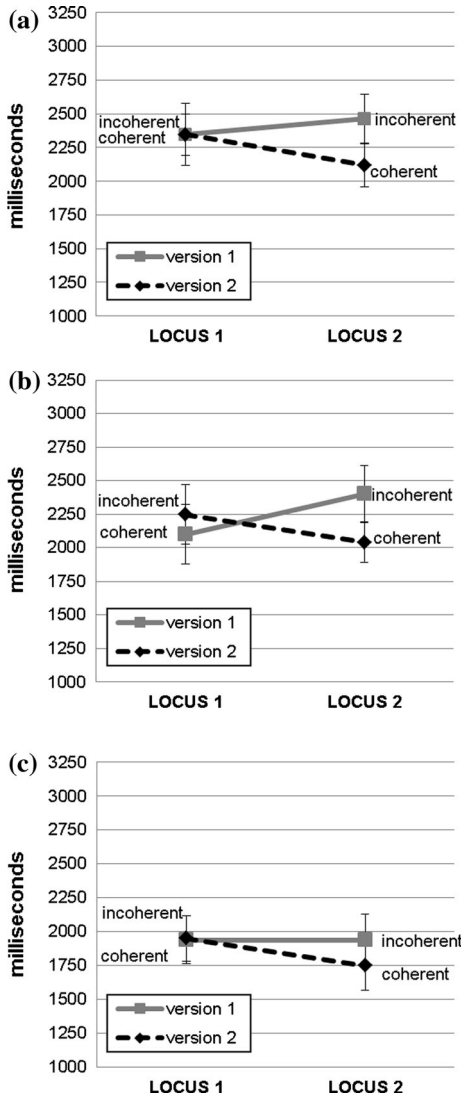

Fig. 1 Mean target reading times in Experiment 1 by version and locus in the typically developing (**a**), poor comprehension (**b**), and autism spectrum disorder (**c**) groups (*error bars* indicate standard errors)

with greater reaction times when the characters' emotions and the target phrases were not coherent.

These results are surprising because prior studies have shown difficulties in readers with autism in producing inferences and establishing the local and global coherence of a text (Frith and Snowling 1983; Happé 1997; Jolliffe and Baron-Cohen 1999a, b, 2000; Myles et al. 2002; Norbury and Nation 2011; Snowling and Frith 1986). We should however recall that these results were found in off-line processing tasks and that, although they might seem strange at first, our results coincide with those found in other studies exploring automatic inference processing (Saldaña and Frith 2007; Sansosti et al. 2013).

Poor comprehenders also behaved similarly to the TD group. Nation et al. (2003) had found that these children

were able to process and make inferences automatically at the phrase level. At the text level, Calleja et al. (2009) did use a task with a design similar to ours. They found that poor comprehension limited the ability to produce inferences related to the emotional status of protagonists. Their stories contained a variable number of phrases and the target phrase was in a different position in each story. It is therefore unclear at which level—phrase, paragraph or text—the participants' comprehension was being explored. The ability to produce emotional inferences might be related to the distance between the phrases that are used to facilitate the inferences and the target. The larger this separation, the greater the memory load of the inferential task should be. Our second experiment precisely manipulates this variable in order to study the impact of increased memory load in inferencing in poor comprehenders and readers with autism.

Experiment 2

A detailed analysis of the emotional stories used in Experiment 1 showed that in 88 % of the experimental stories the target appeared immediately after the phrases that provided the information necessary for the inference. One could question whether our participants were actually building a coherent view of the situation described in the text and inferring the character's emotion from there or, on the other hand, we were observing a recency effect (e.g., Oliphant 1983). Increased distance between contradictory information in a text seems to affect the ability to detect these inconsistencies (Ackerman 1984a, b; Zabrucky and Ratner 1986). Differences in inconsistency detection between good and poor comprehenders increase when they have to detect contradictions separated in a large text compared to pairs of sentences (Oakhill et al. 2005). Schoot et al. (2012) found in their study using a similar paradigm to ours that poor comprehenders were capable of detecting inconsistencies between the character of a protagonist and his or her actions when character and actions were close in the text, but not when they were separated by filler phrases. Working memory limitations have been found in other studies looking at the nature of poor comprehension and could be related to deficits in inferencing at the text level (Cain 2006). If this were the case, the results in Experiment 1 would be the result of a very low demand on working memory and adequate construction of local cohesion, but not the result of global text comprehension.

Experiment 2 followed the same structure as Experiment 1, but added neutral phrases between the relevant information and the target emotion phrases. We expected that with this manipulation poor comprehenders would present worse results, with no differences in reading times between coherent and incoherent target phrases. Due to normal working memory scores in the ASD group and unclear evidence in the literature regarding the status of working memory in autism in general and in the performance of readers with autism in particular, we did not expect differences in the performance of readers with ASD with respect to Experiment 1.

Method

Participants

The participants were 66 individuals with ASD, poor comprehension or typically developing ($n = 22$ in each group). Groups were matched on chronological age, reading speed, nonverbal IQ, and gender (see Table 1). All participants with ASD except for one were the same as in the previous study (due to the difficulty associated with recruiting this population), but PC and controls were all new to the task. The PC group had a significantly lower mean standard working memory score than the ASD group ($p = .031$), but the values were within the normal range in all the participants (≥ 79). A Kolmogorov–Smirnov two-sample test showed that the groups had equivalent distributions on all the variables, with the exception of reading speed, which differed between the ASD and TD groups, $Z = 1.66$, $p = .008$. The PC and ASD groups had poorer reading comprehension accuracy scores than the TD group, $U\ (n = 44) = 0.00$, $p < .001$, $r = 0.96$ and $U\ (n = 44) = 59.00$, $p < .001$, $r = 0.57$, respectively.

Materials and Procedure

Based on the design of the previous task, we developed new stories by including additional (neutral) sentences between the phrases that could be used for the generation of the inference and the target. We again used 24 experimental and 15 filler texts to maintain the parameters of Experiment 1 as much as possible (see Table 3). The neutral phrases did not offer information that could have been relevant for the production of the inference. The programming and procedure followed in this experiment were the same. The approximate average time for completion was 50 min. It was administered a minimum of 12 months later than Experiment 1.

Results

Since a square-root transformation did not succeed in achieving normality, we performed a logarithmic transformation of the data. A mixed-effects ANOVA on target reading times, with version and locus as the within-subjects

Table 3 Example of a text from Experiment 2, with targets for different conditions

Section 1	Isabel's boss has told her that she has to go to England for four months. She can't sleep since she received the news. She doesn't know how she will live there. She won't have her family nearby and, most important, she won't be able to talk to anyone because she doesn't speak English.
Neutral sentences	Twenty years ago, people rarely studied English at school and students could choose to study other languages, such as French or German. But nowadays, to get a job, you must speak English.
Target	Isabel was feeling unhappy. [*Locus 1 Version 1*]
	Isabel was feeling happy. [*Locus 1 Version 2*]
Section 2	After a month living there, Isabel has a lot of new friends. She also visits beautiful cities with her friends at the weekends. Now she doesn't want to leave England and she is learning English quickly.
Neutral sentences	Isabel's new friends are from different countries. If you want everyone to get on well, you must respect other people's cultures, and always try to be as tolerant as possible.
Target	Isabel was feeling unhappy. [*Locus 2 Version 1*]
	Isabel was feeling happy. [*Locus 2 Version 2*]
Filler phrase	In England, meal times are very different from ours.
Question	Does Isabel go to visit cities with her friends at the weekends?
Correct answer	Yes

factors and group (TD, PC, and ASD) as the between-subjects factor was carried out.

A main effect of group was found, F_1 (2, 63) = 8.87, $MCE = 0.13$, $p < .001$, $\eta_p^2 = .22$. The ASD group had significantly faster target reading times than the control group in all conditions (see Fig. 2). The mean reading time difference between these groups was 614 ms, CI 95 % (160, 1068), $p < .001$.

The expected interaction effect between version and locus was also significant: F_1 (1, 63) = 11.36, $MCE = 0.01$, $p = .001$, $\eta_p^2 = .15$ and F_2 (1, 23) = 4.45, $MCE = 608210.89$, $p = .046$, $\eta_p^2 = .16$.

We found a third-order interaction for Locus × Version × Group (see Fig. 2), F_1 (2, 63) = 6.38, $MCE = 0.01$, $p = .003$, $\eta_p^2 = .17$ and F_2 (1, 23) = 10.63, $MCE = 125057.09$, $p = .003$, $\eta_p^2 = .32$. We carried out follow-up repeated-measures ANOVAs for each group, with locus and version as within-subject variables. The Locus × Version interaction was significant in the TD group, after Bonferroni-corrected adjustment for multiple testing, F_1 (1, 21) = 10.97, $MCE = 0.02$, $p = .003$, $\eta_p^2 = .34$. This same interaction did not reach significance in either the poor comprehension or the ASD group, F_1 (1, 21) = .06, $MCE = 0.01$, $p = 1.00$, $\eta_p^2 = .003$ and F_1 (1, 21) = 5.35, $MCE = 0.01$, $p = .093$, $\eta_p^2 = .20$, respectively.

Differences were found among the groups in their accuracy in responding to the questions at the end of the text, .92 ($SD = .09$), .78 ($SD = .14$), and .87 SD = .10, for the TD, PC, and ASD groups respectively, F_1 (2, 63) = 8.48, $MCE = 0.01$, $p = .001$, $\eta_p^2 = .21$. Bonferroni-corrected post-hoc comparisons showed that the PC group underperformed with respect to the ASD ($p = .035$) and TD groups ($p < .001$). There were no differences between the ASD and TD groups ($p = .44$).

Discussion

This experiment replicates the results of Experiment 1 for the TD group in finding that readers slow down when they find a target phrase that is contradictory with implicit inferable information about a character's emotions, even when additional filler phrases are introduced between the information leading to the inference and the target phrase. However, this was not the case for either of the clinical groups. As we had expected, poor comprehenders faced difficulties in distinguishing between emotional consistency and inconsistency, due to the inclusion of the neutral filler phrases. These results are coherent with previous studies that indicate that the capacity of readers with specific comprehension problems drops with increased working memory load and the introduction of fillers (Cain 2006; Oakhill et al. 2005). Contrary to our expectations, readers with autism also failed to produce inferences at the same level as the typically developing group when neutral phrases were introduced.

Schoot et al. (2012) had found similar results to ours using a similar paradigm with poor comprehenders, who did not detect inconsistencies in texts with fillers between protagonists' character and their actions. They argued that poor comprehenders have the ability to detect inconsistencies and attempt repair of comprehension, but that they also construct a poorer mental representation of the story. They interpreted their results as an indication that poor comprehenders were not incorporating enough relevant

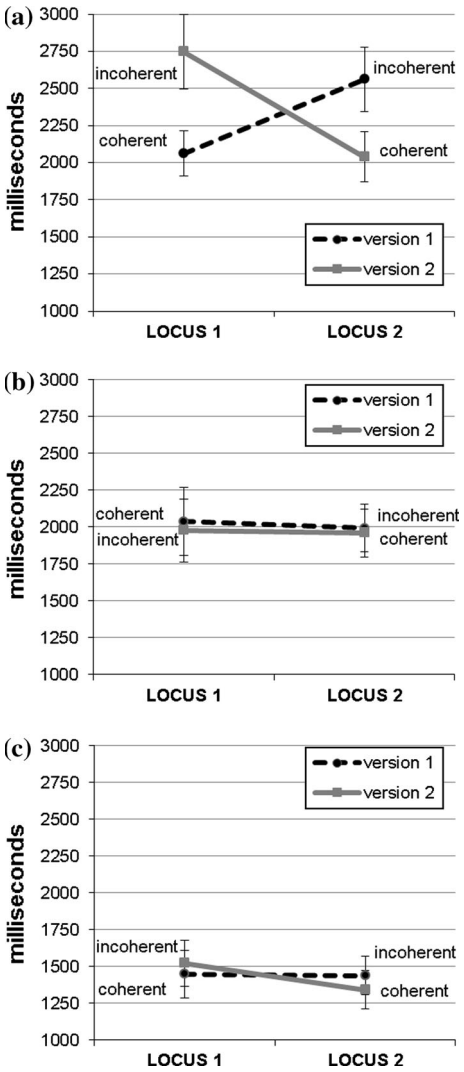

Fig. 2 Mean target reading times in Experiment 2 by version and locus in the typically developing (**a**), poor comprehension (**b**), and autism spectrum disorder (**c**) groups (*error bars* indicate standard error)

information into the mental model of the texts they were reading. In their view, it is not that poor comprehenders do not try to construct and update this representation with new information, it is just that it has not been adequately incorporated into a rich enough mental model for later retrieval. Our results seem to support this view. The participants with poor comprehension in our study can make use of the contextual information, produce an inference about emotions, and are reluctant to accept the inconsistency of the target phrase. However, this information is probably incorporated very weakly into the mental representation of the text, and therefore lost a few sentences later. This interpretation cannot be applied as clearly to the readers with autism. There is a trend to significance in the interaction effect in this group, which might be indicative of differences in the ability to respond to this task among individuals with autism. They do not only seem to attempt to update their mental model of the text, but their representation might be rich enough to provide sufficient information to detect inconsistencies a certain number of phrases later.

On the other hand, in spite of the ability of the readers with PC and ASD to at least produce inferences within smaller sections of text, this is still contrary to results in studies using off-line methods. Thus, it might be interesting to study what would happen if we expressly asked the participants to answer a specific question about a protagonist's emotion. This is what we did in our last experiment.

Experiment 3

Experiment 1 has shown that readers with autism and poor comprehenders are capable of producing the inferences necessary to construct a mental model of characters' emotions in a narrative, although Experiment 2 seems to indicate that this representation may be incomplete or fade quickly. The presence of some form of inferencing is coherent with other studies using on-line measures (Saldaña and Frith 2007; Sansosti et al. 2013), but not with studies using multiple-choice or other off-line tests (Jolliffe and Baron-Cohen 1999b, 2000; Norbury and Bishop 2002; Norbury and Nation 2011). However, up to now no study has explicitly compared these readers' comprehension in the same task with both on-line and off-line measures. This experiment, coupled with Experiment 1, intended to do so. The hypothesis was that neither readers with autism or with poor comprehension would be able to respond correctly to inferential questions, just like similar previous studies have found.

Method

Participants

Participants included 66 individuals, divided equally into each group, TD, PC, and ASD. All except 9 of the participants—eight from the TD group and one from the PC group—had taken part in Experiment 2. The groups were matched on the same variables as in previous experiments with the exception of working memory and reading comprehension (see Table 1). For working memory, we found that the PC group had a lower score than the ASD group, $p = .023$. The differences for reading comprehension were the same as in previous experiments. With the groups barely modified, we found, as in Experiment 2, that the distributions for variables among them were similar, with

the exception of reading speed in the comparison between the ASD and TD groups, $Z = 1.66$, $p = .008$.

Materials and Procedure

Texts from Experiment 1 were modified, adapted, and converted into an off-line task. The task consisted of 24 experimental texts of 12 phrases each; the only difference from the original design in Experiment 1 was the lack of a critical or target phrase where the emotion was made explicit and of filler phrases (see Table 2). A question about the emotional status of the main character at the end of the story was added. Readers were presented with four emotions, and asked to rank them according to how well they reflected the character's emotional status at the end of the story. Two of the emotions (the *main* emotions) were the emotions implicit in the story in Sections 1 and 2 and of opposite valence (e.g. *happy* and *sad*). The other two (*secondary* emotions) were of the same valence, but did not exactly correspond to the character's emotion (e.g. *satisfied* and *irritated*). The task instructions and aim were made explicit to the participants and thus no filler texts were used.

In other respects, the procedure was the same as in Experiments 1 and 2. Average approximate duration of the task was 30 min. Experiment 3 was administered a minimum of 12 months later than Experiment 1.

Results

Although participants were asked to rank scores, accuracy was measured only as correct identification of the character's emotion. ANOVAs on accuracy scores resulted in a main effect of group: F_1 (2, 63) = 19.29, $MCE = 0.04$, $p < .001$, $\eta_p^2 = .38$ and F_2 (2, 46) = 68.95, $MCE = 0.02$, $p < .001$, $\eta_p^2 = .75$. Participants with autism performed significantly worse than both the TD group, $t(35.74) = 6.91$, $p < .001$, $d = 2.06$ and the PC group, $t(42) = 3.04$, $p = .004$, $d = 0.91$ (Fig. 3). The PC group was less accurate than the TD group, $t(33.70) = 2.88$, $p = .007$, $d = 0.86$.

Since it is possible that accuracy on this task could be related directly to comprehension levels on the standardized reading test, and due to the great variability within the autism group, we divided it into two subgroups: those with percentile scores on the reading test below 20 (the closest cutoff to 1 SD below the population mean) were classified as poor readers with autism (ASD-P, n = 12) and those above percentile 35 (<0.5 SD below the mean in a normal distribution) as readers with autism and without comprehension difficulties, (ASD-N, n = 10). Again we found differences between groups, F_1 (3, 62) = 12.79, $MCE = 377.20$, $p < .001$, $\eta_p^2 = .38$. While typically developing participants and poor comprehenders had mean accuracy scores of 81 and 65 %, respectively, ASD-N and ASD-P groups only responded correctly in a mean 47 and 43 % of occasions. Post-hoc Bonferroni-corrected analyses showed that the ASD-N group's performance was significantly worse than the TD group, $t(30) = 5.81$, $p < .001$, $d = 2.05$, and the ASD-P group was significantly worse than the TD group, $t(15.28) = 5.39$, $p < .001$, $d = 2.07$ and less accurate than the PC group, $t(32) = 2.68$, $p = .044$, $d = 0.96$, respectively.

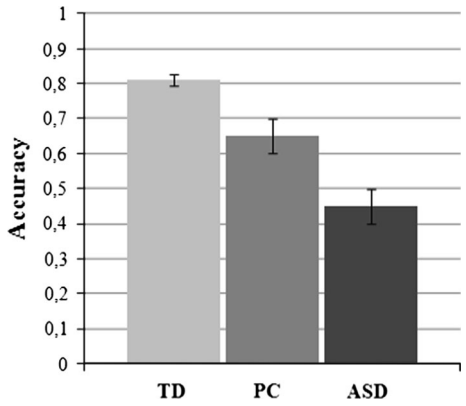

Fig. 3 Mean accuracy in selecting the correct emotion of typically developing (TD), poor comprehender (PC), and autism spectrum disorder (ASD) groups. *Error bars* indicate standard error

Also, in order to reduce the complexity of the task and compensate for potential problems some participants may have had with the exact definition of some of the emotions, accuracy scores were recalculated. We accepted as valid any response that provided the adequate emotional valence. For example, for positive character emotions both the main positive emotion and the positive secondary emotion were considered correct. Original undivided-group differences were still significant, F_1 (2, 63) = 18.77, $MCE = 0.04$, $p < .001$, $\eta_p^2 = .37$ y F_2 (2, 46) = 97.91, $MCE = 0.01$, $p < .001$, $\eta_p^2 = .81$. Once again, the ASD group had poorer scores than both the TD, $t(24.78) = 6.78$, $p < .001$, $d = 2.04$, and the PC groups, $t(42) = 2.59$, $p = .013$, $d = .81$. The PC group also had lower scores than the TD group, $t(25.13) = 3.48$, $p = .002$, $d = 1.00$.

Discussion

The results from Experiment 3 show that typically developing participants were producing the inference that allowed them to select the correct emotion over 80 % of the time. This was not the case for either poor comprehenders or readers with autism, who had significantly lower accuracy scores. This occurred even when they only had to

choose between an emotion of the same valence as the one of the main character and an emotion of opposite valence.

The data for the autism group agree with those found in the literature regarding inferencing in general in off-line studies (Jolliffe and Baron-Cohen 1999b, 2000; Norbury and Bishop 2002; Norbury and Nation 2011). The difficulties observed in the poor comprehension group also appear to be consistent with the evidence that the problems encountered by these readers are the result of deficits in producing inferences during tasks requiring the conscious manipulation of information (Cain and Oakhill 1999; Nation 2005). It should be noted that these texts were the same ones as those used in Experiment 1, and therefore did *not* include neutral phrases.

Although both the ASD and the PC groups had significantly poorer scores than the TD group, participants with autism were also worse than the PC group. In addition, even the ASD group without comprehension problems showed a performance similar to the PC group and significantly poorer than the TD groups. This could indicate that, in addition to potential comprehension problems, readers with autism might be facing some specific issues related to the actual processing of the off-line task itself.

General Discussion

The combined results of our experiments provide us with a surprising picture of inference production in readers with autism: we see them inferring the emotions of main characters in short narratives, but not being able to respond to questions about those same inferred emotions. Prior studies had found evidence of inference production at the local between-sentence level in very short texts (Saldaña and Frith 2007; Sansosti et al. 2013). This also what we find here in the context of longer stories. However, when the same participants with ASD were asked to respond to a question about the emotional status of a certain character *after* the same texts (Experiment 3), their performance was relatively poor.

In Experiment 1, the PC group also showed signs of having detected the implicit emotional status of the main character, just like the ASD group. They presented the same dissociation between their reading times, which seemed to demonstrate an ability to produce inferences and detect inconsistencies, and the ability to respond to a question about the content of these inferences. They were then also unable to respond to a question related to this particular inference.

The reason for the discrepancy between the on-line and multiple-choice measures is unclear. Experiment 2 might provide some indications as to why this may be happening. In this task the demand for the construction of a global representation of the text is much clearer, due to the distance that existed between the phrases necessary to produce the inference and the target sentence. It is possible that ASD and PC readers do detect the inconsistencies at a local level, but do not incorporate all the relevant information to the ongoing mental representation (Schoot et al. 2012). This would explain that inconsistencies of information found further along the text, after the neutral phrases introduced in Experiment 2, are not detected. More relevant to the present discussion, this information might not be available when needed to respond to questions at the end of the text.

This might not be, however, the only factor involved. Poor comprehenders and readers with autism were not exactly identical in their performance. Accuracy rates of the autism group was actually poorer than the poor comprehenders' in the multiple-choice task of the third experiment, indicating that the actual issue of responding to a question might be a greater problem in their case. This was so even in individuals that had comparatively good scores in standardized reading comprehension tasks. The differences in performance in off-line versus on-line tasks could be due to the additional processing necessary to respond to a question, and not only to the production of the text representation itself. Answering a question in a comprehension task is a form of problem-solving that requires paying attention to what is being asked, recalling relevant information and using it to the end of satisfying a speaker or completing a question. We can hypothesize that some of the cognitive features traditionally associated with ASD could be negatively influencing their capacity to respond to questions. Deficits in executive function, and more specifically problem-solving, could be playing a role here. Identifying what is relevant to a given communicative exchange, such as oral or written questions, is a task that also entails certain pragmatic challenges. These could also pose a specific problem for readers with autism. They could also have a limited ability for introspection that could be impacting on their ability to reflect upon their representation of text.

Another possible interpretation of our results could relate to the content of the stories. Although results vary among studies, overall individuals with autism appear to have problems in emotion recognition (see, for example, the meta-analysis by Uljarevic and Hamilton 2013). Recently, Bodner et al. (2015) found that readers with ASD had more problems producing inferences in texts with content related to emotion and theory-of-mind than physical content. However, the use of emotional-content texts does not invalidate our main finding, i.e., that some form of inferencing is occurring on-line while readers with ASD are processing text, even in emotional-content stories. The use of an emotional text could actually be considered a

worst-case scenario for the production of both on-line and off-line inferences in autism.

Another possible limitation to the interpretation of the results could be the large age range of the participants. Some of them could simply be performing worse for developmental reasons, such as poorer background knowledge (Bodner et al. 2015). Although of interest to future studies, we do not feel that the impact of chronological age will substantially modify the results of this study. In preliminary analyses, participants were divided into two subgroups, with ages below and above 12 years, with the same results in each of them as have been presented here. The large age range could actually be seen to counter a potential maturation effect due to the time occurred between experiments. If all participants were within the same small age range, their response to the tasks could have changed as they grew from one small age group to another in different experiments. Considering the group as a whole, precisely because of this ample age range, this is not the case.

Finally, poor verbal abilities are likely to be playing a role. They have been shown to be prevalent in poor comprehenders, and could explain some of the commonality between our two clinical groups. However, one should bear in mind that performance in both groups is not identical. The influence of language and verbal skills on the ability to produce inferencing and oral language in comprehension in autism have been demonstrated and are obviously part of the difficulties of each of our groups (Ricketts et al. 2013). However, Ricketts et al. (2013) also found that measures of social performance predicted variability in reading comprehension in readers with autism after controlling for verbal abilities, as did Norbury et al. (2011), Lucas and Norbury (2015) and Bodner et al. (2015) with an autism diagnosis. In our case, oral language was not specifically measured and pragmatic or other subtle limitations cannot be totally ruled out as a potential confound in the results. In this regard, it would be of interest in future research to specifically evaluate the production of pragmatic inferences that require integration of contextual information and discourse with ASD populations with high and low-level language abilities, both on and off-line. If an interaction between on-line/off-line inferencing and language level were found, it would also have practical implications for how inferencing and reading comprehension are evaluated in different groups of individuals with autism.

Whatever the reason for their inability to respond to inferential questions, if replicated these results could have practical repercussions on both the assessment and treatment of reading comprehension problems in autism. We have to ask ourselves about the extent to which different tasks are correctly assessing reading comprehension when used with persons with autism, even in the case of standardized tests. The results might be contaminated by their ability to respond to questions in these tests. At the same time, if future studies find a certain degree of specificity with respect to poor comprehenders without autism, we should think carefully about the extension of reading comprehension interventions to readers with autism without any adaptation (see, for example, Chiang and Lin 2007).

People with ASD might be able to understand stories and create the corresponding mental representation, but not respond correctly to related academic or professional tasks. In addition to exploring the role of variables such as oral language or text content, one potential focus for future research could be on processes specifically related to question-answering and on the type of demands this kind of task poses.

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Author Contributions The experiments described in this paper were part of María J. Tirado's PhD Dissertation. David Saldaña was her supervisor. María J. Tirado recruited the participants, programmed the experiments, analysed the data, and wrote the first draft of the paper. David Saldaña supervised the planning of the study, stimuli and analyses, and contributed significantly to the final version of the paper.

References

Ackerman, B. P. (1984a). Storage and processing constraints on integrating story information in children and adults. *Journal of Experimental Child Psychology, 38*, 64–92. doi:10.1016/0022-0965(84)90019-5.

Ackerman, B. P. (1984b). The effects of storage and processing complexity on comprehension repair in children and adults. *Journal of Experimental Child Psychology, 37*, 303–334. doi:10.1016/0022-0965(84)90007-9.

Baron-Cohen, S., Hoekstra, R. A., Knickmeyer, R., & Wheelwright, S. (2006). The autism-spectrum quotient (AQ)–adolescent version. *Journal of Autism and Developmental Disorders, 36*, 343–350. doi:10.1007/s10803-006-0073-6.

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 and Allied Disciplines, 42*, 241–251. doi:10.1017/S0021963001006643.

Bodner, K. E., Engelhardt, C. R., Minshew, N. J., & Williams, D. L. (2015). Making inferences: Comprehension of physical

causality, intentionality, and emotions in discourse by high-functioning older children, adolescents, and adults with autism. *Journal of Autism and Developmental Disorders,*. doi:10.1007/s10803-015-2436-3.

Brock, J., & Bzishvili, S. (2013). Deconstructing frith and snowling's homograph-reading task: Implications for autism spectrum disorders. *The Quarterly Journal of Experimental Psychology, 66*, 1764–1773. doi:10.1080/17470218.2013.766221.

Brock, J., Norbury, C., Einav, S., & Nation, K. (2008). Do individuals with autism process words in context? Evidence from language-mediated eye-movements. *Cognition, 108*, 896–904. doi:10.1016/j.cognition.2008.06.007.

Brown, H. M., Oram-Cardy, J., & Johnson, A. (2013). A meta-analysis of the reading comprehension skills of individuals on the autism spectrum. *Journal of Autism and Developmental Disorders, 43*, 932–955. doi:10.1007/s10803-012-1638-1.

Cain, K. (2006). Individual differences in children's memory and reading comprehension: An investigation of semantic and inhibitory deficits. *Memory, 14*, 553–569. doi:10.1080/09658210600624481.

Cain, K., & Oakhill, J. V. (1999). Inference making ability and its relation to comprehension failure in young children. *Reading and Writing, 11*, 489–503. doi:10.1023/A:1008084120205.

Cain, K., Oakhill, J. V., & Elbro, C. (2003). The ability to learn new word meanings from context by school-age children with and without language comprehension difficulties. *Journal of Child Language, 30*, 681–694. doi:10.1017/S0305000903005713.

Cain, K., Oakhill, J. V., & Lemmon, K. (2004). Individual differences in the inference of word meanings from context: The influence of reading comprehension, vocabulary knowledge, and memory capacity. *Journal of Educational Psychology, 96*, 671–681. doi:10.1037/0022-0663.96.4.671.

Calleja, M., Rodríguez-Santos, J. M., Torres, S., & García-Orza, J. (2009). La generación de inferencias causales de naturaleza emocional en sujetos con alto y bajo nivel lector [production of causal inferences of an emotional nature in good and poor readers]. *Infancia y Aprendizaje, 32*, 583–586.

Castles, A., Crichton, A., & Prior, M. (2010). Developmental dissociations between lexical reading and comprehension: Evidence from two cases of hyperlexia. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 46*, 1238–1247. doi:10.1016/j.cortex.2010.06.016.

Chiang, H. M., & Lin, Y. H. (2007). Reading comprehension instruction for students with autism spectrum disorders a review of the literature. *Focus on Autism and Other Developmental Disabilities, 22*, 259–267. doi:10.1177/10883576070220040801.

Cornoldi, C., & Oakhill, J. V. (1996). *Reading comprehension difficulties: Processes and intervention*. New York, NY: Routledge.

Davies, R., Cuetos, F., & González-Seijas, R. M. (2007). Reading development and dyslexia in a transparent orthography: A survey of Spanish children. *Annals of Dyslexia, 57*, 179–198. doi:10.1007/s11881-007-0010-1.

De Vega, M., León, I., & Díaz, J. M. (1996). The representation of changing emotions in reading comprehension. *Cognition and Emotion, 10*, 303. doi:10.1080/026999396380268.

Flores, M. M., & Ganz, J. B. (2009). Effects of direct instruction on the reading comprehension of students with autism and developmental disabilities. *Education and Training in Developmental Disabilities, 44*(1), 39–53.

Foley-Nicpon, M., Assouline, S. G., & Stinson, R. D. (2012). Cognitive and academic distinctions between gifted students with autism and Asperger syndrome. *Gifted Child Quarterly, 56*, 77–89. doi:10.1177/0016986211433199.

Frith, U., & Snowling, M. (1983). Reading for meaning and reading for sound in autistic and dyslexic children. *British Journal of Developmental Psychology, 1*, 329–342. doi:10.1111/j.2044-835X.1983.tb00906.x.

Gernsbacher, M. A., Goldsmith, H. H., & Robertson, R. (1992). Do readers mentally represent characters' emotional states? *Cognition and Emotion, 6*, 89–111. doi:10.1080/02699939208411061.

Gygax, P., Garnham, A., & Oakhill, J. (2004). Inferring characters' emotional states: Can readers infer specific emotions? *Language and Cognitive Processes, 19*, 613–639. doi:10.1080/01690960444000016.

Happé, F. (1997). Central coherence and theory of mind in autism: Reading homographs in context. *British Journal of Developmental Psychology, 15*(1), 1–12. doi:10.1111/j.2044-835X.1997.tb00721.x.

Huemer, S. V., & Mann, V. (2010). A comprehensive profile of decoding and comprehension in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 40*, 485–493. doi:10.1007/s10803-009-0892-3.

Hulme, C., & Snowling, M. (2011). Children's reading comprehension difficulties nature, causes, and treatments. *Current Directions in Psychological Science, 20*, 139–142. doi:10.1177/0963721411408673.

Jolliffe, T., & Baron-Cohen, S. (1999a). A test of central coherence theory: Linguistic processing in high-functioning adults with autism or Asperger syndrome: Is local coherence impaired? *Cognition, 71*, 149–185. doi:10.1016/S0010-0277(99)00022-0.

Jolliffe, T., & Baron-Cohen, S. (1999b). The strange stories test: A replication with high-functioning adults with autism or Asperger syndrome. *Journal of Autism and Developmental Disorders, 29*, 395–406. doi:10.1023/A:1023082928366.

Jolliffe, T., & Baron-Cohen, S. (2000). Linguistic processing in high-functioning adults with autism or Asperger's syndrome: Is global coherence impaired? *Psychological Medicine, 30*, 1169–1187. doi:10.1017/S003329179900241X.

Jones, C. R. G., Happé, F., Golden, H., Marsden, A. J. S., Tregay, J., Simonoff, E., & Charman, T. (2009). Reading and arithmetic in adolescents with autism spectrum disorders: Peaks and dips in attainment. *Neuropsychology, 23*, 718–728. doi:10.1037/a0016360.

Lucas, R., & Norbury, C. (2015). Making inferences from text: It's vocabulary that matters. *Journal of Speech, Language, and Hearing Research,*. doi:10.1044/2015_JSLHR-L-14-0330.

Mayes, S. D., & Calhoun, S. L. (2008). WISC-IV and WIAT-II profiles in children with high-functioning autism. *Journal of Autism and Developmental Disorders, 38*, 428–439. doi:10.1007/s10803-007-0410-4.

Myles, B. S., Hilgenfeld, T. D., Barnhill, G. P., Griswold, D. E., Hagiwara, T., & Simpson, R. L. (2002). Analysis of reading skills in individuals with Asperger syndrome. *Focus on Autism and Other Developmental Disabilities, 17*(1), 44–47. doi:10.1177/108835760201700104.

Nash, H., & Heath, J. (2011). The role of vocabulary, working memory and inference making ability in reading comprehension in down syndrome. *Research in Developmental Disabilities, 32*, 1782–1791. doi:10.1016/j.ridd.2011.03.007.

Nation, K. (2005). Children's reading comprehension difficulties. In M. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (1st ed., pp. 248–265). Oxford: Blackwell.

Nation, K., Cocksey, J., Taylor, J. S. H., & Bishop, D. V. M. (2010). A longitudinal investigation of early reading and language skills in children with poor reading comprehension. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 51*, 1031–1039. doi:10.1111/j.1469-7610.2010.02254.x.

Nation, K., Marshall, C. M., & Altmann, G. T. M. (2003). Investigating individual differences in children's real-time sentence comprehension using language-mediated eye

movements. *Journal of Experimental Child Psychology, 86*, 314–329. doi:10.1016/j.jecp.2003.09.001.

Norbury, C., & Bishop, D. V. M. (2002). Inferential processing and story recall in children with communication problems: A comparison of specific language impairment, pragmatic language impairment and high-functioning autism. *International Journal of Language & Communication Disorders, 37*, 227–251. doi:10.1080/13682820210136269.

Norbury, C., & Nation, K. (2011). Understanding variability in reading comprehension in adolescents with autism spectrum disorders: Interactions with language status and decoding skill. *Scientific Studies of Reading, 15*, 191–210. doi:10.1080/10888431003623553.

Oakhill, J., Hartt, J., & Samols, D. (2005). Levels of comprehension monitoring and working memory in good and poor comprehenders. *Reading and Writing: An Interdisciplinary Journal, 18*, 657–686.

Oliphant, G. W. (1983). Repetition and recency effects in word recognition. *Australian Journal of Psychology, 35*, 393–403. doi:10.1080/00049538308258751.

Ricketts, J., Jones, C. R. G., Happé, F., & Charman, T. (2013). Reading comprehension in autism spectrum disorders: The role of oral language and social functioning. *Journal of Autism and Developmental Disorders, 43*, 807–816. doi:10.1007/s10803-012-1619-4.

Saldaña, D., & Frith, U. (2007). Do readers with autism make bridging inferences from world knowledge? *Journal of Experimental Child Psychology, 96*, 310–319. doi:10.1016/j.jecp.2006.11.002.

Sansosti, F. J., Was, C., Rawson, K. A., & Remaklus, B. L. (2013). Eye movements during processing of text requiring bridging inferences in adolescents with higher functioning autism spectrum disorders: A preliminary investigation. *Research in Autism Spectrum Disorders, 7*, 1535–1542. doi:10.1016/j.rasd.2013.09.001.

Schneider, W., Eschman, A., & Zuccolotto, A. (2007). *E-Prime program. (Versión 2.0)*. Pittsburgh: Psychology Software Tools Inc.

Schoot, M., Reijntjes, A., & Lieshout, E. C. D. M. (2012). How do children deal with inconsistencies in text? An eye fixation and self-paced reading study in good and poor reading comprehenders. *Reading and Writing, 25*, 1665–1690. doi:10.1007/s11145-011-9337-4.

Serrano, F., & Defior, S. (2005). Dyslexia in Spanish: The state of the matter. *Electronic Journal of Research in Educational Psychology, 2*, 13–34.

Singer, M., & Halldorson, M. (1996). Constructing and validating motive bridging inferences. *Cognitive Psychology, 30*, 1–38. doi:10.1006/cogp.1996.0001.

Snowling, M., & Frith, U. (1986). Comprehension in "hyperlexic" readers. *Journal of Experimental Child Psychology, 42*, 392–415. doi:10.1016/0022-0965(86)90033-0.

St Clair, M. C., Durkin, K., Conti-Ramsden, G., & Pickles, A. (2010). Growth of reading skills in children with a history of specific language impairment: The role of autistic symptomatology and language-related abilities. *The British Journal of Developmental Psychology, 28*(Pt 1), 109–131.

Toro, J., Cervera, M., & Urio, C. (2002). *EMLE: Escalas Magallanes De Lectura Y Escritura: TALE-2000 [Magellan scales for reading and writing]*. Madrid: Grupo ALBOR-COHS.

Uljarevic, M., & Hamilton, A. (2013). Recognition of emotions in autism: A formal meta-analysis. *Journal of Autism and Developmental Disorders, 43*, 1517–1526. doi:10.1007/s10803-012-1695-5.

Wechsler, D. (2002). *WAIS-III: Escala De Inteligencia De Wechsler Para Adultos-III*. Madrid: TEA.

Wechsler, D. (2005). *WISC-IV: Escala De Inteligencia De Wechsler Para Niños IV*. Madrid: TEA.

Yuill, N., & Oakhill, J. V. (1988). Understanding of anaphoric relations in skilled and less skilled comprehenders. *British Journal of Psychology, 79*, 173–186. doi:10.1111/j.2044-8295.1988.tb02282.x.

Yuill, N., Oakhill, J. V., & Parkin, A. (1989). Working memory, comprehension ability and the resolution of text anomaly. *British Journal of Psychology, 80*, 351–361. doi:10.1111/j.2044-8295.1989.tb02325.x.

Zabrucky, K., & Ratner, H. H. (1986). Children's comprehension monitoring and recall of inconsistent stories. *Child Development, 57*, 1401–1418. doi:10.2307/1130419.