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Caruana N, Brock J. 2014. No association between autistic traits and contextual influences on eye-movements during reading. PeerJ 2:e466 <u>https://doi.org/10.7717/peerj.466</u>

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3 4 Nathan Caruana & Jon Brock 5 Department of Cognitive Science, Macquarie University, Sydney, Australia 6 7 8 Individuals with autism spectrum disorders are claimed to show a local 9 cognitive bias, termed "weak central coherence", which manifests in a reduced 10 influence of contextual information on linguistic processing. Here, we investigated 11 whether this bias might also be demonstrated by individuals who exhibit sub-clinical 12 levels of autistic traits, as has been found for other aspects of autistic cognition. The 13 eye-movements of 71 university students were monitored as they completed a reading 14 comprehension task. Consistent with previous studies, participants made shorter 15 fixations on words that were highly predicted on the basis of preceding sentence 16 context. However, contrary to the weak central coherence account, this effect was not 17 reduced amongst individuals with high levels of autistic traits, as measured by the 18 Autism Spectrum Quotient (AQ). Further exploratory analyses revealed that 19 participants with high AQ scores fixated longer on words that resolved the meaning of 20 an earlier homograph. However, this was only the case for sentences where the two 21 potential meanings of the homograph result in different pronunciations. The results 22 provide tentative evidence for differences in reading "style" that are associated with 23 autistic traits, but fail to support the notion of weak central coherence extending into 24 the non-autistic population.

No association between autistic traits and contextual influences on eye-

movements during reading

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No association between autistic traits and contextual influences on eyemovements during reading

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29 Autism spectrum disorders are currently defined and diagnosed in terms of 30 clinically significant social and communication impairments, co-occurring with 31 repetitive behaviours and restricted interests (APA, 2013). Diagnosis is categorical 32 but it is generally acknowledged that there is no clear cut off, with autistic-like 33 behavioural traits being continuously distributed in the general population. Moreover, 34 a number of studies have reported that non-autistic individuals who self-report high 35 levels of autistic traits also evidence cognitive strengths and weaknesses that are 36 similar to those identified in studies of individuals with a clinical diagnosis of autism. 37 Examples include impaired performance on a test of facial emotion recognition 38 (Baron-Cohen et al., 2001; Voracek & Dressler, 2006) and enhanced performance on 39 visual search tasks (Almeida et al., 2010; Brock et al., 2011; Milne, Dunn, Freeth, & 40 Rosas-Martinez, 2013; but see Gregory & Plaisted-Grant, 2013). 41 The current study was motivated by another classic finding in autism research 42 - the poor performance of autistic individuals on a test of homograph reading (see 43 Brock & Caruana, in press for review). In the homograph reading test, participants

44 read aloud sentences containing heterophonic homographs - words such as "tear" and

45 "bow" that have two or more meanings associated with different pronunciations. If

46 the sentence has been understood correctly then participants should give the

47 contextually appropriate pronunciation of the homograph. However, autistic

- 48 individuals tend to perform relatively poorly on the test, suggesting a failure of
- 49 sentence-level language comprehension (Burnette, Mundy, Meyer, Sutton, Vaughan,

50 & Charak; Burnette et al., 2005; Frith & Snowling, 1983; Happe, 1997; Joliffe & 51 Baron-Cohen, 1999; Lopez & Leekam, 2003; but see Snowling & Frith, 1986). 52 Impaired homograph reading has been interpreted in terms of a deficit in 53 context processing, termed "weak central coherence" (Frith, 1989). On this view, 54 autistic individuals make errors on the task because they process each word in 55 isolation, ignoring the surrounding context. However, studies involving ambiguous 56 spoken words have been less supportive of this account, indicating that individuals 57 with autism show a degree of sensitivity to sentence context that is commensurate 58 with their language abilities (Brock, Norbury, Einav, & Nation, 2008; Henderson, 59 Clarke, & Snowling, 2011; Lopez & Leekam, 2003; Norbury, 2005). For example, 60 Brock et al. (2008) used a language-mediated eye-movements paradigm in which 61 participants viewed a display of four objects whilst listening to spoken sentences. 62 Children with autism and control children matched on language ability showed the 63 same tendency to make anticipatory saccades towards objects that were predicted by 64 the sentence context. They also showed the same mediating effect of sentence context 65 on gaze towards objects that were phonologically similar to the word they were 66 hearing. These findings challenge the central coherence account and suggest that there 67 may be some alternative explanation for poor performance on the homograph test. 68 In their original study of homograph reading, Frith and Snowling (1983) noted 69 that, whereas typically developing and dyslexic children often hesitated or began the 70 sentence again after they had mispronounced a homograph, autistic children "never 71 showed any signs of being aware of their errors" (p. 336). Similarly, Happé (1997) 72 noticed "striking" differences in the tendency of autistic and non-autistic participants 73 to self-correct their homograph reading errors. Such observations suggest that poor 74 performance may reflect, not a failure of context sensitivity, but a failure of

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comprehension monitoring. That is, autistic individuals may not recognize when the
sentence stops making sense because they have misconstrued the homograph.

77 In fact, Happé (1997) argued against this comprehension monitoring account, 78 noting that group differences in performance remained when self-corrections were 79 ignored and participants were scored only on their initial attempts at producing the 80 homograph (see also Lopez & Leekam, 2003). However, this argument rests on the 81 assumption that the participant's first attempt at articulating the homograph necessarily corresponds to their initial interpretation of it. This is clearly not the case, 82 83 as many participants perform the task without overt errors, even when the 84 disambiguation comes some time *after* the homograph. Indeed, a recent eye-tracking 85 study of the task showed a considerable lag between participants fixating on the 86 homograph and beginning to articulate it (Brock & Bzishvilli, 2013). Given the 87 challenges to the weak central coherence account, the issue of comprehension 88 monitoring in autism is certainly worth revisiting.

89 As a forerunner to studies of individuals with autism, the current study aimed 90 to contrast these two opposing accounts of impaired homograph reading by looking at 91 the relationship between autistic traits in a nonclinical population and participants' 92 eye-movements during reading. To test the "central coherence" account, participants 93 read a series of short sentences involving a predictability manipulation, whereby the 94 same target words were either highly predictable or completely unpredictable 95 (although not semantically anomalous) based on the preceding sentence stem. 96 Previous research has shown that readers spend less time fixating on words the more 97 predictable they are (Ehrlich & Rayner, 1981), presumably because the processing of 98 words is facilitated if they are already anticipated (Kliegl, Nuthmann, & Engbert, 99 2006; Rayner & Well, 1996). If individuals with autism process words out of context,

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100 we would expect this contextual facilitation effect to be reduced amongst those101 reporting high levels of autism-like traits.

102 The "comprehension monitoring" account was assessed via an ambiguity 103 manipulation. Participants read sentences containing an early homograph that was 104 later disambiguated towards its less common meaning. In a corresponding control 105 condition, the same sentences were presented but with the homograph replaced by an 106 unambiguous synonym. Previous studies have shown that participants spend longer 107 fixating on regions of text that disambiguate an earlier homograph (Duffy, Morris, & 108 Rayner, 1988; Rayner & Duffy, 1986). This is attributed to the longer time required to 109 integrate the disambiguating word with the preceding sentence, particularly if it 110 requires a reevaluation of the meaning of the homograph. However, Van der Schoot et 111 al. (2009) found that non-autistic children with reading comprehension difficulties 112 failed to show an ambiguity effect in this paradigm. This suggests that these children 113 were unaware when they had misinterpreted the homograph and thus made no attempt 114 to reconcile the disambiguating word with the homograph. As the authors noted, this 115 finding is consistent with a large body of evidence for reduced comprehension 116 monitoring in this population (cf. Ehrlich, 1996; Ehrlich, Remond, & Tardieu, 1999; 117 Yuill & Oakhill, 1991; Zabrucky & Moore, 1989). If individuals with autism also 118 have difficulties in comprehension monitoring, we would likewise expect a reduction 119 in this ambiguity effect amongst participants with high levels of autistic traits. 120 121 Method

122 Ethics

123 The study was approved by the Macquarie University Human Research Ethics

124 Committee (Ref D00167). Participants provided written consent prior to participation.

125 **Participants**

Seventy-one 18- to 23-year-old undergraduate students (49 females, 22 males)
were recruited at Macquarie University, Sydney where they received course credit for
their participation. All participants were native English speakers and had either
normal or corrected to normal vision.

130 The Autism Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, 131 Martin, & Clubley, 2001) was used as a measure of sub-clinical autistic traits. This is 132 a 50-item questionnaire organized into five domains - social skills, attention 133 switching, attention to detail, communication and imagination. It has high test-retest 134 reliability (r = .7, p = .002; Baron-Cohen et al., 2001) and provides good 135 discrimination between high functioning individuals with autism and other clinical 136 and non-clinical groups (Baron-Cohen et al., 2001; Hoekstra et al., 2008). Our 137 participants' scores ranged from 4 to 28 (mean = 14.9, SD = 5.1). 138 Previous studies of homograph reading in autism have matched participant 139 groups on receptive vocabulary knowledge. Here, we used the vocabulary scale of the 140 standardized Shipley-2 Composite A as a measure of written word knowledge 141 (Shipley, Gruber, Martin, & Klein, 2009) and a potential covariate in analyses of eye-142 movements. The scale consists of 40 multiple-choice items in which individuals select 143 the appropriate synonym for a target word (e.g., PARDON) from four alternatives 144 (e.g., forgive, pound, divide, or crash). Participants' scores ranged from 20 to 38 145 (mean = 30.0, SD = 3.6).146 Stimuli 147 Stimuli for the predictability manipulation (see Appendix A) were adapted from

148 the Speech Perception in Noise stimulus set (Kalikow, Stevens & Elliot (1977) in

149 which the same words appear at the end of two sentences – one that is highly

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150 constraining and one in which there is essentially no constraint provided by the 151 preceding context. Our adaptations involved adding extra words to the end of each 152 sentence so that the target word was not the final word (see Appendix for complete 153 sentence sets).

(1) Crocodiles live in muddy swamps most of the time. (2) The girl knows about the swamps in the bush.

156 For the ambiguity manipulation (Appendix B), we first identified 30 noun-noun or verb-verb homographs, including 25 homophonous (same pronunciation for both 157 158 meanings) and 5 heterophonic (different pronunciation) pairs. From these, we created 159 30 sentences in which the meaning of the homograph early in the sentence could be 160 altered by changing a single word later in the sentence. A sentence stem completion 161 task was administered to 45 Macquarie University students (not participants in the 162 main experiment), who were asked to read the 30 sentence stems (3) and complete 163 each sentence using the first word that came to mind.

(3) The crane was slowly _____.

165 We then calculated for each sentence stem the proportion of responses that 166 were consistent with each of the possible meanings of the homograph (disregarding any ambiguous or nonsensical responses) and chose the less common meaning, 167 168 adding extra words after the disambiguating word (4). Thirty matched unambiguous 169 sentences were also constructed by replacing the homograph with an unambiguous 170 word that was semantically related to the less common meaning of the homograph 171 (5). 172

- (4) The crane was slowly flying over the lake.
 - (5) The bird was slowly flying over the lake.

The stimuli from the predictability and ambiguity manipulations were divided into two alternate forms, each consisting of 55 sentences, such that (a) the number of predictable, unpredictable, ambiguous, and unambiguous sentences was balanced across alternate forms; and (b) members of sentence pairs (e.g., (1) and (2); (4) and (5)) were assigned to different forms. Half the participants received one form and half the other, although each participant was presented with sentences in a different random order.

181 Apparatus

182 Participants were seated approximately 70cm away from a 40cm x 40cm 183 display screen. The right eye was tracked at 500Hz using an Eyelink 1000 remote eye 184 tracker. The system was mounted below the desktop display in front of the participant, and consisted of a camera and infrared illuminator. Participants were 185 186 required to wear a small circular target sticker on their forehead, allowing them to 187 move freely within a 20cm radius during the experiment. A standard (for reading 188 experiments) three-point camera calibration and validation was conducted prior to the 189 test phase with the three points in a horizontal row at the same screen height as the 190 text.

191 **Procedure**

192 Stimuli were presented using the SR Research Experiment Builder software (SR 193 Research, 2004). Participants were instructed to silently read each sentence and press 194 the space bar to indicate that they were ready for the next sentence. Participants were 195 also informed that after some trials, the sentence would be followed by a related 196 comprehension question. This ensured that they were reading for meaning, and were 197 appropriately attending to the stimuli. Four practice trials were conducted before the 198 test phase. Although no feedback was provided, participants had the opportunity to ask questions before beginning the test trials.

Each trial began with a fixation point at the left of the screen. When the participant was looking at the fixation point, the experimenter would cue the sentence, with the first word appearing at the fixation point location. Comprehension questions followed 40% of trials (see Appendix C). Participants gave a yes or no response by pressing the "Y" or "N" keys respectively. Unfortunately, these responses were not recorded due to a programming error.

Following the eye-tracking tasks, subjects completed the vocabulary test andfinally the AQ.

208 Data screening

For the predictability manipulation, we required that the first fixation on the target word was progressive (i.e. it was not preceded by a fixation on a word later in the sentence), and lasted at least 50 milliseconds (Rayner, 2009). In total, there were 1446 valid trials (81.5%).

For the ambiguity manipulation, we required a valid fixation on the

214 disambiguating word (using the same criteria as above). A further criterion was that

the homograph (or control word) was fixated before the disambiguating word.

216 Screening left 1762 trials (82.7%) for analysis.

217 Statistical Analyses

218 Analyses focused on first fixation duration on the relevant word and first run

219 duration (the sum of consecutive fixations on the same word). Durations were log-

- transformed (c.f. Hohenstein, Laubrock, & Kliegl, 2010) and subjected to mixed
- random effects analyses using the lme4 library (Bates, 2005) in R (2.13.0; Baayen,
- 222 Davidson, & Bates, 2008). In all analyses, condition (predictable vs unpredictable;
- homograph vs unambiguous) was treated as a binary fixed factor, coded as +/-0.5.

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For the ambiguity manipulation, homophony (of the homograph in the pair) was also coded as a fixed factors, but because there were more homophonic than heterophonic homographs, they were coded as +0.1667 and -0.8333 so that the intercept corresponded to the middle of the data. For the same reason, the sex of participants was coded as female (0.310) or male (0.690). Characteristics of the participants (AQ, vocabulary scores) were z-transformed.

Participant and item (target word or disambiguating word) were treated as
random factors. Following Barr (2013; Barr et al., 2013), we adopted "maximal"
random factor structures, with random intercepts, slopes, and interactions as
appropriate (i.e., "for the highest-order combination of within-unit factors subsumed
by each interaction"; Barr, 2013, pp 1).

Outliers were removed using a model-based approach, whereby data points with 235 236 a residual outside of +/- 2.5 SD were excluded and the analysis repeated (Baayen & 237 Milin, 2010). Quantile-quantile plots were used to confirm a normal distribution of 238 residuals. As p-values cannot be calculated for such models in current versions of 239 mle4, we relied on the assumption that, with sufficient data, t- and z-values are 240 normally distributed and that values outside the range +/-1.96 are statistically 241 significant at an alpha level of .05. 242 For each analysis, we initially used a relatively simple fixed effects model in

which z-transformed AQ score was allowed to interact with the fixed factor of interest (predictability or ambiguity). When effects of interest were found, we then repeated analyses adding other participant characteristics (age, sex, vocabulary) to the model in order to determine whether they moderated the effect of interest.

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Results

248	Predictability manipulation	

According to the central coherence hypothesis, individuals with high autistic traits should benefit less from a sentence context that makes the target word more predictable. In other words, there should be an interaction between the size of the predictability effect and autistic traits. To test this hypothesis, we used a relatively simple model in which first fixation duration was determined by the interaction of target predictability and z-transformed AQ score.

1. LogFirstFixationDuration ~ Predictability * zAQ + (1
 + Predictability | SubjectID) + (1 + Context * zAQ |
 TargetWord)

Somewhat surprisingly, the main effect of Predictability narrowly failed to 258 259 achieve significance, t = -1.92. However, inspection of the random effects revealed 260 that one target word, "ditch" was a significant outlier with a strong predictability 261 effect in the unexpected direction. Analyses were therefore repeated excluding trials 262 involving this target word (see Table 1 and Figure 1). There was now a significant 263 effect of predictability, t = -2.66, with predictable target words being fixated for less 264 time than unpredictable targets. Unexpectedly, there was a significant effect of AQ 265 score with high AQ scores being associated with longer fixation times, t = 2.22. 266 However, contrary to predictions of the context hypothesis, there was no hint of an 267 interaction between predictability and AQ score, t = -0.14. 268

270 Figure 1: Influence of AQ scores on first fixation duration on the target word in

271 the predictability manipulation



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274 Table 1: Fixed effects in the analysis of predictability effects

	Estimate	Std Error	T value
Intercept	2.33041	0.009216	
Predictability	-0.025763	0.009697	-2.66
AQ	0.015343	0.006905	2.22
Predictability x AQ	-0.001227	0.008557	-0.14

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Further analyses were conducted in which age, sex, vocabulary, and trial

number were added to the model in varying combinations. However, in all of the

279 models, the predictability by AQ interaction remained non-significant. Model

280 comparison (using the anova function in R) suggested the following as the optimal

281 model.

282 2. LogFirstFixationDuration ~ Predictability + 283 TrialNumber + zAQ + Sex + (1 + Predictability | 284 SubjectID) + (1 + Context * zAQ | TargetWord)

As before, target words were fixated for significantly less time in the predictable condition, t = -2.86. There was also a significant reduction in fixation time across trials, t = -3.25. Fixation durations were significantly shorter for females, t = -2.28, for participants with high vocabulary scores, t = -2.80, and for those with low AQ scores, t = 2.03.

290 Ambiguity manipulation

Based on previous studies, we expected that participants would spend longer 291 292 fixating on a disambiguating word that forced them to reinterpret the meaning of an 293 earlier homograph. The "comprehension monitoring" account predicted this effect 294 would be reduced amongst individuals with high levels of autistic traits who should 295 be less likely to notice and attempt to repair any miscomprehension. As our main 296 objective was to investigate individual differences in effect size, we report here the 297 analyses based on the first run dwell time, which gave the clearest effects of 298 condition.

The initial model (Model 3) we employed included ambiguity and AQ scores as interacting fixed effects. The model also included random intercepts and slopes (ambiguity effects) for subjects. For items (target homographs), we included random intercepts and slopes for both ambiguity and AQ as well as a random ambiguity by AQ interaction.

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304 3. LogFirstRunDwellTime ~ Ambiguity * zAQ + (1 +
305 Ambiguity | SubjectID) + (1 + Ambiguity * zAQ |
306 Homograph)
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307	As expected, dwell times on the disambiguating words were longer when they
308	followed a homograph compared to control words. However, this effect fell well short
309	of significance, $t = 1.32$. The effects of AQ score, $t = 1.60$, and the interaction
310	between ambiguity and AQ score, $t = 1.61$, were also non-significant, with the
311	interaction trending in the opposite direction to that predicted by the comprehension
312	monitoring account.
313	Given that our stimuli included a mixture of homophonic and heterophonic
314	homographs, we conducted further exploratory analyses, coding whether or not the
315	homograph in the homograph-control pair was homophonic (Model 4).
316317318	<pre>4.LogFirstRunDwellTime ~ Ambiguity * Homophony * zAQ + (1 + Ambiguity * Homophony SubjectID) + (1 + Ambiguity * zAQ Homograph)</pre>
319	This reanalysis revealed a highly significant three-way interaction between
320	ambiguity, homophony, and AQ score, $t = -3.48$. We therefore re-examined the data
321	for homophonic and heterophonic homographs separately (using Model 3) (see Table
322	2 and Figure 2). For homophonic homographs, there was no effect of ambiguity, no
323	effect of AQ, and no interaction between ambiguity and AQ. For heterophonic
324	homographs, there was again no main effect of ambiguity, but there was a significant
325	effect of AQ score and a significant interaction such that high AQ scores were
326	associated with a larger (more positive) ambiguity effect - that is, in the opposite
327	direction to predictions.

328 Given that there are only five heterophonic homographs, we repeated the

329 analyses excluding each homograph in turn. However, the pattern of results was

identical in each case, indicating that the interaction was not driven by any single

331 homograph.

333 Figure 2: Influence of AQ scores on first run dwell time on the disambiguating





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337	Table 2: Fixed	l effects in the	analysis of am	biguity (homo	graph) effects o	n first
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338 run dwell times for the disambiguating word. Separate analyses were conducted

339 fo	r homopho	nic and	heteropho	onic homograp	hs
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	Estimate	Std Error	T value
Homophonic homographs			
Intercept	2.410683	0.013960	
Ambiguity	0.009856	0.010725	0.92
AQ	0.012909	0.009544	1.35
Ambiguity x AQ	0.001535	0.008290	0.19
Heterophonic homographs			
Intercept	2.41887	0.04647	
Ambiguity	0.02283	0.03723	0.61
AQ	0.03301	0.01338	2.47
Ambiguity x AQ	0.08044	0.02412	3.34

Discussion

341 There is now a growing body of evidence to suggest that cognitive strengths and 342 weaknesses associated with autism may also be found amongst individuals in the 343 general population who show high levels of autistic traits. Given the poor 344 performance of autistic individuals on tests of homograph reading, we predicted 345 similar difficulties would be experienced by adults with relatively high levels of 346 autistic traits. The eye tracking test devised for this study allowed us to go beyond 347 previous studies and examine two competing explanations of homograph reading 348 difficulty in autism – a reduced influence of prior context (weak central coherence) 349 and a failure of comprehension monitoring. However, neither of these accounts 350 received support.

351 According to the weak central coherence account, individuals with autism tend 352 to process words out of context. Thus we predicted that high autistic traits should be 353 associated with insensitivity to preceding sentence context, measured with respect to 354 gaze time on the target word. While we did find the expected main effect of 355 predictability, there was no hint of an interaction with AQ scores, and thus no support 356 for our hypothesis. One interpretation of this finding is that lack of context sensitivity 357 is not in fact a characteristic of autism and thus should not be expected in association 358 with autistic traits. Our findings are thus consistent with the numerous studies using 359 tasks other than homograph reading that have failed to find an autism-specific 360 reduction in context sensitivity. However, until we collect data from clinically 361 diagnosed individuals with autism using the current task, it is impossible to exclude 362 an alternative interpretation - that individuals with autism experience reduced context 363 sensitivity but this does not extend to non-autistic individuals with high levels of 364 autistic traits.

365 Our alternative explanation for homograph reading difficulties faired no better 366 than the central coherence account. We had hypothesized that, like non-autistic 367 children with reading comprehension problems, participants with autism fail to 368 monitor for errors of comprehension during reading. Therefore, we predicted that 369 participants would spend longer fixating on words that required them to revise their 370 initial (incorrect) interpretation of a homograph, but that this effect would be reduced 371 in participates with higher AQ scores. Again this prediction was not supported, with 372 no interaction between AQ score and condition.

373 An important point to note here is that the main effect of ambiguity (homograph 374 vs control) did not achieve statistical significance. Thus, a reasonable interpretation of 375 our findings is simply that the ambiguity manipulation was unsuccessful and the lack 376 of an interaction with AQ score is, therefore, difficult to interpret. Our design was 377 motivated by previous studies involving homographs that are disambiguated later in 378 the sentence. However, where previously, a disambiguating *clause* has been inserted 379 after the homograph, and analyses have focused on the time to read the entire clause, 380 here we identified a disambiguating word. Arguably, ours is a tighter and more 381 controlled design. Our null result for the ambiguity manipulation indicates that 382 participants do not necessarily attempt to resolve any ambiguity as soon as they 383 encounter a word that is inconsistent with their initial interpretation. It may be that, by 384 the time this process takes place, participants' eyes have already moved one or more 385 words further along the sentence and thus our eye-tracking measures, focusing on the 386 disambiguating word itself, do not capture this resolution of ambiguity.

That being said, closer inspection revealed an intriguing interaction, whereby the interaction between the size of the ambiguity effect and AQ scores was itself moderated by homophony – that is, whether the two meanings of the homograph had 390 the same pronunciation or not. For homophonic homographs, there was no effect of 391 ambiguity and no interaction with AQ scores. In contrast, for heterophonic 392 homographs, there was a significant interaction between ambiguity and AQ scores, 393 but this was in the opposite direction to predictions, with high AQ scores being 394 associated with a larger rather than a smaller ambiguity effect. One possibility is that, 395 at least for some individuals, the (as it happens incorrect) phonological memory 396 representation of the preceding homograph prompts an immediate attempt to resolve 397 the ambiguity. It is perhaps notable here that individuals with higher AQ scores also 398 tended to have relatively longer fixation times regardless of sentence type or 399 condition. This slower and perhaps more deliberate reading style might allow these 400 participants to register the incongruity between the disambiguating word and the 401 preceding homograph even before they have saccaded to the next word in the 402 sentence.

403 Clearly this account of our data is speculative and there are a number of 404 important caveats. First, there were only five heterophonic homographs and the 405 counterbalancing design entailed that each participants only received two or three of 406 these (with the other corresponding sentences appearing in the control condition). 407 Second, although significant, the three-way interaction between group, homophony, 408 and ambiguity was part of an exploratory post hoc analysis. These findings would 409 have to be replicated, ideally in an orthography such as Hebrew that has many more 410 heterophonic homographs than English, before drawing any strong conclusions.

In summary, while providing a tantalizing suggestion of differences in reading style associated with subclinical autistic traits, the main outcome of the current study is a lack of support for either the weak central coherence account or our alternative "comprehension monitoring" account. Although the findings from the ambiguity 415 manipulation are open to several interpretations, the results from the predictability
416 manipulation provide clear evidence *against* the proposal that high levels of autistic
417 traits are associated with reduced sensitivity to sentence context.

418 Despite the oft-repeated claim that individuals with autism are insensitive to 419 sentence context, this is, to our knowledge, this is the first investigation of sentence 420 context effects in relation to autistic traits. In perhaps the closest existing study, 421 Stewart and Ota (2008) reported that high levels of autistic traits were associated with 422 a reduction in the Ganong effect, whereby perception of an ambiguous phoneme (e.g., 423 the sound between /g/ and /k/) is affected by its lexical context. It is important to note 424 that our study had considerably more participants (71 vs 51) and used a task that was 425 conceptually closer to those used in autism research, targeting sentence- rather than 426 lexical-level context effects. Stewart and Ota claimed support for the weak central 427 coherence account – and for its extension into the non-autistic population. However, a 428 cited reference search indicates that there have subsequently been no published 429 studies investigating the assumption that the Ganong effect will also be reduced in 430 individuals with autism.

431 In this context, we believe it is important to publish the failures to find 432 significant associations with autistic traits as well as the "successes". Indeed, studies 433 investigating subclinical autistic traits may be particularly susceptible to publication 434 bias. Statistically significant associations provide the compelling narrative that 435 "everybody is a little bit autistic" and are relatively straghtforward to publish, often in 436 high impact journals. In contrast, a null result may be easily dismissed because the 437 study did not involve bona fide individuals with autism, because the study is 438 considered underpowered, or simply of lesser interest. In our view, it is only by 439 gaining a complete picture of all results that researchers will be able to determine how

440	and to what extent the characteristics of autistic individuals extend into the typical
441	population.
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