The Quality of Everyday Eye Contact in Williams Syndrome: Insights from Cross-syndrome Comparisons

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1   **Abstract**

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3   Past research shows that individuals with Williams syndrome (WS) have heightened and

4   prolonged eye contact. Using parent report measures, we examined not only the presence of

5   eye contact but also its qualitative features. Study 1 included individuals with WS (n=22, age

6   6.0–36.3). Study 2 included children with different neurodevelopmental (ND) conditions

7   (WS, autism spectrum disorder, fragile X syndrome, attention-deficit hyperactivity disorder)

8   and children with neurotypical development (NT) (n=262, age 4.0–17.11). Unusual eye

9   contact features, including staring, were found in approximately half of the WS samples.

10   However, other features such as brief glances were frequently found in WS and in all ND

11   conditions, but not NT. Future research in ND conditions should focus on qualitative as well

12   as quantitative features of eye contact.

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14   *Keywords:* Williams syndrome; eye contact; neurodevelopmental condition; cross-syndrome

15   comparison

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27   **The Quality of Everyday Eye Contact in Williams Syndrome: Insights from Cross-**

28   **syndrome Comparisons**

29
30   **Introduction**

31   Eye contact – the act of looking another person in the eyes – plays a powerful role in

32   our everyday human social interactions. It signals mutual understanding and affiliation

33   between people, and promotes social-emotional relationships and communication (Emery,

34   2000; Falck-Ytter et al., 2015; Kleinke, 1986). Experiences of eye contact also elicit a range

35   of cognitive and affective reactions in the perceiver (for reviews see Conty et al., 2016; and

36   Hietanen, 2018). In Western European societies, direct eye contact induces a range of

37   positive evaluations (Kreysa et al., 2016; Willis et al., 2011). In contrast, a lack of eye contact

38   may infer disinterest, whereas overly persistent eye contact may be deemed threatening and

39   overly arousing (Akechi et al., 2013; Helminen et al., 2011). Therefore, when an individual's

40   eye contact is reduced or overly prolonged, or unusual in some way, this may adversely affect

41   social impression-formation with consequences for the development of social relationships

42   (Morrison et al., 2020; Sasson et al., 2017).

43   Several theoretical perspectives have been put forward to explain how eye contact

44   modulates cognition and behaviour for those with neurodevelopmental (ND) conditions (for a

45   review, see Senju & Johnson, 2009). The majority of these theoretical accounts apply

46   particularly to the literature on autism spectrum disorder (hereafter 'autism'[1]) and to the

47   assumption by several different theories (e.g. social motivation theory, Chevallier et al.,

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[1] There is a growing literature emphasising the importance of adopting non-ableist language in academic articles and the need to move away from the term 'disorder' when describing Autism (Bottema-Beutel et al., 2020). In this article we use person-first language ("autistic person") in line with the preference of the majority of the autistic community (Kenny et al., 2016).

48   2012; hyperarousal model, Hadjikhani et al., 2017), that autistic individuals have diminished

49   eye contact. One problem is that the evidence for this view rests mainly on studies that report

50   reduced frequency or presence of eye contact. However, there has been remarkable neglect in

51   considering the nature of the quality of eye contact, which could possibly lead to a different

52   understanding of eye contact in individuals with ND conditions. One reason for the past focus

53   on quantity rather than quality is that much of the research knowledge on eye contact stems

54   from a broader laboratory-based research tradition on eye gaze more generally, which tends

55   to equate looking at the eyes of computerised facial stimuli with 'eye contact'. While this

56   paradigm affords a high level of experimental control, the passive viewing of socially-

57   relevant stimuli is very different from how eye contact is experienced in everyday dyadic

58   social interactions (see Kingstone, 2009). Research has shown that the realism of the stimuli

59   used in social attention research (e.g. static versus dynamic images; isolated faces versus

60   multiple faces in a social scene), impacts on eye contact (e.g. Hanley et al., 2013; Speer et al.,

61   2007). Consequently, researchers have emphasised the importance of studying everyday

62   situations to understand social attention in real-life interactive situations (e.g. Hanley et al.,

63   2015; Kingstone, 2009; Risko et al., 2012). In the current investigation, we examine both the

64   presence and quality of everyday eye contact of individuals with ND conditions, using the

65   caregiver's perspective of eye contact.

66   **Eye contact behaviour in Williams syndrome**

67   Williams syndrome (WS) is a genetic ND condition commonly associated with a

68   heightened desire for social contact (termed "hyper sociability"; for a review of the WS social

69   phenotype, see Thurman & Fisher, 2015). Indeed, WS is a really important ND condition to

70   study various aspects of social behaviour because its genetic basis is well-defined

71   (hemizygous deletion of ~25-28 genes on chromosome 7q11.23; Ewart et al., 1993), therefore

72   research with this group has the potential to inform debate about gene-brain-behaviour links

73   and further our understanding of the "typical" social brain. Consequently, the WS social

74   profile has garnered a significant amount of research attention at the level of both brain and

75   behaviour. For example, evidence that WS is associated with structural and functional

76   atypicalities in key areas of the "social brain network" known to activate in response to eye

77   contact, such as the amygdala (Haas et al., 2009; Martens et al., 2009) and fusiform face area

78   (FFA; Golarai et al., 2010), has informed understanding of how different features of the WS

79   social phenotype may be subserved by neural substrates (for a review see Haas & Reiss,

80   2012). At the behavioural level there has been a great deal of interest in capturing various

81   aspects of social behaviour in WS, including eye gaze and eye contact behaviour. The

82   predominant evidence of gaze behaviour in WS comes from face scanning and eye-tracking

83   studies that have examined eye gaze behaviour towards images or movies on screen. These

84   studies show that the face, particularly the eye region, attracts and holds the attention of

85   individuals with WS for longer than is typical for children, adolescents and adults (Porter et

86   al., 2010; Riby & Hancock, 2008, 2009a, 2009b). This tendency for heightened, prolonged

87   looking to faces and eyes has been linked to a lack of habituation to faces (Järvinen et al.,

88   2012), to physiological reactivity and to attentional mechanisms related to arousal, suggesting

89   the possibility of hypo-arousal in this group (Doherty-Sneddon et al., 2009; Riby et al., 2012;

90   Skwerer et al., 2009, 2011).

91   Beyond laboratory studies using eye tracking and measuring gaze to computerized

92   images, a few other observational studies have also reported that young children with WS (<

93   5 years old) show intense and prolonged looking in real-world settings; during interactions in

94   clinics (Mervis et al., 2003) and with experimenters (Jones et al., 2000). Although studies

95   using a clinical measure, the Autism Diagnostic Observation Schedule (ADOS; Lord et al.,

96   2000), have reported up to 52% of children with WS had "definite abnormality" with eye

97   contact (Klein-Tasman et al., 2007, 2009), we know little about the nature of the unusual eye

98   contact, as the ADOS assessment does not capture quality features of eye contact. Given this

99   limited evidence of prolonged, intense eye contact in naturalistic settings, it is still not

100   established whether this quality of eye contact is common in individuals with WS, if it is a

101   feature distinctive to WS or frequently found in other ND conditions. Research that examines

102   eye contact behaviour in WS alongside other ND conditions will help to identify features of

103   eye contact that may be particularly distinctive to WS (syndrome-specific) or shared across

104   diagnostic groups (syndrome-general). See Asada and Itakura (2012) for further discussion.

105   **Eye contact behaviour across ND conditions**

106   While WS has been characterized by social interest associated with a heightened and

107   prolonged presence of eye contact, other ND conditions, particularly Autism, in contrast have

108   traditionally been associated with reduced presence of eye contact (Asada & Itakura, 2012;

109   Senju & Johnson, 2009). Reduced eye contact, in turn, has been connected to a lack of social

110   interest (Chevallier et al., 2012); an assumption that has been challenged by those with

111   subjective, lived experience of autism (Jaswal & Akhtar, 2019) who argue that reduced

112   quantity of eye contact does not necessarily equate with lack of interest. We propose that the

113   clarification of this issue has been hampered by a single dimensional approach to the

114   understanding of eye contact; that conflates presence and quality of eye contact.

115   Characterizing eye contact by a single dimension leads to a view that reduced eye contact is

116   poor eye contact and increased eye contact is good eye contact; an assumption that tends to

117   polarise the social phenotypes of ND groups into opposite profiles (see Asada & Itakura,

118   2012 for review of the Autism/WS distinction). By considering multiple qualitative features

119   of eye contact in everyday life contexts, across ND conditions, the current study attempts to

120   move away from examining eye contact through a quantitative, single dimensional lens.

121   Like studies of WS, much previous research on eye contact in autism has also tended

122   to focus on its presence or degree. Eye-tracking studies show that some autistic individuals

123   spend less time than is typical attending to face areas and eye areas on a screen (Sasson et al.,

124   2007; Shic et al., 2011). For reviews of the Autism eye tracking literature see Guillon et al.

125   (2014) and Papagiannopoulou et al. (2014). Both eye tracking studies (e.g. Hanley et al.,

126   2014, 2015) and face-to-face observational studies (e.g. Leekam & Ramsden, 2006) also find

127   differences in attentional orienting in autistic individuals compared to neurotypical (NT) and

128   intellectually disabled peers, and that reduced eye contact is very dependent on context (Jones

129   et al., 2017; Kasari et al., 1993). Furthermore, reduced presence of eye contact has been

130   associated with failure to automatically attend to the salience of social cues, rather than to

131   active avoidance of others in several eye tracking studies (Hanley et al., 2013; Klin et al.,

132   2002) and has been associated with over-arousal (Hadjikhani et al., 2017). First-hand insights

133   from autistic adults also describe reduced eye contact as a strategy for arousal reduction

134   (McGlensey, 2016; Trevisan et al., 2017) and report the use of qualitative strategies used

135   such as non-eye fixation, blurring focus and strategic fixation (Trevisan et al., 2017).

136   However, the perceived experience of unfocused eye gaze in these first-hand accounts has not

137   been measured from another person's perspective and the research reported here targets this,

138   by exploring parents' perspective of eye contact taken from their everyday experience.

139   While Autism and WS are two frequently studied ND conditions in the eye gaze and

140   eye contact literature, these are not the only ND conditions that are associated with social

141   difficulties related to eye contact. Like WS, fragile X syndrome (FXS) is a genetic condition

142   associated with mild to moderate intellectual disability (ID) and impacts upon social

143   functioning. The FXS social phenotype can be summarised as a mix of both social approach

144   (Cornish et al., 2008) and social withdrawal behaviours (Roberts et al., 2007, 2019),

145   alongside heightened social anxiety (Crawford et al., 2017). Studies to date consistently show

146   that FXS is associated with gaze avoidance (Hall et al., 2006, 2009, 2010; Hessl et al., 2006),

147   which increases when the interlocutor is unfamiliar (Hall & Venema, 2017), but which may

148   improve over the course of an interaction ('warm up effect'; Hall et al., 2009; Roberts et al.,

149   2007). People with FXS show a tendency for shorter gaze episodes towards another person

150   and for brief glances when the person is looking elsewhere rather than making direct eye

151   contact (Cohen et al., 1991; Hall et al., 2006, 2015; Klusek et al., 2020).

152   Although social difficulties are not part of the diagnostic criteria for attention-deficit

153   hyperactivity disorder (ADHD), there is a growing literature reporting socio-cognitive

154   difficulties, problematic peer relationships (for reviews see Gardner & Gerdes, 2015;

155   Soucisse et al., 2015) and high rates of social vulnerability (Ridley et al., 2020). Studies

156   reporting on aspects of gaze orienting and attention indicate impairments in attending to

157   socially relevant information (Airdrie et al., 2018; Marotta et al., 2014, 2017; Muszkat et al.,

158   2015), however everyday eye contact behaviors in this population have scarcely been

159   documented. One relevant study using the ADOS found that unusual eye contact was

160   reported statistically more frequently in a sample of autistic children compared to children

161   with ADHD (Grzadzinski et al., 2016). Nevertheless, 31% of the ADHD sample were

162   reported to have "abnormal" eye contact, yet the nature of the unusual eye contact was not

163   described.

164   **The current study**

165   In this study, we explored the quality of everyday eye contact in individuals with WS

166   in comparison with each of these ND groups using parent report. First, we studied the single

167   dimension of 'presence' (or degree of presence). Second, we included a specific measure of

168   different qualitative features that have been associated with different ND conditions. A two-

169   stage approach was adopted. First, given the gap in the literature on the quality of eye contact

170   in WS, particularly from a parent perspective, Study 1 used a set of standard interview

171   questions to explore the qualitative features that parents might observe in their son/daughter's

172   everyday eye contact. Although we expected a high presence of eye contact in WS, we also

173 expected, given the findings of Mervis et al. (2003) and Jones et al. (2000), that parents might

174 observe a quality of intense, prolonged eye contact (equated with staring in this study).

175 However, we did not know whether other qualitative features would be frequently seen or the

176 extent to which staring would be found across all WS individuals and across all ages.

177   In Study 2, we used a parent questionnaire method to examine further the eye contact

178 quality features used in Study 1 as well as other qualitative features, making cross-syndrome

179 comparisons across children with WS, Autism, FXS and ADHD. In addition, we included a

180 NT comparison group to examine whether particular qualitative aspects of eye contact were

181 specific to the presence of a ND condition. The research will contribute new evidence to an

182 ongoing debate about the similarities and differences in eye contact in ND conditions,

183 particularly between WS and Autism. The study will also add new findings to the literature

184 on eye contact behaviour in FXS, and in ADHD; a topic that has received limited attention.

185   **Study 1: Examining the nature of eye contact in Williams Syndrome**

186   The first study explored the presence and quality of eye contact used by individuals

187 with WS in their everyday life. A semi-structured set of interview items was used that

188 enabled parents to describe both the presence of eye contact and qualitative features, such as

189 brief glances, staring behavior and unfocused gaze. The individual's developmental level of

190 language and visuospatial ability was also recorded during the interview.

191 **Participants**

192   Twenty-two individuals with WS and their families were recruited throughout the

193 North of England and Scotland following institutional ethical approval and study approval

194 from the Professional Advisory Panel of the Williams Syndrome Foundation. Informed

195 consent was given by all participants. The researcher (BA) conducting the interviews with

196 parents was trained in its use by SL. In all cases, it was the primary caregiver who completed

197 the interview with the researcher, either at home or in the University.

198   Individuals were sampled across a wide age range. At the time of the parent interview,

199   individuals with WS ranged between 6 years 0 months and 36 years 3 months of age (male n

200   = 10, female n = 12; M_{age} = 196 months, SD = 98 months). All individuals were attending

201   school, college or work placements; including five in mainstream school with support, 10 in

202   special educational provision and five in supported work or college (two had information

203   missing). All individuals had previously been diagnosed phenotypically by clinicians and

204   their diagnosis had been confirmed with positive fluorescent in situ hybridization (FISH)

205   testing.

206   Information on language delay, and current language and visuospatial ability was

207   collected from parents during the interview. As Table 1 shows, the group was

208   developmentally delayed. In terms of language delay, 78% of individuals (14/18, four

209   missing) were late to use 2-3 phrases and 84% (16/19, three missing) were late to understand

210   word meanings. In terms of current language ability, 21 participants (one missing) had

211   sentence-level expressive language and all but one participant had sentence-level receptive

212   language (simple or complex sentences). However, only two-thirds (14 individuals) used

213   expressive language at the highest level (complex age-appropriate grammatical constructions)

214   and only one third (seven individuals) understood language at this level. Visuospatial data

215   (two missing) showed that only three individuals (15%) had age-appropriate level of current

216   skill.

217   **Materials and procedure**

218   A research form of the Diagnostic Interview for Social and Communication Disorders

219   (DISCO; Leekam, 2020; Wing et al., 2002) was used. The DISCO is a semi-structured

220   clinical interview used with parents and carers. It is most commonly used for parents of

221   autistic individuals of any age, but is also suitable for use with individuals with other ND

222   conditions and includes items applicable for ADHD, WS and FXS. The current interview

223 followed the format of previous research that has used and published subsets of DISCO items

224 (e.g. Prior et al., 1998). The eye contact and language items used in Study 1 are included in

225 the published DSM-5 algorithm (Kent et al., 2013) and DISCO ICD-10 Childhood Autism

226 algorithm (Leekam et al., 2002), and the visuospatial skill item is a non-algorithm item in the

227 DISCO (Wing et al., 2002). Each of the four eye contact items and each of the language and

228 visuospatial items has a high level of inter-rater reliability ranging from κ = .89 to κ = 1.00

229 (Wing et al., 2002).

230   Information on language delay and current language and visuospatial ability was

231 collected using age-appropriate scales within the DISCO (see Table 1). Items from the

232 current language scales have been published (Honey et al., 2007). Age-equivalent

233 visuospatial skill was indicated by the ability to construct complex puzzles according to age

234 group. Language delay (use of phrases, comprehension of word meanings without visible

235 cue) was indicated by delay after 48 months old. Age-appropriate current sentence skills were

236 recorded when complex grammatical constructions and past, present and future tense were

237 present.

238   Information on the presence and quality of eye contact was collected using four eye

239 contact items and scored using the DISCO syntax rules that have previously been applied in

240 both interview (Kent et al., 2013) and questionnaire (Jones et al., 2020), research formats.

241 The first item related to the presence of eye contact. The interviewer asked the caregiver

242 whether it was easy to get eye contact with the individual. The item was scored as "eye

243 contact present" if the answer was "yes", even if the eye contact given was described as

244 unusual in some way, and "no" if the parent reported little or no eye contact. The next three

245 questions related to quality of eye contact seen as usual behaviour on an everyday basis.

246 These were whether the individual (a) makes eye contact only in brief glances e.g. out of the

247 corner of eyes, but not for the purpose of gaining another's attention, (b) whether the

248   individual has a blank, unfocussed gaze and (c) whether the individual stares too long and

249   hard, perhaps holding another person's face to make eye contact and/or looking closely into

250   another's eyes. Each item was sequentially assessed by the interviewer who established

251   whether this was a typical behaviour for the individual (used routinely with adults and age

252   peers) and whether it was marked (or frequent), occasional, or rarely/never seen. Following

253   DISCO syntax rules, each item was scored as having a markedly unusual quality if judged to

254   be "marked" (brief glances), "marked and frequent" (blank, unfocused gaze), and "marked

255   staring or otherwise inappropriate" (staring) in that individual, but not if the feature was

256   sometimes, rarely or never seen.

Results and Discussion

257

258   Case-by-case profiles of eye contact patterns are shown in Table 1, together with age

259   and language/visuospatial level. The cells that include the plus symbol (+) indicate

260   endorsement of a score for each individual (e.g. presence of eye contact or a marked quality

261   of eye contact), while the blank cells indicates non-endorsement. Results showed that 20

262   (91%) individuals (male $n = 9$, female $n = 11$) gave eye contact easily (even if

263   inappropriately), while two (9%), gave little or no eye contact. Subsequent analyses focused

264   on these 20 individuals, 13 of whom (65%; male $n = 7$, female $n = 6$), had a "marked"

265   unusual quality of eye contact, as indicated by at least one out of three unusual features –

266   brief glances, unfocused gaze, or staring. Brief glances at marked level were endorsed by

267   eight (40%), unfocused gaze by eight (40%), and staring was endorsed by 10 (50%; see Table

268   1). Six individuals had marked scores for all 3 features.

269   *INSERT TABLE 1 HERE*

270   Further exploration was made of the characteristics of the 13 individuals with marked

271   unusual quality of eye contact. More than half, nine of the 13 (69%), had early developmental

272   delay in understanding of word meanings (two had no delay, two had missing data), and of

273   these nine individuals, all but one (data missing) were also delayed in using 2-3 word

274   phrases. The gender distribution was also approximately equal for endorsement of each of the

275   three eye contact quality features.

276   To explore how each of the unusual eye contact quality features was affected by other

277   variables (current age, current language level, and visuospatial level), Mann-Whitney tests

278   were carried out with the 20 participants who were reported by parents as giving eye contact

279   easily. For each analysis, the group of individuals with 'marked' responses was compared with

280   the group without marked features (scoring 'sometimes' or 'rarely/never'). Analyses were

281   repeated to examine brief glances, unfocused gaze, and staring features separately and

282   Bonferonni adjustment was applied to accommodate multiple comparisons (.05/3, $p = .02$). An

283   age difference was found (see Table 1), as the group with marked staring features was older,

284   having a mean age of 20 years 11 months ($M_{age} = 251.20$ months, $SD = 108.37$, $n = 10$) while

285   those without marked staring features had a mean age of only 12 years 6 months, ($M_{age} = 150.60$

286   months, $SD = 56.44$, $n = 10$), $U = 99.0$, $p < .010$. However, there were no age differences for

287   the other unusual quality features (unfocused gaze, $p = .92$; brief glances $p = 1.00$). No

288   differences were found in visuospatial ability, current expressive and receptive language for

289   those with marked unusual eye contact quality.

290   In summary, Study 1 used a set of parent interview questions for the first time, to

291   explore the qualitative features of everyday eye contact in individuals with WS. The results

292   showed positive presence of eye contact by 91%, together with an unusual quality of staring

293   in 50%. This pattern supports previous evidence from laboratory and clinic studies (Jones et

294   al., 2000; Mervis et al., 2003). However, in addition, new evidence was found. Results

295   showed that staring was more frequent among older ages. However, staring was not an

296   exclusive or predominant quality feature and parents endorsed features of unusual quality of

297   eye contact beyond staring, including brief glances and unfocused gaze. These were reported

298   by parents in 40% of individuals with least one of these features often co-occurring alongside

299   staring.

300

301   **Study 2: Comparing eye contact in WS, other neurodevelopmental conditions and**

302   **neurotypical development**

303   To gather a larger sample of reports, Study 2 asked the same questions as in Study 1

304   but used a questionnaire measure with parents of children with WS. In addition, we adopted a

305   cross-syndrome approach to examine potential syndrome-specific aspects of eye contact

306   behaviour in WS, Autism, FXS and ADHD, as well as NT development.

307   Given the research findings reviewed above and the results of Study 1, we predicted

308   1) a high presence of eye contact in WS compared with other ND groups 2) that unusual

309   qualitative features would be found in WS and also in the other ND groups, with staring

310   reported for children with WS (Klein-Tasman et al., 2007; Mervis et al., 2003), brief glances

311   and avoidance reported for FXS children (Klusek et al., 2020) and a blurred, blank or

312   unfocused gaze (Trevisan et al., 2017) and/or avoidant gaze (Senju & Johnson, 2009)

313   reported for autistic children. Given the results for the WS group in Study 1, we expected not

314   only staring but also other qualitative features to be reported. However, it was not known

315   whether other ND groups might have particular distinctive and predominating qualitative

316   features.

317   **Participants**

318   Parents/caregivers of children were recruited for this study as part of a larger

319   investigation of social interaction behaviours in children with and without ND conditions.

320   Survey responses were received for 276 caregivers/parents in total. Responses were included

321   for data analysis based on the child's primary diagnosis if the parent reported that their child:

322   (1) had a primary diagnosis of either WS, autism, FXS or ADHD, or had NT development

323   and did not have an ID or statement of Special Educational Need (SEN), and (2) was 4–17

324   years old. Of the 276 respondents, 262 met the aforementioned inclusion criteria and fell in

325   the following groups: WS (n = 29), Autism (n = 29), FXS (n = 18), ADHD (n = 36) and TD

326   (n = 150). None of the participants in Study 1 were included in the WS sample in Study 2.

327   Table 2 shows the child characteristics per group. Fifty-nine percent of the full sample

328   were males. The ND groups (apart from the WS group) included significantly more males

329   than the NT group. Of the ND groups, FXS included significantly more males than the WS

330   group. However there was no significant difference in the distribution of genders between the

331   other ND groups. The ND groups differed in parent-reported ID status as seen in Table 2,

332    $\chi^2(df = 3) = 50.98$, $p < .001$. As expected, the WS and FXS groups included a significantly

333   higher frequency of children with an ID compared to the Autism and ADHD groups (but no

334   difference in the frequency of ID-status between WS and FXS, or between Autism and

335   ADHD). For receptive language ability, the WS and FXS groups had a higher frequency of

336   children without full sentences compared to the Autism and ADHD groups. Likewise, for

337   expressive language ability, the WS and FXS groups had a higher frequency of children

338   without full sentences compared to the ADHD group, but no difference with the Autism

339   group.

340   *INSERT TABLE 2 HERE*

341   **Procedure**

342   Separate advertisements invited parents of (i) children with a diagnosis of WS,

343   Autism, ADHD or FXS, and (ii) parents of children with NT development, to complete an

344   online survey about their child's social interactions and were distributed via a university

345   research participation database for local families, social media, and UK charity networks.

346   Informed consent was obtained from all participating caregivers/parents following positive

347   ethical opinion from the University ethics committee. Parents did not receive financial

348   remuneration.

Materials

350   Parents/caregivers reported on their child's eye contact behaviours as part of a larger

351   bespoke survey on social interactions throughout development[2], via online survey software

352   (www.onlinesurvey.ac.uk). In addition to the questions addressing the research aims, parents

353   provided demographic information concerning the child's date of birth, gender, diagnostic

354   status and ID-status. To gather information about language abilities we included the

355   following questions "does your child use language to communicate" (*none*; *single words*;

356   *simple phrases*; *full sentences*), and "does your child understand language" (*none*; *single*

357   *words*; *simple phrases*; *full sentences*).

358   The eye contact items corresponded exactly with interview items of Study 1 but the

359   method was distinct as the items were presented in a fixed response format more suitable for

360   a questionnaire. Items were presented as statements with options to select as follows: Item 1

361   "He/she makes eye contact (even if inappropriate, learned or occasional)" with a response

362   option "yes/no". The next set of items relating to quality of eye contact, unlike Study 1, were

363   not presented sequentially. Instead, they were presented as a forced choice format and

364   caregivers could select only one item in response to the following question: "Please tell us

365   more about the quality of eye contact. Which of the following applies most usually?" Six

366   response options were offered (shown in full in Table 3). In addition to the three items in

367   Study 1 (staring, unfocused gaze, brief glances), two other items were offered to capture a

368   wider range of qualitative features that might be seen in any of the children. These were (a)

369   "always appropriate and natural", and (b) "avoids eye contact". One of the six (indicating the

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[2] The data reported in the current paper were not included in Ridley et al. (2020).

370   one that applies most usually) could be ticked. The next item, "If none of the above applies

371   you can give more information here if you wish (this is optional)" allowed parents to

372   elaborate on their child's eye contact behaviour if it did not easily fit one of the pre-specified

373   categories

374   **Results and Discussion**

375   The first hypothesis, that there would be a high presence of eye contact in WS

376   compared with other ND groups, was not supported. Instead, results showed that the vast

377   majority of all children with a ND condition engaged in eye contact. Although as many as

378   93% (27/29) of parents of children with WS endorsed this item, similar to Study 1,

379   endorsement was also high for Autism: 86% (25/29), FXS: 72% (13/18) and ADHD: 86%

380   (31/36). A Chi-Square test of Independence showed no significant difference between the

381   four ND groups, $\chi^2(3) = 3.98$, $p = .264$. Nevertheless, the strong presence of eye contact in all

382   ND groups (96/112, 86%), was still lower than for the NT sample, virtually all of whom were

383   endorsed as showing eye contact (146/149, 98%, one missing response), $p < .001$ (Fisher's

384   Exact Test).

385   The second hypothesis was that unusual qualitative features would be found in WS

386   and in other ND groups. This hypothesis was examined in several ways. Table 3 presents the

387   distribution of responses (i.e. children with endorsement of "yes" to Item 1 reporting

388   presence of eye contact). First, taking the responses for "eye contact always natural and

389   appropriate" (Column 3 of Table 3), this was the most highly endorsed option for 87% of the

390   parents of NT children and significantly higher than endorsement for the ND sample as a

391   whole (31%; $p < .001$ Fisher's Exact Test) or for the WS group alone (44%; $p < .001$ Fisher's

392   Exact Test). This evidence supports the prediction that even when children with a ND

393   condition do give eye contact, the quality of their eye contact is not predominantly natural or

394   appropriate. Nevertheless, the WS group did show a significantly higher frequency of

395   appropriate eye contact compared to the Autism group (12%; $p =.01$), but no difference

396   compared to FXS (15.4%; $p =.09$) or ADHD groups (42%; $p = 1$).[3]

397   *Insert Table 3 here*

398   Second, initial examination of the pattern of unusual qualitative features revealed that

399   the option "avoids eye contact" was rarely selected for any of the ND groups. This was

400   surprising, given descriptions of avoidance in the Autism and FXS literature (e.g. Hall et al.,

401   2006; Senju & Johnson, 2009), but it demonstrates parents' interpretation of their child's eye

402   contact quality when selecting from different behavioural options.

403   Subsequent analysis therefore focused on the three unusual quality descriptors from

404   Study 1 (staring, brief glances, and blank, unfocused gaze). Results showed that the majority

405   of parents in the ND sample selected one of these features as the most usual qualities of their

406   child's eye contact (ranging from 48% to 77% of each group and 54% of the total ND

407   sample) in comparison to only 8% of the NT group. A Fisher's Exact Test confirmed higher

408   endorsement any of these three (see Table 3) in the ND groups taken together (54%)

409   compared to the NT group ($p < .001$).

410   Given the result of Study 1, we did not predict specificity or dominance in one

411   qualitative feature (e.g. staring) for the WS group. However, it was not known whether other

412   ND groups might have specific qualitative features that are distinctive or dominating. To

413   analyse this, a series of 2 x 2 Fishers Exact Chi-square analyses were carried out, using only

414   the samples endorsed with brief glances, unfocused gaze or staring (totals from columns 4-6

415   of Table 3 (i.e., WS $n = 13$; Autism $n = 14$; FXS $n = 10$; ADHD $n = 15$). The categories

416   "unfocused, blank gaze" and "staring" were collapsed together (due to small expected

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[3] Tested in a series of 2 x 2 Fishers Exact Chi-square analyses, with WS compared with each

ND group for responses to the "appropriate" option versus the remaining response options.

417   frequencies) and compared with "brief glances". This confirmed a different distribution of

418   response: brief glances were more frequently selected for Autism (78.6%, $p = .05$), FXS

419   (90%, $p = .03$) and ADHD (86.7%, $p = .02$) groups compared to the WS group (5/13, 38.5%),

420   while the presence of staring behaviour (with unfocused gaze) was more frequently endorsed

421   in the WS group (7/13, 61.5%) This finding supports previous descriptions of persistent and

422   prolonged eye contact in young children (Klein-Tasman et al., 2007; Mervis et al., 2003),

423   showing these behaviours are also found in older children and adolescents. In summary,

424   although dominance of one specific qualitative feature was neither predicted nor found, the

425   results indicate that when given a forced choice format, a small but significant proportion of

426   parents of children with WS tend to preferentially select "staring/unfocused gaze" in favour

427   of "brief glances", while the majority of parents of all other ND groups select "brief glances".

428   Only a very small minority of parents selected the option "none of the above apply"

429   (5.4% of the full sample; NT $n = 5$, ND $n = 8$), indicating that the options provided were

430   mostly consistent with the range of parent experiences. All of these parents also answered "if

431   none of the above apply please leave further information here (this is optional)". The majority

432   of the free-text responses (NT $n = 4$, ND $n = 5$) reported that the child might show more than

433   one type of eye contact behaviour according to situational or person context.

434   Follow-up analyses examined the relationship between eye contact behaviour, first for

435   presence and then for quality ("blank, unfocused gaze" collapsed with "staring" as above)

436   and the demographic variables: age, gender, ID-status (yes/no) and language-status

437   (with/without full sentences) analysed using Chi-square tests. Small samples limited the

438   opportunities for finding significant associations with other demographic variables

439   throughout. No significant associations were found between type of unusual eye contact and

440   language ability (expressive or receptive), ID, gender or age, and it was not meaningful to test

441   the comparison between staring and age found in Study 1 because of the sample sizes.

442   **General Discussion**

443   Eye contact strengthens the communication process during human social interaction

444   and shapes our judgements about others (Conty et al., 2016; MacDonald, 2009). For this

445   reason, it is important to understand how eye contact manifests in everyday life for those with

446   WS and with other ND conditions. The results of Study 1 and 2 show that parents of

447   individuals with WS, nearly all of whom described their child as making eye contact, also

448   described their child's eye contact as unusual rather than natural and appropriate. Our

449   findings support previous evidence showing prolonged and intense looking in individuals

450   with WS and Study 1 also found first evidence of an association between staring and

451   increased age. However, importantly, staring was not the only type of unusual feature as

452   many parents also reported the use of brief glances and blank, unfocused gaze.

453   The cross-syndrome comparison with other ND groups in Study 2 revealed surprising

454   insights. First, the research literature for Autism and FXS, often describes individuals as

455   having reduced or avoidant eye contact. But parents of these children, who must be looking at

456   their children's eyes on an everyday basis, tend not to describe a lack of eye contact. Like the

457   parents of children with WS, most parents in the Autism, FXS and ADHD groups reported

458   that their child does make eye contact; however, when given different options to indicate the

459   quality of that eye contact, they indicate an unusual quality to it. The most frequently

460   endorsed feature for parents of all three groups was brief glances, whereas this was not the

461   case for the parents of the WS group who more frequently than the other groups, selected

462   staring or unfocused gaze in this forced choice question format. However, staring/unfocused

463   gaze was not unique to WS and many parents also endorsed brief glances in their children

464   with WS.

465   This study contributed to the literature by moving beyond the conventional

466   measurement of eye contact as being either present or absent, in varying degree. By

467   separating the measurement of "presence" from an additional measurement of "quality", we

468   found different results from studies that have used a single measure of presence of eye

469   contact as an indicator that eye contact is good versus poor. In contrast, our results suggest

470   that nearly all individuals with WS (study 1), and nearly all children whether WS, Autism,

471   FXS or ADHD (study 2), do make eye contact even if in an unusual manner. The type of this

472   unusual quality also seems to be consistently identified by parents as taking the form of brief

473   glances, unfocused gaze or staring, as evidenced by the fact the option "none apply" was

474   rarely endorsed in Study 2. In Study 2 we also found that the option of "avoids eye contact"

475   was rarely endorsed by parents in preference to these other three items. However, it is not

476   clear why they made this preference. Possibly, the choice of one of six forced choice options

477   constrained them and resulted in few cases of "avoids eye contact". Further research is

478   needed to test out why parents did not choose "avoids" in preference to other items and to

479   evaluate whether this is because it is not a feature of eye contact according to caregiver

480   perspective, or whether it is because other types of contact behaviour are merely more

481   common.

482   We learn from the cross-syndrome comparison design of Study 2 that unusual eye

483   contact is found across multiple ND conditions, rather than specific conditions being

484   associated with specific patterns of eye contact. It is unclear the extent to which this is due to

485   direct yet variable effects of the ND condition on eye contact, or whether these behaviours

486   are differently acquired through factors which may vary but show commonalities across ND

487   conditions, along with external and internal environment. To disentangle this further, the next

488   stage of research enquiry may benefit from moving towards a more transdiagnostic design. In

489   a recent review on the transdiagnostic model for understanding neurodevelopment, Astle et

490   al. (2021) outline a spectrum of study designs that can offer transdiagnostic insights, which

491   vary in the emphasis placed on diagnostic status. Based upon this classification, studies like

492   ours that test for syndrome-specific associations offer value in elucidating where aspects of

493   cognition and behaviour cross over different ND conditions, or are distinctive. However, this

494   traditional, categorical approach is problematic as it rests on the assumption that ND

495   conditions are homogenous and have clear-cut boundaries; an assumption that does not match

496   up with the clinical reality. Consequently, researchers have argued for the need to

497   reconceptualise neurodevelopment and embrace more transdiagnostic features of design

498   throughout the research process (Astle et al., 2021; Casey et al., 2014; Sonuga-Barke &

499   Thapar, 2021). In the case of research on eye contact, there would be value in following a

500   model similar to that used in research areas of cognition and learning (e.g. Bryant et al., 2020;

501   Mareva et al., 2019), by recruiting a large heterogeneous sample of individuals with ND

502   conditions known to impact on social attention and social interaction, and stratifying on the

503   basis of particular eye contact styles (see the "diagnostic-blind" approach in Astle et al.,

504   2021).

505   An important consideration for studies such as ours that do compare groups according

506   to diagnostic label, is that children and adults who receive a diagnosis of any ND condition

507   may also receive other associated diagnoses (Cleaton & Kirby, 2018). Autism frequently co-

508   occurs with other conditions and as atypical eye contact is a diagnostic feature of Autism, this

509   might explain unusual eye contact differences in other conditions as well. As information on

510   co-occurring Autism diagnoses had been collected at the time of recruitment, we were able to

511   carry out further analysis of those with associated diagnoses (WS $n = 2$, FXS $n = 9$, ADHD n

512    $= 9$). The pattern of results for presence of eye contact and for unusual quality of eye contact

513   remained unchanged; therefore, significant effects of an associated autism diagnosis were not

514   evident in this study, but given the small sample sizes, future research designs should test

515   more fully for the effect of co-occurring diagnoses on eye contact presence and quality (see

516   model of study designs outlined in Astle et al., 2021).

517 **Limitations**

518   There are several important limitations to this study. While the results from parent

519 reports in these studies appear striking, it should also be remembered that there are problems

520 using subjective methods of this kind. Parents were aware that this was an interview or

521 questionnaire studying social interactions in those with ND conditions and responses could be

522 attributed to a response bias. Therefore, a recommendation for future research would be for

523 the inclusion of different measures that combine insights from direct observations and

524 experiments, along with multi-informant reports of everyday eye contact. Teacher insights

525 would make a valuable addition given teachers are interacting with children on a regular

526 basis, but within a different setting compared to parents.

527   Another limitation was that the measure adapted from Study 1 for use in Study 2, did

528 not use exactly the same format. Parents were given a forced choice which did not include

529 options for reporting overlapping types of eye contact quality, as measured in Study 1. This

530 means we cannot make exact comparisons between the measures. Nevertheless, despite

531 differences in the presentation format, the measurement of common behaviour indicators of

532 quality of eye contact (staring, unfocused gaze, brief glances) in each of the two studies

533 contributes new evidence to this sparse literature on the quality of eye contact within WS and

534 across other ND groups. Further testing and replication is still a priority however. Although

535 we might be encouraged by the endorsement rates for Study 2 across the options linked to

536 Study 1, with few choosing the option "none of these apply", still further validation of the

537 Study 2 method is needed. For example, we recommend further testing of internal,

538 convergent and discriminant validity as has been carried out for other questionnaires using

539 DISCO items (e.g. Jones et al., 2020).

540   The most serious limitation of the study was that the lack of associations with ID, age

541 and gender, were likely due to a lack of power due to small samples distributed across the ND

542   groups. Although the sample size for the WS group in both studies was the same as the

543   sample size for other studies (Klein-Tasman et al., 2007, 2009), there were limitations in

544   making group-wise comparison for each ND condition and in drawing conclusions on the

545   effects of ID, age, gender and language level. As this was compounded by the constraint on

546   caregivers to select only one of six options to describe their child's eye contact, further

547   replication is needed by comparing larger participant groups and testing different research

548   designs.

549   **Future directions and implications**

550   The relationship between older age and staring behaviour in Study 1 is an intriguing

551   finding. One explanation is that staring behaviour emerges throughout development in WS.

552   Another interpretation is that the reporting of marked staring in adults relates more to a

553   change in the perception of this behaviour. From the perspective of the interlocutor, an adult

554   showing staring behaviour may be more striking and deemed less socially acceptable

555   compared to a child staring. However, it is important to note this association with age was not

556   found in the child-only sample of Study 2; therefore, future research should help to

557   corroborate differences and similarities across age and ND groups.

558   Future cross-syndrome comparisons will also benefit from a fine-grained analysis of

559   the differential qualitative aspects of unusual eye contact in relation to social interaction and

560   communication. Klein-Tasman et al. (2007, 2009) noted findings of "abnormal eye contact"

561   in young children with WS as measured within the ADOS domain of reciprocal social

562   interaction. Common difficulties were also found in the ADOS domains of declarative

563   pointing, showing and giving objects, reciprocal social interactions and social

564   communication, and cognition. However, as the qualitative nature of unusual eye contact

565   (e.g. specific type of qualitative features) is not recorded by the ADOS, follow up research

566   using the ADOS, DISCO or other assessment measures could help to clarify the relation

567   between particular qualitative types of eye contact and other social interaction,

568   communication and social cognition difficulties. The prediction would be that unusual

569   qualitative features have particular implications for other aspects of social interaction and for

570   social cognition as the flow of interaction is affected.

571   Our findings may also prove useful in future transdiagnostic research, with respect to

572   (1) separating out the cognitive processes involved in attention and arousal, (2) elucidating

573   the neural circuitry associated with eye contact, and (3) the psychosocial factors associated

574   with qualities of eye contact. In terms of the cognitive processes, it may be possible to test

575   whether unfocused gaze is related to slow allocation of automatic attention (Kuhn et al.,

576   2010), whether staring is related to attentional shifting and hypo arousal (Riby et al., 2011),

577   and whether brief glances are linked to gaze aversion strategies during information

578   processing (Doherty-Sneddon et al., 2012). In the case of neural processes, a more

579   transdiagnostic analysis would be particularly informative for revealing the neural processes

580   associated with qualities of eye contact in people with genetic and non-genetic ND

581   conditions. Not only is there a dearth of research documenting how the brain circuitry

582   responds to eye contact in people with ND conditions, to our knowledge, no research has

583   examined how qualitative features of eye contact are subserved by neural substrates. Indeed,

584   the characteristic use of qualitative features of eye contact early in life may itself have a role

585   in neural development, indicating bi-directional biology-behaviour relations, rather than a

586   simple underpinning of neural processes driving eye contact quality. The results also address

587   psychosocial influences on eye contact and how different qualitative features may serve as

588   adaptive functions to increase or avoid social contact when eye contact is experienced as

589   overly stimulating, distracting in some way, or not as socially rewarding. With respect to

590   brief glances for example, for some people who find it aversive to look in the eyes of others

591   (hyperarousal), brief glances may serve to reduce the uncomfortable sensation, as indicated

592   by evidence of increased activation of the subcortical system when focusing on the eye region

593   (Hadjikhani et al., 2017) and first-hand insights from autistic people (McGlensey, 2016;

594   Trevisan et al., 2017). However, brief glances may also indicate an opportunity for

595   information processing during gaze aversion (Doherty-Sneddon et al., 2012). Collecting

596   further parental data on the quality of eye contact used by their child in varying contexts (e.g.

597   interaction partners, social situations) would add valuable insights into the psychosocial

598   factors that may influence eye contact behaviour.

599   The findings also point to the direction for future research priorities in the areas of

600   FXS and ADHD. Our findings regarding brief glances support previous research with

601   children with FXS. However, the previous research has largely referred to brief glances made

602   while the individual looks elsewhere rather than as part of making eye contact; therefore,

603   further fine-grained observational research is needed to examine the extent to which the well

604   documented finding of brief glances in FXS (e.g. Hall et al., 2015) provides a communication

605   strategy for eye contact, at least as far as parents are concerned. At the same time, the results

606   open a new direction of research in ADHD; a ND condition in which eye contact profiles

607   have previously been neglected. The fact that only 42% of this group showed eye contact that

608   is always appropriate and natural, and similarities in the pattern of unusual eye contact

609   quality to that seen in other ND conditions, should be investigated in relation to their known

610   challenges establishing and maintaining friendships (Normand et al., 2011, 2013) and broader

611   socio cognitive skills (Bora & Pantelis, 2016; Sibley et al., 2010; Uekermann et al., 2010).

612   Further research is also needed with this group to understand eye contact patterns in those

613   with co-occurring ADHD and autism.

614   From a clinical and societal perspective, the findings emphasise that eye contact given

615   by people with ND conditions may look different from the NT preference of direct, steady

616   gaze, but that the observable qualities may vary across individuals with the same diagnosis.

617 Difference from a NT pattern of eye contact should not be interpreted as a call for

618 intervention, given these behaviours likely serve an adaptive role. One important

619 consideration however, is the potential impact that different eye contact behaviours may have

620 on the wider social interaction, in terms of impression formation and potential stigma

621 (Morrison et al., 2020; Sasson et al., 2017). Unusual qualities of eye contact may

622 miscommunicate information about the intentions and attitudes of people with ND

623 conditions. For example, brief glances may infer that the person is disinterested in the

624 interaction. Equally, being on the receiving side of prolonged eye contact may be an

625 uncomfortable experience. Prolonged staring at a time of greater social independence during

626 adolescence and young adulthood is particularly important, given the vulnerability issues that

627 have been emphasised in people with ND conditions (Fisher et al., 2013; Jawaid et al., 2012;

628 Ridley et al., 2020)**.**

629   To conclude, it is known that measurement differences lead to particular

630 interpretations of eye contact (Jongerius et al., 2020). We argue that the previous single

631 dimension interpretation, based on measurement of the degree or strength of eye contact, has

632 led to the oversimplified assumption that reduced eye contact equates to poor eye contact,

633 while eye contact that is not reduced equates to good eye contact. This in turn has led to an

634 interpretation that polarises different ND groups, such as WS and Autism, and makes the

635 incorrect assumption about underlying social motivational and cognitive factors. Given our

636 findings on similarities across ND conditions, we think it is time to focus on describing eye

637 contact profiles more in terms of different qualitative styles, and less in terms of a single

638 dimension (i.e. degree of presence/absence). This new perspective would have implications

639 for research on psychological and neural mechanisms related to eye contact, as it indicates

640 that quality of eye contact subtypes may be studied independently of traditional diagnostic

641 groupings and divisions.

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Table 1

Data for each Individual with Williams Syndrome (WS) for Diagnostic Interview for Social and Communication Disorders (DISCO) Items Assessing Eye Contact, and

Language and Visuospatial Skill Level

Age in months	M/F	Language Delay		Age-appropriate level of current skill			Eye contact present	Unusual quality of eye contact (marked or frequent)		
		Late to use 2-3 phrases	Late to understand word meanings	Expressive language Level 1-9 [a]	Receptive language Level 1-7 [b]	Visuospatial skill Level 1-12 [c]		Brief glances	Blank unfocused gaze	Staring
72	F	Yes	Yes	8	5	9	+	+	+	+
89	M	Yes	Yes	8	5	5				
100	F	No	No	9	6	9	+			
101	M	–	–	9	3	12	+			
106	M	Yes	Yes	9	7	10	+	+		
115	F	Yes	Yes	7	6	10	+			
124	F	Yes	Yes	8	7	10	+			
153	M	Yes	Yes	9	7	9	+		+	
159	M	Yes	Yes	9	7	9	+			
161	F	Yes	Yes	9	5	12	+			
172	F	Yes	Yes	9	4	10	+	+	+	+
193	M	No	–	9	4	10	+	+	+	+
193	M	–	Yes	8	5	8	+	+	+	+
205	F	Yes	Yes	8	4	–				
206	M	Yes	Yes	9	4	12	+		+	+
210	F	No	Yes	9	7	6	+			
258	F	Yes	Yes	8	5	8	+			
277	M	Yes	Yes	9	5	6	+	+		
286	F	–	No	9	7	8	+	+	+	+
301	M	Yes	Yes	9	7	3	+			+
396	F	No	No	9	6	8	+			+
435	F	–	–	–	6	–	+	+	+	+

Note. Dash sign (–) = parent data was not available. Cells with plus sign (+) indicate endorsement of either (a) presence of eye contact and (b) unusual quality of eye contact at a marked level. M = male; F = female.

[a] Language expression: 0-2 = No speech or babbles, 3-4 = Says names for things only, 5 = says phrases of 2 words only, 6 = Says longer phrases, 7 = Uses spontaneous sentences, present tense only, 8 = Uses sentences/phrases including 'but' and 'because', 9 = Uses past, present and future tenses and complex grammatical constructions.

[b] Language comprehension: 0-1 = No response or responds to name only, 2 = Understands simple words from phrases in context (learned from gestural cues, e.g. time for bed), 3 = Knows the meaning of some words and can responds e.g. 'give me your cup', 4 = Follows instructions involving 2 new objects "Put the doll on the chair", 5 = Can reliably follow instruction to fetch 2 or more objects from outside of the room, 6 = understands a sequence of commands, 7 = Understands instructions involving decisions (conditionals) "see if my phone is in my bedroom and if not look for it in the bathroom".

[c] Visuospatial skill: 0 = does not hold objects in hands, 1 = holds objects in hands, 2 = examines objects, 3 = handles objects, 4 = rolls toys on floor, 5= builds tower of 2-5 bricks, 6 = builds tower of 6 bricks, 7 = arranges objects in size order, 8 = completes puzzle 6 pieces, 9 = completes puzzle 10 pieces, 10 = completes puzzle 20-30 pieces, 11 = completes puzzle 50 pieces, 12 = completes puzzle 150 pieces.

Table 2

Demographic Characteristics of the Sample (% Reported) Split by Diagnostic Group

Demographic variables	Autism (*n* = 29)	WS (*n* = 29)	ADHD (*n* = 36)	FXS (*n* = 18)	NT (*n* = 150)
Males/females/prefer not to say	72/28/0	59/41/0	78/19/3	94/6/0	48/51/1
Age (months)					
$\quad$ *M* (*SD*)	127 (28.4)	100 (36.3) [a]	127 (38.8) [b]	118 (36.9)	107 (45.8) [c]
$\quad$ Range	59-187	48-204	54-179	54-197	48-215
Presence of an intellectual disability	21	90	28	89	0
Expressive language					
$\quad$ None	3	7	0	11	1
$\quad$ Single words	3	7	0	17	0
$\quad$ Simple phrases	7	24	6	33	0
$\quad$ Full sentences	86	62	94	39	99
Receptive language					
$\quad$ None	0	0	0	6	0
$\quad$ Single words	0	7	0	0	0
$\quad$ Simple phrases	17	28	6	28	0
$\quad$ Full sentences	83	66	94	67	100

Note. WS = Williams syndrome; ADHD = attention-deficit hyperactivity disorder; FXS = fragile X syndrome; NT = neurotypical.

[a] Missing data (*n* = 1). [b] Missing data (*n* = 1). [c] Missing data (*n* = 1).

Table 3

Quality of Eye Contact Behaviour Endorsed by Parents in Each Group

Group	n [a]	Quality of eye contact applied most usually					
		Eye contact always appropriate and natural	Brief glances	Blank, unfocused gaze	Staring	Avoids eye contact	None of these apply
WS	27	12 (44.4)	5 (18.5)	1 (3.7)	7 (25.9)	1 (3.7)	1 (3.7)
Autism	25	3 (12)	11 (44)	2 (8)	1 (4)	3 (12)	5 (17.2)
FXS	13	2 (15.4)	9 (69.2)	0 (0)	1 (7.7)	0 (0)	1 (7.7)
ADHD	31	13 (41.9)	13 (41.9)	1 (3.2)	1 (3.2)	2 (6.5)	1 (3.2)
NT	143 [b]	124 (86.7)	11 (7.7)	1 (0.7)	0 (0)	2 (1.4)	5 (3.5)
Total ND	96	30 (31.3)	38 (39.6)	4 (4.2)	10 (10.4)	6 (6.3)	8 (8.3)

Note. Percentages are presented in parentheses. WS = Williams syndrome; FXS = fragile X syndrome; ADHD = attention-deficit hyperactivity disorder; NT = neurotypical; ND = neurodevelopmental.

[a] Parents who reported "yes" to Q1 about the presence of eye contact. [b] Of the 146 TD parents who reported yes to Q1, 3 data points were missing.