Violations of personal space in young people with Autism Spectrum Disorders and Williams syndrome: Insights from the Social Responsiveness Scale

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Abstract

Interpersonal distance regulation is crucial for successful social interactions. We investigated personal space awareness in Williams syndrome (WS) and Autism Spectrum Disorder (ASD) compared to typical development (TD). Parents reported that individuals with WS and ASD were significantly more likely than those developing typically to invade the personal space of others. WS individuals were reported to have the least awareness of the personal space boundaries of others. Despite the suggested opposing social profiles of WS and ASD, some similarities are present in the ability, or indeed inability, to regulate interpersonal distance during social interactions. Findings are discussed in relation to implications of atypical amygdala function, inhibitory control and anxiety on real-world behaviour for such socially vulnerable groups.

Keywords: personal space, social distance, Autism, Williams syndrome, social behaviour

Abbreviations: SRS, Social Responsiveness Scale

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Personal space refers to the distance that individuals strive to maintain between themselves and other people (Hall, 1966). Intrusion of another person's personal space can have significant implications on social interactions, prompting feelings of discomfort and anxiety (Perry et al., 2013) or transferring fallacious social intentions (Kaitz et al., 2004). In order to proactively avoid such intrusions, we automatically regulate the boundaries for our personal space, and these boundaries are continuously re-assessed dependent on social dynamics and context (Lloyd, 2009). For example, the physical distance maintained between two people, i.e. interpersonal distance, can vary as a function of many factors, including familiarity, age and gender (Horne, 2006; Beaulieu, 2004). As such, successful interpretation of these social cues and subsequent appropriate decisions on context-dependent personal space regulation, play a vital role in positive social interactions (Gessaroli et al., 2013).

Despite the regulation of personal space being an automatic and adaptive process in typically developing individuals, several studies have shown that patterns of personal space regulation are altered in individuals who follow an atypical developmental trajectory. For instance individuals with developmental disorders such as Autism Spectrum Disorder (ASD), which is characterised by notable difficulties in social interactions (APA, 2013), often find interpreting and responding to social situations challenging (Smith et al., 2010). A recent study by Gessaroli and colleagues (2013) used an experimental stop-distance paradigm (Hayduk, 1978) to examine the issue of interpersonal distance in children with ASD. For that task, the participants were asked to approach the experimenter and stop at the distance that felt most comfortable to them, which was in turn measured using a digital laser measurer. Gessaroli et al. (2013) found that children with ASD maintained a greater interpersonal distance than their typically developing (TD) peers, and this was not modulated in response to social cues such as familiarity, as it was in TD children. Therefore, they suggested that individuals with ASD not only maintained a greater personal space distance, but their personal space boundaries were also more rigid and less socially responsive than other children of the same age who did not have ASD. In contrast, Kennedy and Adolphs (2014) employed parent rated behavioural measures to examine interpersonal distance in ASD using the Social Responsiveness Scale (SRS) questionnaire (Constantino & Gruber, 2005). Despite the greater self-boundaries identified by Gessaroli et al. (2013), Kennedy and Adolphs found that 79% of parents report that their children with ASD were more likely to violate the personal space of others (e.g. have smaller self-boundaries) when compared to their TD siblings. Although both studies therefore suggest a difficulty of regulating personal space, these two previous studies provide equivocal findings, which could be in part attributed to the different forms of assessment.

A theoretically important developmental disorder, which features atypical social interactions and a lack of appropriate responsiveness to complex social stimuli, is Williams syndrome (WS; Pinheiro et al., 2011). WS is a rare genetic neuro-developmental disorder, affecting approximately 1 in 20,000 individuals (Korenberg et al., 2003). Unlike the variable and largely underdetermined etiology of ASD, WS is caused by the microdeletion of 25 – 28 genes on chromosome 7q11.23 (Hillier et al., 2003). Predominant characteristics of WS include mild-to-moderate intellectual impairment (Searcy et al., 2004) and a hyper-sociable behavioural phenotype (Jarvinen et al., 2013). People with WS often experience difficulties interpreting social nuances and forming and maintaining relationships, especially with peers (Davies et al., 1998). The social profiles of WS and ASD are both viewed as atypical, but the atypicalities are likely to be syndrome-specific (Tager-Flusberg et al, 2006). For example, individuals with WS show an extreme pro-social drive, with excessive face attention, in particular to the eye region (Riby & Hancock, 2009). In contrast, individuals with ASD show a lack of gaze fixation on the eye region (Riby & Hancock, 2008), and may be considered socially aloof (Wing, 1981).

Little is known about how individuals with WS regulate their personal space, and whether this has any bearing on their social interaction style. The inability to interpret and regulate appropriate interpersonal distance may intensify everyday social vulnerability for both ASD and WS individuals. However, we do not know whether the nature of these interactions may be qualitatively different across syndromes.

In the current study, we adopted the questionnaire-based approach to collect data on social distancing, previously employed by Kennedy and Adolphs (2014). Our aim was to measure parent reports of social functioning in relatively large, multi-site samples of individuals with ASD and WS using the Social Responsiveness Scale (Constantino & Gruber, 2005) to compare social profiles between ASD and WS groups. We then sought to verify the robustness of the findings offered by Kennedy and Adolphs (2014) on personal space violations in ASD, as well as offering the first insight into personal space regulation in WS, and directly compare social distancing abnormalities between ASD and WS groups. Based on the work of Kennedy and Adolphs (2014) and what is known about the WS social phenotype, it was hypothesised that the parents of both the ASD and WS individuals would be more likely to report interpersonal distance atypicalities than the parents of typically developing individuals.

Method

Participants

Parent reports were provided for individuals with ASD (n = 101; mean age = 13.5; age range = 8 - 37), WS (n = 77; mean age = 15.3; age range = 4 - 36) and typically developing individuals (n = 118; mean age = 13.5; age range = 3 - 36). Diagnosis of an ASD had previously been confirmed using the Social Communication Questionnaire (SCQ; Rutter et al., 2003), the ADOS or the ADI-R, and all individuals with WS who participated had previously had their diagnosis confirmed with positive *fluorescent in situ hybridization* (FISH) testing. The typically developing individuals were not reported to have any difficulties with everyday functioning or to have any developmental or neurological deficits. A one way ANOVA revealed that there was no significant difference in chronological age across the three groups (p = .09; see Table 1).

Social Responsiveness Scale

The parent report SRS (Constantino & Gruber, 2005) is a 65-item questionnaire that measures the normality/abnormality of social functioning. It was originally designed not just as an autism screener, but also to detect milder traits of autism in the typically developing population. As such it has been used in a range of typical and atypical populations (Barttfeld et al., 2013; Channell et al., 2015; Klein-Tasman, Li-Barber, & Magargee, 2011; Riby et al., 2014). Each item is coded on a scale of 0 – 3, and scores are generated across five subscales: social awareness (e.g. – aware of what others are thinking or feeling), social cognition (e.g. –

recognizes when something is unfair), social communication (e.g. – is able to communicate feelings to others), social motivation (e.g. – self-confident when interacting with others) and autistic mannerisms (e.g. - has an unusually narrow range of interests). Higher scores on these subscales are indicative of greater impairments. Of interest, item 55 directly addresses interpersonal space ("Knows when he or she is too close to someone or is invading someone's space"). Kennedy and Adolphs (2014) also noted three other items which were highly correlated with this statement: item 52 ("Knows when he or she is talking too loud or making too much noise"), item 56 ("Walks in between two people who are talking") and item 63 ("Touches others in an unusual way e.g., he or she may touch someone just to make contact with them then walk away without saying anything"). These items were therefore examined independently as part of a separate interpersonal space subdomain.

Procedure

The study was a multi-site project between UK, USA[1], Australia and Ireland. Parents completed the questionnaires and returned them to the researcher. Ethical approval was obtained from all the host institutions.

Results

Profiles of social functioning in ASD and WS

An initial one-way ANOVA was conducted to assess differences in overall social functioning of individuals with ASD, WS and TD controls using total score on the SRS as completed by

[1] It is important to note that none of the participants in the current study had featured in Kennedy & Adolphs (2014).

parents. The results revealed a statistically significant effect of group/diagnosis on total SRS T-score ($F(2, 293) = 406.2$, $p<.001$). A Tukey post-hoc comparison revealed that the total SRS score for the ASD group (mean = 110.0, ±25.0) was significantly higher than both the WS group (mean = 84.4, ±32.5; $p<0.001$) and the TD group (mean = 21.1, ±17.1; $p<0.001$). Likewise, the WS group scored significantly higher than the TD group ($p<0.001$; see Table 1).

The mean total SRS T-score for both the ASD and the WS group was in the severely abnormal range, whereas the TD group was within the normal range of social functioning (see Table 1). Crucially, only 1 per cent of the ASD group, and 18 per cent of the WS group were reported by parents to function within the 'normal' range (compared to 92 per cent of the typically developing group).

[Table 1]

Exploring patterns at the subscale level, there were significant effects of group on all five sub-domains of the SRS, assessing social awareness, social cognition, social communication, social motivation, and autistic mannerisms (all $p<0.001$; Table 1). Post hoc comparisons showed that the WS and ASD groups both scored significantly higher than the TD group in all five domains ($p<0.001$; Tukey HSD). The ASD and WS groups also scored significantly different to each other in the sub-domains of communication, motivation and mannerisms as the ASD group were more atypical (all at $p<0.001$), but the groups did not differ on the social awareness subscale ($p = 0.12$) and the social cognition subscale ($p = 0.07$). The difference in the profile of individuals categorised in the severe, moderate and normal ranges across these domains is displayed in Figure 1 and shows the similarities / differences in the profiles between the two clinical groups. The mean T scores in all sub-domains indicate that the ASD and WS groups did not show social functioning in the 'normal' range in any of the five areas.

[Figure 1]

Personal space in ASD and WS

In order to specifically assess the characteristics of personal space across individuals with ASD, WS and those who are TD, a Kruskal-Wallis H test was conducted to explore the parent ratings. It was found that scores significantly differed on this item between the three groups ($H(2) = 114.2$, $p<0.001$); with a mean rank item score of 173.3 for the ASD group, 208.6 for the WS group and 88.1 for the TD group. These rank scores suggest that on average the WS group was reported to be significantly less aware of someone else's personal space (i.e., more atypical in this behaviour) compared to the ASD group ($U = 2899$, $Z = -3.12$, $p<0.001$) and to the typically developing group ($U = 903$, $Z = -9.93$, $p<0.001$, Mann-Whitney U test; Figure 2). The ASD group were also reported to be less aware of invading another person's personal space when compared to the typically developing group ($U = 2466$, $Z= -7.89$, $p<0.001$, Mann-Whitney U test). Therefore, individuals with ASD and WS were reported by parents to display personal space difficulties in comparison to TD children, however the parents of those with WS reported the greatest deficits.

[Figure 2]

As suggested by Kennedy and Adolphs (2014), our sense of space is a multimodal construct. Thus, we looked for items on the SRS which were highly correlated with item 55 regarding personal space. We found that item 52 (the volume at which words are spoken) had a high correlation with item 55 in both the ASD and WS groups (r = 0.35, r = 0.47 respectively, both at $p<0.001$), but not the TD group (r = 0.29, $p<0.001$). Likewise item 56 (walks in between two people who are talking) was highly correlated with item 55 in the WS group and the TD group (r = 0.4, r = 0.4 respectively, both at $p<0.001$), but not in the ASD group (r = 0.08, p = 0.46). Both of these items relate to the broad construct of social distancing.

The impact of age on personal space

To explore the impact of age on personal space judgements, the participant groups were split into broad age categories of ‘Child’ (age 3-12 years), ‘Adolescent’ (age 13 – 17 years) and ‘Adult’ (age 18+years) and the data were explored for item 55. Figure 3 illustrates the lack of developmental change in response to this item in the clinical groups, thus suggesting there is little evidence of an age-specific atypicality. These data were analysed using a Kruskal-Wallis H test which revealed that there was no significant difference between the three age categories for the ASD group (H(2) = 1.53, p = 0.46) or for the WS group (H(2) = 0.74, p = 0.69). In the TD group, a significant difference was found (H(2) = 7.09, p<0.05), with children being significantly less aware of invading another person’s personal space than adolescents (U = 912.5, Z = 2.64, p<0.05; Mann-Whitney U test) but no difference between adolescents and adults. Some caution is required due to the uneven proportion of participants per age category in each group.

[Figure 3]

Discussion

By analysing parent-reported Social Responsiveness Scale scores acquired from relatively large samples of individuals with ASD and WS, the current study identified significant difficulties of social functioning, variation across subdomains of communication, social motivation, and autistic mannerisms, and specific impairment in the regulation of appropriate interpersonal distance in the two clinical groups. Crucially, individuals with ASD and with WS were reported by their parents to be less aware of invading another person's personal space, compared to reports from parents of typically developing children. In line with the findings of Kennedy and Adolphs (2014), we also found that a lack of awareness of other people's personal space was correlated with abnormalities in other forms of social distancing. For example, a lack of awareness of personal space may also manifest itself as atypicality of invading another person's space with intrusive loud noise. These data therefore suggest that personal space is a 'multimodal construct' that may be regulated in an atypical manner by individuals with ASD and those with WS. Such atypicalities are highly likely to feed into the profiles of atypical social interaction we associate with both of these developmental disorders and impact upon the range of social difficulties experienced in daily living for both groups.

Interestingly, parents of individuals with WS rated their sons / daughters as being the least aware of another person's space boundaries compared to TD and ASD individuals, thus showing severe abnormality in this domain of social functioning. The findings offer the first insight into interpersonal distance regulation abilities in individuals with WS and suggest that, like individuals on the autism spectrum, this group can also struggle with personal space behaviours, perhaps to an even greater extent. The data here strongly support anecdotal evidence from parents of individuals with WS in terms of the nature of their interactions with unfamiliar people. Given the wide ranging reports of hypersociability associated with the disorder (e.g. Frigerio et al., 2006), increased approach to unfamiliar people (e.g. Jones et al., 2000) and a lack of stranger awareness (e.g. Riby et al., 2014), prolonged fixation on faces during an interaction (e.g. Riby & Hancock, 2008) and generally reduced intellectual capacity to accurately interpret cues during an interaction (e.g. Searcy et al., 2004), a dysregulation of personal distancing may play a crucial role in social vulnerability of individuals who have the disorder (e.g. Lough et al,. 2014). This issue clearly warrants further investigation using a variety of methods to probe its relation to other components of the social profile and wider aspects of the disorder. In addition, it motivates the need to develop interventions that teach individuals with WS and ASD how to maintain appropriate space between themselves and others. This is relevant across ages in these developmental disorder groups given the lack of evidence of developmental change with regards to personal space distancing in the current data.

Similarities between individuals with ASD and WS in social distancing abnormalities are of particular interest as the two developmental disorders have been considered to be associated with such different social profiles (e.g. Brock, Einav & Riby, 2008). Individuals with ASD are often considered to be hypo-social with a lack of social priority for people, which can be very different from the hyper-sociability and extreme social motivation towards people that has been associated with WS (e.g. claims of a prosocial drive, Frigerio et al, 2006). Despite these differences, both groups are considered socially vulnerable (Lough et al., 2014) as a consequence of the atypicalities of their social profiles and the impact upon daily functioning. Indeed, the current study shows that both group show atypical social distancing regulation that will feed into those atypical social profiles. It follows that appropriate social distancing plays a vital role in positive social interactions (Gessaroli et al., 2013), and positive social interactions can be protective against social vulnerability.

The role of the neural systems underpinning social behaviour regulation is of interest in light of our findings, especially social distance. Kennedy et al. (2009) demonstrated that a patient with bilateral amygdala damage (known as patient SM) also showed substantially reduced personal space boundaries. They suggested that the amygdala is therefore a key component of the neural substrate regulating interpersonal distance. This proposal drew strength from the findings of Gessaroli et al. (2013) and Kennedy and Adolphs (2014) who found diminished personal space regulation in individuals with ASD, a condition with known anatomical abnormalities of the amygdala (Baron-Cohen et al., 2000). Individuals with WS are also known to have structural and functional abnormalities of the amygdala (e.g. Bellugi et al. 1999; Haas et al., 2010; Haas et al., 2009; Meyer-Lindenberg et al., 2005), and the current study has shown that these individuals demonstrate severely impaired interpersonal distance awareness. However, although amygdala function may play a role in interpersonal space this region does not necessarily function in the same manner for individuals with WS as it does with ASD. Indeed when engaged in viewing faces individuals with WS show reduced amygdala activation whereas individuals with ASD shown amygdala hyper- responsiveness (Kliemann et al., 2012). Therefore, it remains speculative as to whether interpersonal distance regulation could be an endophenotype for amygdala dysfunction in WS and ASD (Kennedy & Adolphs, 2014).

An alternative explanation is offered by the frontal lobe hypothesis. Frontal lobe dysfunction is thought to be related to impaired response inhibition (Porter et al., 2007). Parallels in social functioning, and specifically approach behaviour, have been drawn between patients with frontal lobe damage and those with WS. Porter and colleagues (2007) suggest that whilst these individuals report knowing not to approach a stranger, they have difficulty inhibiting the impulse they experience to carry out this behaviour. This lack of inhibitory control has also been shown in individuals with ASD (Christ et al., 2006). Therefore, the atypical interpersonal distance findings in the current study for these two groups could be in part explained by their lack of inhibitory control.

Anxiety has also been shown to mediate social behaviour in WS (Kirk et al, 2013) and it is suggested that high levels of anxiety (which are present in both WS and ASD; Riby et al., 2014; Rodgers et al., 2012) may influence the ability to process socially meaningful stimuli. It is therefore possible that mental health issues associated with the disorder are impacting the ability to gauge appropriate social behaviour, and thus affecting interpersonal distance regulation. Considering the contribution of each of these previously mentioned theoretical standpoints to our understanding of interpersonal distance regulation in these clinical groups is a challenge for future research and emphasises the need to consider the whole individual and the cognitive / behavioural profiles associated with these disorders in a more comprehensive manner. Certainly the parent report data provided here suggest that future research is warranted in much greater detail. Indeed it is only once we consider the full profile at an individual level and capture both within- and between-disorder variability that we can begin to disentangle the above interpretations.

A significant strength of the current study is the cross-syndrome approach in a large sample size. This is especially insightful considering the rarity of conditions such as WS. However, there remain limitations which should also be addressed. As the SRS was not originally designed to measure social distancing, it lacks the detail and insight that could be acquired through experimental work. The method reported here is not offered as a replacement for observational or experimental work, rather it serves to assess a large sample of individuals with relatively rare developmental disorders, certainly in the case of WS. As social distancing in WS was previously unexplored, this study offers the first insight into whether or not there is an abnormality that requires further attention in this population – and indeed, the results suggest this to be the case. A further limitation is that item 55 only addresses one direction of social distancing abnormalities by only asking about social violations arising from close proximity rather than violations from being abnormally distant from others. It is therefore entirely possible that the few individuals with ASD and WS who score in the typical range for this question still have social distancing abnormalities related to maintaining too great a distance from other people during social interactions. Furthermore, the fact that item 55 did not correlate with other assessments of personal distancing in the ASD group warrants future exploration to explore syndrome-specific patterns of social behaviour atypicality that may inform intervention. Finally, a measure of general cognitive functioning was not taken in this study, which could have mediating effects on the social distancing phenotype. However, previous work on a large sample of individuals with ASD found that social distancing abnormalities can not be entirely explained by intelligence (Kennedy & Adolphs, 2014). Moreover, when considering the social vulnerability status of these groups, a stranger can get a strong cue from social distancing abnormalities; however, intelligence levels are more hidden and thus may not be immediately apparent. The stranger therefore only has access to estimates of age based on physical appearance with which to make their decision of how to respond as the individual with WS or ASD approaches. The social impact of inappropriate personal distancing may be compounded by reduced intellectual abilities once an interaction begins, further emphasising the importance of social distancing in individuals with lower IQ.

In conclusion, the current findings provide new evidence that individuals with WS have difficulties with social distance regulation, and are rated to be more likely than individuals with ASD and their typically developing individuals of the same chronological age to infringe upon the personal space of others. However, these preliminary findings need to be followed up with experimental paradigms, and the real-world implications of these behaviours need to be considered for these vulnerable individuals with developmental disorders. By doing so, we will begin to develop a greater understanding of the relationship between interpersonal distance, successful interpersonal interactions and social vulnerability status.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC

Baron-Cohen, S., Ring, H. A., Bullmore, E. T., Wheelwright, S., Ashwin, C., & Williams, S. C. R. (2000). The amygdala theory of autism. *Neuroscience & Biobehavioral Reviews*, *24*(3), 355-364.

Barttfeld, P. Amoruso, L., Ais, J., Cukier, S., Bavassi, L., Tomio, A. et al. (2013). Organization of brain networks governed by long-range connections index autistic traits in the general population. *Journal of Neurodevelopmental Disorders*, 5:16

Beaulieu, C. (2004). Intercultural Study of Personal Space: A Case Study. *Journal of Applied Social Psychology*, 34.4, 794–805

Bellugi U., Adolphs R., Cassady C. & Chiles M. (1999). Towards the neural basis for hypersociability in a genetic syndrome. *Neuroreport* 10, 1653–1657

Brock, J, Einav, S & Riby, D M (2008). The other end of the spectrum? Social cognition in Williams syndrome. In Social cognition: Development, Neuroscience and Autism. Reid, V. & Striano, T Blackwell

Channell**,** M. M., Phillips**,** B. A., Loveall, S. J., Conners**,** F. A., Bussanich, P. M. & Klinger, L. G.(2015). Patterns of autism spectrum symptomatology in individuals with Down syndrome without comorbid autism spectrum disorder. *Journal of Neurodevelopmental Disorders*, **7**:5

Christ, S. E., Holt, D. D., White, D. A., & Green, L. (2007). Inhibitory control in children with autism spectrum disorder. *Journal of autism and developmental disorders*, *37*(6), 1155-1165

Constantinno, J., Gruber, C. (2005). The social responsiveness scale: Western Psychological Services

Davies, M., Udwin, O., & Howlin, P. (1998). Adults with Williams syndrome. Preliminary study of social, emotional and behavioural difficulties. *British Journal of Psychiatry, 172***,** 273–276

Frigerio, E., Burt, D. M., Gagliardi, C., Cioffi, G., Martelli, S., Perrett, D. I., & Borgatti, R. (2006). Is everybody always my friend? Perception of approachability in Williams syndrome. *Neuropsychologia*, *44*(2), 254-259.

Gessaroli, E., Santelli, E., di Pellegrino, G., Frassinetti, F. (2013). Personal space regulation in childhood autism spectrum disorders. *PLoS One*, 8 (9), e74959

Hall, E. (1966). The Hidden Dimension. Garden City, New York: Doubleday

Haas, B. W., Hoeft, F., Searcy, Y. M., Mills, D., Bellugi, U., & Reiss, A. (2010). Individual differences in social behavior predict amygdala response to fearful facial expressions in Williams syndrome. *Neuropsychologia*, *48*(5), 1283-1288.

Haas, B. W., Mills, D., Yam, A., Hoeft, F., Bellugi, U., & Reiss, A. (2009). Genetic influences on sociability: heightened amygdala reactivity and event-related responses to positive social stimuli in Williams syndrome. *The Journal of Neuroscience*, *29*(4), 1132-1139.

Hayduk, L. (1978). Personal Space – evaluative and orienting overview. *Psychol. Bulletin*. 85 (1), 117 – 134

Hillier, L., Fulton, R., Fulton, L., Graves, T., Pepin, K., Wagner-McPherson, C. et al. (2003). The DNA sequence of human chromosome. *Nature*, 7 (424), 157 - 164

Horne, N. (2006). The influence of biological sex, sexuality and gender role on interpersonal distance. *The British journal of social psychology* 45.3, 579–597

Järvinen A., Korenberg J. R., Bellugi U. (2013). The social phenotype of Williams syndrome. *Current Opinion in Neurobiology*. 23, 414–422

Jones, W., Bellugi, U., Lai, Z., Chiles, M., Reilly, J., Lincoln, A., & Adolphs, R. (2000). Hypersociability in Williams syndrome. Journal of Cognitive Neuroscience, 12, 30-46.

Kaitz, M., Bar-Haim, Y., et al., (2004). Adult attachment style and interpersonal distance. *Attachment and Human Development*. 6 (3), 285–304

Kennedy, D.P. & Glascher, J., Tyszka, J. & Adolphs, R. (2009). Personal Space Regulation by the human amygdala. Nature Neuroscience, 12, 1226 – 1227

Kennedy, D.P., Adolphs, R. (2014). Violations of personal space by individuals with autism spectrum disorder. *PLoS One*, 9 (8), e103369

Kirk, H. E., Hocking, D. R., Riby, D. M. & Cornish, K. M. (2013). Linking social behaviour and anxiety to attention to emotional faces in Williams syndrome. *Research in Developmental Disabilities* 34(12): 4608-4616.

Klein-Tasman, B.P., Li-Barber, K.T**.**, Magargee, E.T. (2011). Honing in on the social phenotype in Williams syndrome using multiple measures and multiple raters. *Journal of Autism and Developmental Disabilities, 41(3),* 341-351.

Kliemann, D., Dziobek, I., Hatri, A., Baudewig, J., & Heekeren, H. R. (2012). The role of the amygdala in atypical gaze on emotional faces in autism spectrum disorders. *The Journal of Neuroscience*, *32*(28), 9469-9476.

Korenberg J. R., Bellugi U., Salandanan L. S., Mills D. L.& Reiss A. L. (2003) Williams Syndrome: aneurogenetic model of human behaviour. In: *Nature Encyclopaedia of the Human Genome*, pp. 757–66. Nature Publishing Group, London, UK

Lloyd, D.M., (2009). The space between us: a neurophilosophical framework for the investigationof human interpersonal space. *Neuroscience and Biobehavioral Reviews*. 33 (3), 297–304

Lough, E., Flynn, E. & Riby, D. M. (2015). Mapping real-world to online vulnerability in young people with developmental disorders: Illustrations from autism and Williams syndrome. *Review Journal of Autism and Developmental Disorders* 2(1): 1-7.

Meyer-Lindenberg, A., Hariri, A. R., Munoz, K. E., Mervis, C. B., Mattay, V. S., Morris, C. A., & Berman, K. F. (2005). Neural correlates of genetically abnormal social cognition in Williams syndrome. *Nature neuroscience*, *8*(8), 991-993.

Perry, A., Rubinstenb, O., Peled, L. & Shamay-Tsoory, S. G. (2013). Don't stand so close to me: A behavioral and ERP study of preferred interpersonal distance. *NeuroImage* 83, 761–769

Pinheiro A., Galdo-Alvarez, S., Rauber, A., Sampaio, A., Niznikiewicz, M. & Gonçalves O. (2011). Abnormal processing of emotional prosody in Williams syndrome: an event-related potentials study. *Research in Developmental Disability 32*, 133–47

Porter, M. A., Coltheart, M., & Langdon, R. (2007). The neuropsychological basis of hypersociability in Williams and Down syndrome. *Neuropsychologia*, 45(12), 2839–2849

Riby, D. M., & Hancock, P. J. B. (2008). Viewing it differently: Social scene perception in Williams syndrome and Autism. *Neuropsychologia*, 46, 2855–2860

Riby, D. M. & Hancock, P. J. B. (2009). Do faces capture the attention of individuals with Williams syndrome or Autism? Evidence from tracking eye movements. *Journal of Autism and Developmental Disorders* 39(3): 421-431

Rodgers, J., Riby, D. M., Janes, E., Connolly, B., & McConachie, H. (2012). Anxiety and repetitive behaviours in autism spectrum disorders and Williams syndrome: A cross-syndrome comparison. *Journal of Autism and Developmental Disorders*, 42, 175–180

Searcy, Y.M., Lincoln, A., Rose, F., Klima, E., Bavar, N., & Korenberg, J.R. (2004). The relationship between age and IQ in adults with Williams syndrome. *American Journal on Mental Retardation, 109*, 231–236

Smith, M. J., Montagne, B., Perrett, D. I., Gill, M., & Gallagher, L. (2010). Detecting subtle facial emotion recognition deficits in high-functioning autism using dynamic stimuli of varying intensities. *Neuropsychologia, 48*, 2777–2781

Tager-Flusberg, H., Skwerer, D. P. & Joseph, R. M. (2006). Model syndromes for investigating social cognitive and affective neuroscience: a comparison of autism and Williams syndrome. *Soc Cogn Affect Neuroscience*, 1 (3), 175-182

Wing, L. (1981). Language, Social, and Cognitive Impairments in Autism and Severe Mental Retardation. *Journal of Autism and Developmental Disorders*, 11, 1, 31 - 44

Figure Caption Sheet

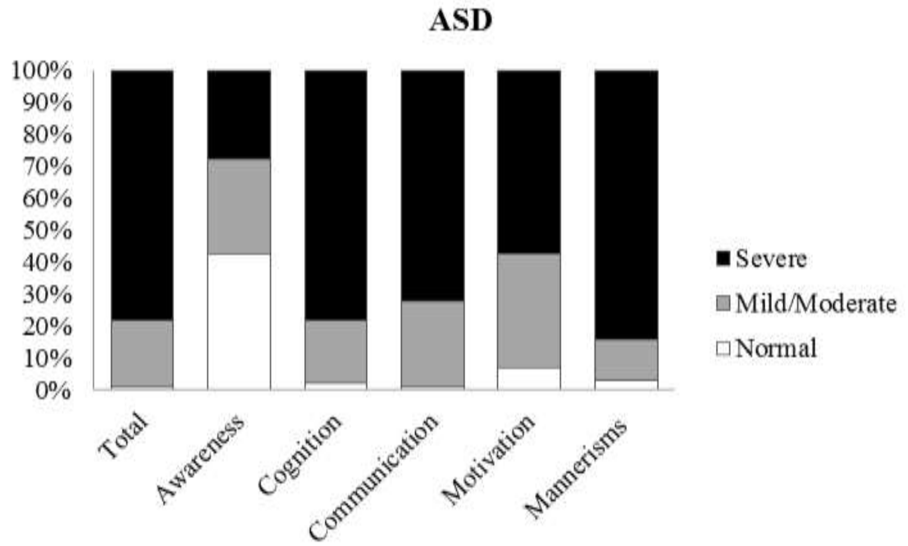
Figure 1. The percentage of individuals classified in the severe, mild-moderate and normal range using the SRS for individuals with ASD, WS and TD.

Figure 2. Percentage of scores relating to each group on item 55. Scores range from 0 – 3, with higher scores highlighting greater social distancing abnormalities.

Figure 3. Group average scores on item 55 per age, with the percentage of participants per group in each of the age categories. Scores range from 0 – 3, with higher scores highlighting greater social distancing abnormalities.

Figure 1 top

Panel A:



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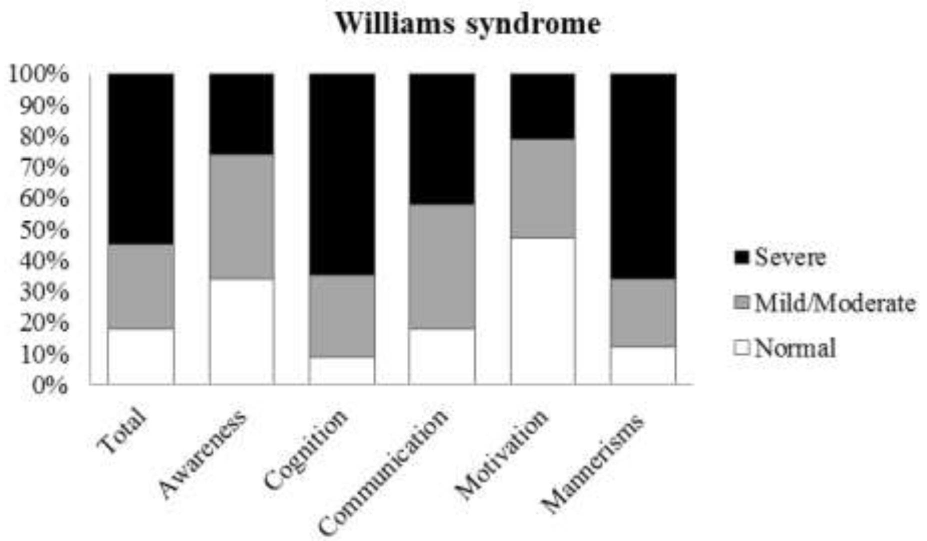


Panel C:

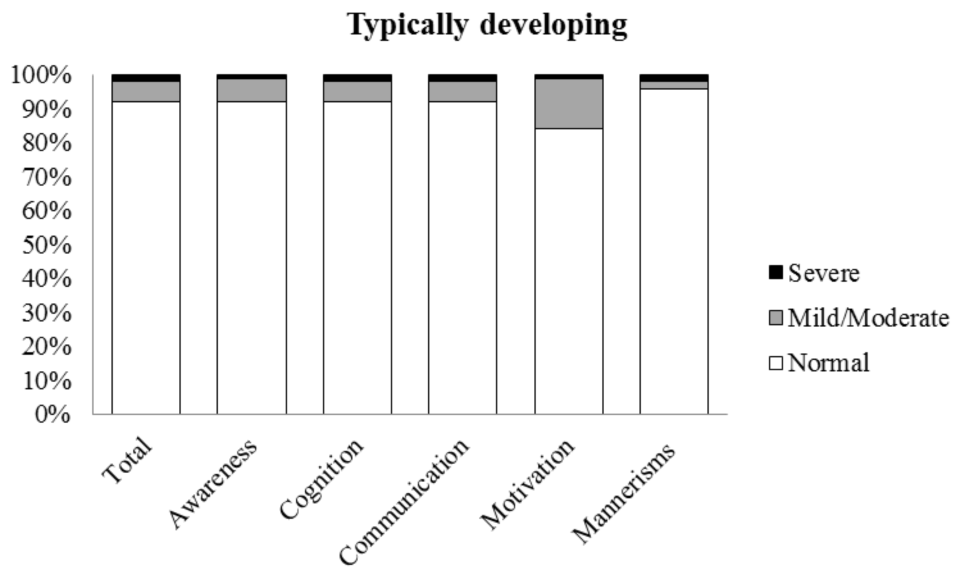


Figure 2 top

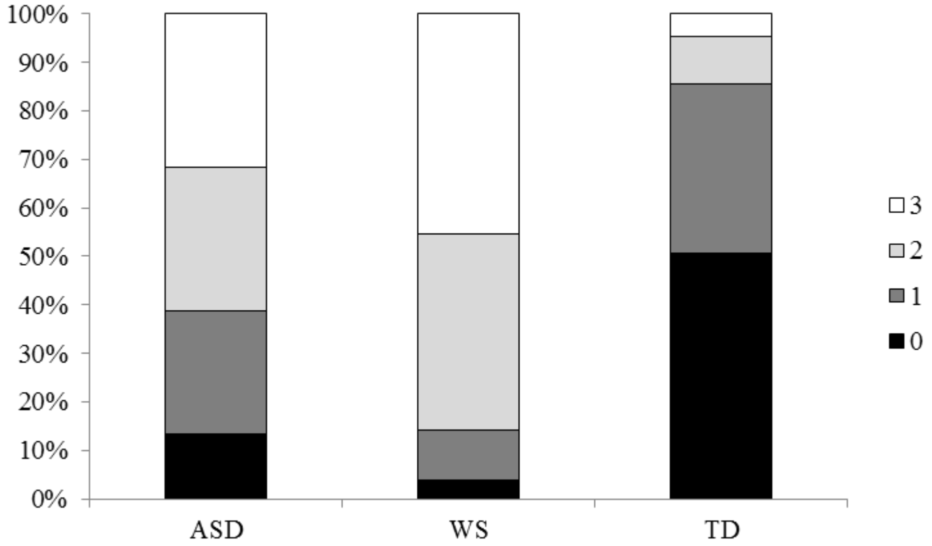
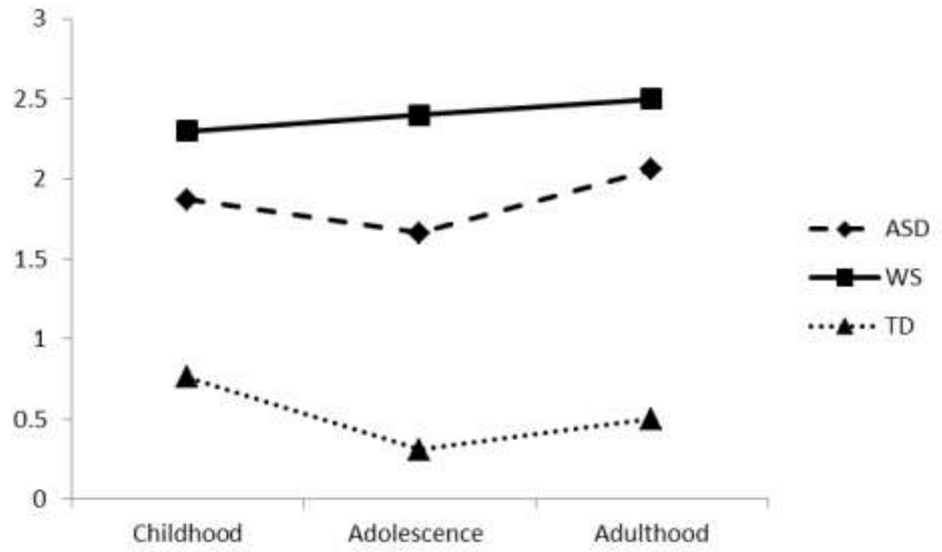


Figure 3 top



% of participants per age category			
ASD	54	30	16
WS	43	26	38
TD	47	38	15

Table 1. Participant characteristics and SRS scores for individuals with ASD, WS and those who are typically developing

	ASD (n = 101)	WS (n = 77)	TD (n = 118)
Mean age (± SD)	13.5 (±5.1) years	15.3 (±8.3) years	13.5 (±5.8) years
Males/Females (%)	84/16	51/49	60/40
SRS T scores			
Total score	110.0 (±25.0)	84.4 (±32.5)	21.1 (±17.1)
Social awareness	68.37 (±12.6)	64.7 (±15.45)	45.47 (±9.04)
Social cognition	81.61 (±9.32)	78.14 (±13.06)	44.74 (8.97)
Social communication	80.94 (±9.26)	71.52 (±14.47)	44.69 (±9.4)
Social motivation	77.75 (±11.96)	62.31 (±13.56)	48.26 (±9.73)
Autistic mannerisms	84.43 (9.55)	79.3 (±13.5)	45.99 (±8.09)