The relations between processing style, autistic-like traits, and emotion recognition in individuals with and without Autism Spectrum Disorder

Authors

Karen McKenzie[1+], Aja Louise Murray[2]*, Andrew Wilkinson[1], George C. Murray[3], Dale Metcalfe[1], Michael O'Donnell,[4] Kris McCarty[1]

[+] Corresponding author

* Joint first author

Conflicts of interest: None

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Abstract

Having a more local processing style may contribute to the difficulties that some people with developmental disabilities, such as Autism Spectrum Disorder (ASD), experience with emotion recognition (ER). This study explored whether autistic-like traits (ALT), as measured by the Autism Spectrum Quotient (AQ), and a more local processing bias predicted performance on an ER task. A cross-sectional study of individuals with a self-reported diagnosis of ASD (*n* = 40) and typically developing (TD) participants (*n* = 216) who completed the AQ, an ER naming task using static coloured images of people, and two processing style tasks (a Navon type task and a false memory recall task using the Deese-Roediger-McDermott (DRM) paradigm). No significant relationships were found between processing style, ER, and ALT**.** Higher general ALT scores were significantly associated with poorer general ER. The implications of the results for interventions to improve ER in people with ASD are discussed.

Key words: Autistic-like traits; Autism Spectrum Disorder; processing bias; emotion recognition

1. Introduction

Individuals with Autism Spectrum Disorder (ASD; see Table 1 for list of abbreviations) experience difficulties with socio-emotional relationships, of which the ability to correctly identify and interpret the emotions of others is an important part (Hext & Lunsky, 1997). Many people with ASD perform worse on emotion recognition (ER) tasks compared with their typically developing (TD) peers, although there is a lack of agreement about the exact nature and extent of these differences and some researchers have found no differences at all (for an overview, see Harms, Martin, & Wallace, 2010).

It has been proposed that the socio-emotional difficulties of people with ASD may result from deficits in cognitive (theory of mind) and affective empathy, combined with a preference for systematising and an associated preference for local or detail based information processing (Baron-Cohen, 2008). The reformulated Weak Central Coherence theory (Happé & Frith, 2006) and the Enhanced Perceptual Functioning model (EPF; Mottron, Dawson, Soulières, Hubert, & Burack, 2006), while not explicitly attempting to explain ER difficulties, also propose that people with ASD have a more local processing style, but differ in their emphasis. The former suggests this local style results from a global processing deficit, while the latter posits an enhanced local processing ability.

There is some inconsistency in the results of research into the processing styles of people with ASD (see Behrmann, Thomas, & Humphreys, 2006; Simmons et al., 2009; Van der Hallen, Evers, Brewaeys, Van den Noortgate, & Wagemans, 2015). A recent meta-analysis suggests that, while there is limited evidence for individuals with ASD having a global processing deficit, global processing does take longer and seems to require more effort than for TD individuals. The authors suggest that this may indicate that people with ASD move from local to global processing, with details being processed first (Van der Hallen et al., 2015). This work indicates that it is likely to be misleading to consider processing style in terms of local *versus* global; it might be better considered in terms of an initial strategy which is utilised for a specific task or in a specific context (D'Souza, Booth, Connolly, Happé, & Karmiloff-Smith, 2016).

There is, however, some suggestion that information processing style may play a role in ER ability (e.g. Fallshore & Bartholow, 2003; Scotland, McKenzie, Cossar, Murray, & Michie, 2016) and that, to the extent that people with ASD perform poorly on ER tasks, they do so, at least partly, because of the initial adoption of a more local processing style in situations where a more global approach would be more effective (Behrmann, Avidan, et al., 2006).

There has only been limited research which has directly tested this hypothesis. Gross (2005) explored the relationship between processing style and ER in children with ASD and other developmental disorders. He used a Navon type global/local identification task (Simmons et al., 2009) that asked the participant to choose which of three pictures most resembled a target image. The options were of a picture reflecting the general configuration of the target picture (global response), a picture reflecting the detail of the target picture (local response), and a picture that was unrelated to the target image. He found that children with ASD had fewer global responses and were less accurate when recognising both human and canine emotions. When considering all children, significant negative correlations were found between recognising human emotions and selecting local responses.

Scotland et al. (2016), using the same processing task as Gross (2005), found that, after controlling for group (adults with an intellectual disability or TD child controls), having a more local processing style was associated with poorer performance on an ER task for all participants.

As task type and difficulty appear to influence information processing style (e.g. D'Souza et al., 2016), it is advisable for researchers to consider more than one processing style task. The present study used the Deese-Roediger-McDermott (DRM) paradigm (Roediger & McDermott, 1995). This suggests that if gist/global processing dominates encoding of the stimulus, then these traces will be stronger at recall, resulting in higher recall of incorrect, but semantically related, answers. Conversely, if a more local processing style dominates, the fact that intrusions are semantically related should lead to less false recall. Previous evidence supports its validity and reliability and it has been used extensively and successfully in research measuring processing style in both TD individuals and people with ASD (see Miller, Odegard, & Allen, 2014).

A further question about the nature of the relationship between processing style and the ER of people with ASD arises from the continuum theory of ASD. This argues that autistic-like traits (ALTs) are characteristics that are distributed throughout the population to varying degrees, with individuals with a clinical diagnosis simply being those who have a more extreme presentation of the different characteristics (for an overview, see Murray, Booth, McKenzie, Kuenssberg, & O'Donnell, 2014). ALTs are measured by tools such as the Autism Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). This work raises the question of whether the relationship that is proposed to exist between a local processing style and ER in people with ASD, would also be found in individuals with subclinical levels of ALTs. That such a link might exist is suggested by the work of Vanmarcke and Wagemans (2016), which found that the responses of individuals with higher ALTs to a non-emotion based identification task were influenced by the nature of prime information (coarse [global], fine [local], or a hybrid of both) which preceded the task.

The current study aims to add to the limited extant literature on processing style and ER by examining the extent to which having a more local processing style (as indicated by a higher endorsement of local responses on the task developed by Gross [2005] and lower false recall scores on the DRM task) impacts on the relation between autistic traits – at the sub-clinical and clinical levels – and ER overall.

2. Method

For further details on the method, please see the supplementary materials.

2.1 Design

The study adopted a cross-sectional design, using both online and paper versions of a questionnaire, to assess the relationship between AQ score, DRM lure (false recall) score, and local score as predictors of ER score in TD individuals and individuals with ASD.

2.2 Participants

A total of 511 people participated, of whom 255 provided data on the ER task only. These were included in order to contribute to the ER measurement model and optimise the ER ability estimates. The remaining 256 participants also completed the AQ and at least one information processing task.

The ages of the 256 participants (male = 75, female = 117, bi-gender/transgender = 5, 59 chose not to respond) ranged from 16 to 73 (m = 29.8; SD = 13.4). Within this group, 40 people (male = 20, female =18, bi-gender/transgender = 2) had a reported/self-reported diagnosis of ASD. Ages ranged from 16 to 62 years (m = 29; SD = 10.5). All 256 participants completed the global/local task and 154 also completed the DRM task, including 15 participants with ASD.

Individuals with and without a diagnosis of ASD were included in order to ensure an adequate range of variability in ALT. Participants were included if they were aged 18 or above (or aged 16-18 with parental consent) and were able to give informed consent.

Individuals who had a condition other than ASD which was likely to impact on ER were excluded, e.g. an uncorrected visual impairment.

2.3 Materials

2.3.1 ER task

This was based on an assessment reported in McKenzie, Matheson, McKaskie, Hamilton, and Murray (2001) and subsequently used by Scotland et al. (2016). This involved presenting participants with examples of emotions depicted in photographs and asking them to identify the specific emotion. Nine different emotions – "happy", "sad", "worried", "afraid", "angry", "surprised", "disgusted", "bored", and "neutral" – were depicted. Participants were asked to note the name of the emotion depicted below each picture in response to the question "What is the person in this picture feeling?" The scores across the emotions were added to give a total ER score (possible range 0 – 18).

2.3.2 AQ (Baron-Cohen et al., 2001)

The AQ is a 50 item self-report questionnaire designed to measure ALTs. It is organised into 5 subscales – "Social Skills", "Communication", "Attention Switching", "Attention to Detail" (ATD), and "Imagination" – and rated on a four-point Likert scale (scoring "definitely agree", "slightly agree", "slightly disagree", and "definitely disagree"). As research suggests that, while the majority of items of the AQ form a coherent scale, the ATD items measure a relatively distinct construct (Murray, McKenzie, Kuenssberg, & Booth, 2015) which may be related to a preferred local processing style (Stevenson et al., 2016), the AQ was scored in two parts in the present study: "general autistic traits" excluding the ATD items, and ATD.

2.3.3 Processing task 1: DRM paradigm memory task (Roediger & McDermott, 1995)

This measures susceptibility to semantically based intrusions in memory recall. After individuals are presented with a list of words or pictures, they may falsely recall a word/item which was not present in the original list because it was semantically related to the items presented. We used a variation of a DRM based task adopted by Carlin et al. (2008). Here, semantically similar pictures are presented instead of words and the participant is asked to try and remember them. In the recognition phase, the related words are presented and participants have to confirm which items they had seen presented pictorially. Words instead of pictures were used in the recognition phase to avoid ceiling effects (Carlin et al., 2008). The result of interest for the current study was the total lure score (possible range 0 – 12). The lower a participant scored on the lure measure, the lower their incidence of false item recall, thought to indicate a more local processing style.

2.3.4 Processing task 2: Global/local task (Gross, 2005)

Participants were instructed to look at the target picture (e.g. pairs of red shoes arranged in a circle) and were then presented with 3 different response choice pictures and asked to select which of these was most like the target picture. One of the choices retained the overall configuration of the target (e.g. a red circle) representing the global response, one showed items which were similar to the target (e.g. different sized shoes arranged in a line) representing the local response, and one was dissimilar to the target in configuration and type (unrelated). There were 6 trials in total (possible range of scores = 0 – 6). The number of local responses was the variable of interest, with higher scores indicating a more local processing bias.

2.4 Demographic information

Participants were asked to provide basic demographic information, including age, gender, level of education, and occupation.

2.5 Procedure

Ethical approval for the study was obtained from the first author's educational establishment. Participants were recruited via social networking websites, online forums, and through the researchers' networks. Some individuals with ASD (*n* = 25) were also recruited via a local support organisation. Prospective participants for the online version were sent a hyperlink which provided them with information concerning the research, a consent section, and the online assessments. Participants who completed the paper version were first identified as potential participants by the support organisation. They were provided with information about the study, a consent form, and provided with an opportunity to ask questions. Those who consented were contacted by a researcher who arranged for the questionnaire to be completed.

2.6 Statistical procedure

We fit two models to assess the associations between ALTs, local processing style, and ER. In Model 1 we examined the associations between ATD, DRM lure score, local processing bias, and ER. ATD and ER were specified as latent variables, the former defined by the ATD items of the AQ and the latter by the ER items described in the Materials section (2.3.1). The two measures of local processing style were each single scores. For ER, a bi-factor model was fit with specific factors for the individual emotions. The purpose of the specific factors was to account for violations of local dependence.

In Model 2 we examined the associations between general ALT, DRM lure score, local processing style, and ER. The latter four were specified as in the first model. For general ALT, a bi-factor model was fit with specific factors corresponding to the AQ subscales, again to account for multi-dimensionality arising from the design of the AQ as comprising multiple subscales.

3. Results

3.1 Descriptive statistics

Table 2 illustrates the descriptive statistics for AQ, processing, and ER tasks.

[Insert Table 2 here]

3.2 Associations between ALTs, local processing style, and ER

Parameter estimates from Model 1 are provided in Figure 1 and Table 3 (for full results, see Model 1 Output in the supplementary materials). One item from the ER scale (disgust) was omitted because everyone in the sample answered the item correctly. Figure 1 shows the measurement models for ATD and ER, and Table 3 provides the correlations among the constructs in these measurement models, DRM lure, and local processing. The model showed good fit by conventional criteria (Root Mean Square Error of Approximation [RMSEA] = 0.02). Given the lack of significant associations between ATD and either ER or local processing style, we did not proceed to test for mediation of an effect of ATD on ER by local bias. As the only significant associations were between local processing preference and the "angry" (p = 0.005) and "bored" (p = 0.013) specific ER factors, we did not pursue any models beyond estimating these zero-order correlations. Here, local processing preference was associated with poorer ability to recognise these emotions, although these relationships were no longer significant following Bonferroni correction.

[Insert Figure 1 here]

[Insert Table 3 here]

Model 2 is summarised in Figures 2a and 2b, and in Table 4. Figure 2a shows the measurement model for general ALT and Figure 2b for ER. Table 4 provides the correlations among the constructs in these models, DRM lure, and local processing. Full results are provided in Model 2 Output in the supplementary materials. The fit of this model was good by conventional criteria (RMSEA = 0.03). Although we estimated the associations between the specific ALT factors and the local processing bias and ER variables, we do not interpret them because the measurement of the constructs represented by these factors was not supported after partialling out the general ALT factor. General ALT was significantly associated with general ER ability ($p < 0.001$). Here, higher ALT scores were associated with poorer ER performance.

[Insert Figure 2a here]

[Insert Figure 2b here]

[Insert Table 4 here]

4. Discussion

We found that higher ALT scores were associated with reduced accuracy in respect of the general ER variable. There were no significant associations between the general ALT factor, or the ATD subscale, and the measures of local processing, nor between ATD and ER.

The lack of significant associations between the ATD subscale, local processing bias in the global/local task, and DRM lure scores suggests that these three measures may tap relatively distinct domains. Past research has suggested that processing style may differ with the type of task (D'Souza et al., 2016) and that having a local processing bias is not necessarily accompanied by deficits in global processing (Van der Hallen et al., 2015). Thus, our participants may have exhibited a local bias in the global/local task without showing an attenuated lure effect in the DRM.

The weak association between the processing style tasks and self-reported ATD may be because the relevant items from the AQ refer to local-focussed behaviour in the context of daily life, such as noticing small sounds. Furthermore, the subscale includes behaviours that might be better characterised as relating to obsessive interests or systematising and some researchers have preferred to fit a "Numbers/Patterns" factor (Hoekstra et al., 2011).

The general ALT was significantly negatively associated with ER ability, but not with either of the measures of local processing style. While this study is the first, to our knowledge, to explore these relationships using the DRM and global/local paradigms in the context of ER, previous studies have found ALT and local processing style associations (e.g. Almeida, Dickinson, Maybery, Badcock, & Badcock, 2013). Associations between ER ability and ASD have been inconsistent in the past and some researchers have suggested that ER may not be a primary impairment in ASD but a correlated feature due, for example, to its co-morbidity with alexithymia (e.g. Cook, Brewer, Shah, & Bird, 2013).

Finally, there was a general lack of association between processing style and ER. The initial associations between global/local scores and the "bored" and "angry" specific factors were found to be no longer significant following Bonferroni correction. Previous research has found that people with ASD have particular difficulties with negative emotions, which has been explained in terms of a dysfunction of the amygdala and associated difficulty with attending to relevant social cues, such as the eyes (Uljarevic & Hamilton, 2013).

Collectively, the results of the present study provide only limited evidence for a processing style model as providing a general account of the relation (or lack thereof) between ALT and ER ability (Behrmann, Avidan, et al., 2006). This must, however, be considered in light of the limitations of the current study. First, no time limit was imposed on attending to the emotion stimuli or responding which may have impacted on processing style by allowing individuals with ASD/high ALTs time to 'switch' to global processing or 'decode' the emotion from the features of the face (Capps, Yirmiya, & Sigman, 1992). Further research which compares ER under conditions with and without time limits using both static and dynamic stimuli would help clarify the nature of the processing style being used in each condition. In this vein, Rump, Giovannelli, Minshew, and Strauss (2009) employed a dynamic facial recognition methodology using short video clips and found a difference in ER between TD children and those with ASD. However, when compared on ER of static stimuli presented without a time limit, the group difference disappeared. This suggests that the latter conditions are more conducive to accurate ER in children with ASD.

Our study was also not population representative, with more females than males overall taking part, whereas ASD has typically been considered a predominantly male condition, although recent studies suggest a decreasing male predominance (Rutherford et al., 2016). In the general population, female participants are known to perform better on ER compared to males (Kret & De Gelder, 2012). Thus, overall, there may have been more power to detect effects with a larger number of males as well as the opportunity to assess whether results varied by sex.

Information from this study and others, such as by Rump et al. (2009) and Gross (2005), may help inform interventions to help address difficulties in ER that individuals with ASD/high ALTs might have. This may be particularly important in the context of the increasing use of universal school-based programmes to develop the socio-emotional skills of children (Connolly, Miller, Mooney, Sloan, & Hanratty, 2016). For example, a phased approach may be the most beneficial learning situation whereby the individual is given unlimited time to process static emotion stimuli and is prompted or primed to use a particular processing approach, depending on the emotion being taught. Thus, priming a more global processing approach may increase the accuracy of ER in relation to more negative emotions, which have been found to present particular difficulties for people with ASD. Once these strategies are established, the use of dynamic stimuli and time-limits to processing could be introduced, which would increase the ecological validity of the task and reflect more accurately the nature of ER in the natural environment.

5. Conclusion

Our results indicate that having higher ALT was associated with poorer performance in relation to the general emotion variable, no significant relationships were found between processing style, ALT, and ER overall.

Acknowledgements: The authors would like to acknowledge the help of Kara Murray, Jill Cossar, Claire Murray, Katie Cebula, Kevin White, and Helen Gaillard

References

Almeida, R. A., Dickinson, J. E., Maybery, M. T., Badcock, J. C., & Badcock, D. R. (2013). Visual search targeting either local or global perceptual processes differs as a function of autistic-like traits in the typically developing population. *Journal of Autism and Developmental Disorders, 43*(6), 1272-1286. https://doi.org/10.1007/s10803-012-1669-7

Baron-Cohen, S. (2008). Theories of the Autistic Mind. *The Psychologist, 21*(2), 112-116.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism Spectrum Quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*(1), 5-17. https://doi.org/10.1023/a:1005653411471

Behrmann, M., Avidan, G., Leonard, G. L., Kimchi, R., Luna, B., Humphreys, K., & Minshew, N. (2006). Configural processing in autism and its relationship to face processing. *Neuropsychologia, 44*(1), 110-129. https://doi.org/10.1016/j.neuropsychologia.2005.04.002

Behrmann, M., Thomas, C., & Humphreys, K. (2006). Seeing it differently: Visual processing in autism. *Trends in Cognitive Sciences, 10*(6), 258-264. https://doi.org/10.1016/j.tics.2006.05.001

Capps, L., Yirmiya, N., & Sigman, M. (1992). Understanding of simple and complex emotions in non-retarded children with autism. *Journal of Child Psychology and Psychiatry, 33*(7), 1169-1182. https://doi.org/10.1111/j.1469-7610.1992.tb00936.x

Carlin, M. T., Toglia, M. P., Wakeford, Y., Jakway, A., Sullivan, K., & Hasel, L. (2008). Veridical and false pictorial memory in individuals with and without mental retardation. *American Journal on Mental Retardation, 113*(3), 201-213. https://doi.org/10.1352/0895-8017(2008)113[201:vafpmi]2.0.co;2

Connolly, P., Miller, S., Mooney, J., Sloan, S., & Hanratty, J. (2016). *Universal school-based programmes for improving social and emotional outcomes in children aged 3-11 years: A systematic review and meta-analysis.* The Campbell Collaboration Systematic Reviews. Retrieved from http://www.campbellcollaboration.org/lib/project/369/

Cook, R., Brewer, R., Shah, P., & Bird, G. (2013). Alexithymia, not autism, predicts poor recognition of emotional facial expressions. *Psychological Science*, *24*(5), 723-732. https://doi.org/10.1177/0956797612463582

D'Souza, D., Booth, R., Connolly, M., Happé, F., & Karmiloff-Smith, A. (2016). Rethinking the concepts of 'local or global processors': Evidence from Williams syndrome, Down syndrome, and Autism Spectrum Disorders. *Developmental Science*, *19*(3), 452–468. https://doi.org/10.1111/desc.12312

Fallshore, M., & Bartholow, J. (2003). Recognition of emotion from inverted schematic drawings of faces. *Perceptual and Motor Skills, 96*(1), 236-244. https://doi.org/10.2466/pms.2003.96.1.236

Gross, T. F. (2005). Global–local precedence in the perception of facial age and emotional expression by children with autism and other developmental disabilities. *Journal of Autism and Developmental Disorders, 35*(6), 773-785. https://doi.org/10.1007/s10803-005-0023-8

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 36*(1), 5-25. https://doi.org/10.1007/s10803-005-0039-0

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in Autism Spectrum Disorders: A review of behavioral and neuroimaging studies. *Neuropsychology Review*, *20*(3), 290-322. https://doi.org/10.1007/s11065-010-9138-6

Hext, L. J., & Lunsky, Y. (1997). Relationships etc. – A social skills programme. *Habilitative Mental Healthcare Newsletter, 16*, 7-10.

Hoekstra, R. A., Vinkhuyzen, A. A., Wheelwright, S., Bartels, M., Boomsma, D. I., Baron-Cohen, S., ... van der Sluis, S. (2011). The construction and validation of an abridged version of the Autism Spectrum Quotient (AQ-Short). *Journal of Autism and Developmental Disorders, 41*(5), 589–596. https://doi.org/10.1007/s10803-010-1073-0

Kret, M. E., & de Gelder, B. (2012). A review on sex differences in processing emotional signals. *Neuropsychologia, 50*(7), 1211-1221. https://doi.org/10.1016/j.neuropsychologia.2011.12.022

McKenzie, K., Matheson, E., McKaskie, K., Hamilton, L., & Murray, G. C. (2001). A picture of happiness. *Learning Disability Practice, 4*(1), 26-29. https://doi.org/10.7748/ldp2001.05.4.1.26.c1451

Miller, H. L., Odegard, T. M., & Allen, G. (2014). Evaluating information processing in Autism Spectrum Disorder: The case for fuzzy trace theory. *Developmental Review, 34*(1), 44-76. https://doi.org/10.1016/j.dr.2013.12.002

Mottron, L., Dawson, M., Soulières, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: An update, and eight principles of autistic perception. *Journal of Autism and Developmental Disorders, 36*(1), 27–43. https://doi.org/10.1007/s10803-005-0040-7

Murray, A. L., Booth, T., McKenzie, K., Kuenssberg, R., & O'Donnell, M. (2014). Are autistic traits measured equivalently in individuals with and without an Autism Spectrum Disorder? An invariance analysis of the Autism Spectrum Quotient Short Form. *Journal of Autism and Developmental Disorders, 44*(1), 55-64. https://doi.org/10.1007/s10803-013-1851-6

Murray, A. L., McKenzie, K., Kuenssberg, R., & Booth, T. (2015). Do the Autism Spectrum Quotient (AQ) and Autism Spectrum Quotient Short Form (AQ-S) primarily reflect general ASD traits or specific ASD traits? A bi-factor analysis. *Assessment, 24*(4), 444-457. https://doi.org/10.1177/1073191115611230

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*(4), 803-814. https://doi.org/10.1037/0278-7393.21.4.803

Rump, K. M., Giovannelli, J. L., Minshew, N. J., & Strauss, M. S. (2009). The development of emotion recognition in individuals with autism. *Child Development, 80*(5), 1434-1447. https://doi.org/10.1111/j.1467-8624.2009.01343.x

Rutherford, M., McKenzie, K., Johnson, T., Catchpole, C., O'Hare, A., McClure, I., … Murray, A. L. (2016). Gender ratio in a clinical population sample, age of diagnosis and duration of assessment in children and adults with Autism Spectrum Disorder. *Autism, 20*(5), 628-634. https://doi.org/10.1177/1362361315617879

Scotland, J., McKenzie, K., Cossar, J., Murray, A. L., & Michie, A. (2016). Recognition of facial expressions of emotion by adults with intellectual disability: Is there evidence for the emotion specificity hypothesis? *Research in Developmental Disabilities, 48,* 69-78. https://doi.org/10.1016/j.ridd.2015.10.018

Simmons, D. R., Robertson, A. E., McKay, L. S., Toal, E., McAleer, P., & Pollick, F. E. (2009). Vision in autism spectrum disorders, *Vision Research, 49*(22), 2705–2739. https://doi.org/10.1016/j.visres.2009.08.005

Stevenson, R. A., Sun, S. Z., Hazlett, N., Cant, J. S., Barense, M. D., & Ferber, S. (2016). Seeing the forest and the trees: Default local processing in individuals with high Autistic traits does not come at the expense of global attention. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-016-2711-y

Uljarevic, M., & Hamilton, A. (2013). Recognition of emotions in autism: A formal meta-analysis. *Journal of Autism and Developmental Disorders*, *43*(7), 1517–1526. https://doi.org/10.1007/s10803-012-1695-5

Van der Hallen, R., Evers, K., Brewaeys, K., Van den Noortgate, W., & Wagemans, J. (2015). Global processing takes time: A meta-analysis on local-global visual processing in ASD. *Psychological Bulletin*, *141*(3), 549-573. https://doi.org/10.1037/bul0000004

Vanmarcke, S., & Wagemans, J. (2016). Individual differences in spatial frequency processing in scene perception: The influence of autism-related traits. *Visual Cognition, 24*(2), 115-131. https://doi.org/10.1080/13506285.2016.1199625

Table 1. Abbreviations used in the article

Phrase	**Abbreviation**
Attention to detail	ATD
Autism Spectrum Disorder	ASD
Autism Spectrum Quotient	AQ
Autistic-like traits	ALT
Emotion recognition	ER
Enhanced Perceptual Functioning model	EPF
Deese-Roediger-McDermott	DRM
Root Mean Square Error of Approximation	RMSEA
Typically developing	TD

Table 2. Descriptive statistics for Autism Spectrum Quotient (AQ), processing, and emotion recognition (ER) tasks

Score	**Mean (SD)**
Attention to detail (ATD)	24.2 (5.1)
General autistic-like traits (ALTs)	83.9 (18.1)
Total AQ	108.2 (20.4)
Global/local	2.3 (1.9)
Deese-Roediger-McDermott (DRM) lure	6.6 (3.0)
ER	12.5 (2.9)
Emotion	**Number of participants correctly identifying (%)***
Worried 1	304 (59.5)
Worried 2	183 (38.2)
Sad 1	338 (66.1)
Sad 2	249 (51.9)
Surprised 1	441 (86.3)
Surprised 2	424 (88.5)
Neutral 1	103 (20.2)
Neutral 2	132 (27.6)
Happy 1	470 (92.2)
Happy 2	421 (87.7)
Bored 1	335 (65.8)
Bored 2	406 (84.8)

Angry 1	442 (86.8)
Angry 2	346 (72.1)
Scared 1	122 (24)
Scared 2	298 (62.1)
Disgust 1	511 (100)
Disgust 2	384 (80.2)

* Based on 511 participants for whom data on ER task were available

Table 3. Correlations between “Attention to Detail” (ATD) subscale, local processing style, and emotion recognition (ER)

	Deese-Roediger-McDermott (DRM) lure	**Local bias**	**ATD**
ER	0.120	-0.003	-0.148
Worried	0.074	0.001	-0.067
Surprised	0.273	0.099	-0.159
Bored	0.048	-0.210*	-0.091
Angry	0.204	-0.284**	0.156
OK	-0.055	-0.094	-0.013
ATD	-0.026	-0.024	-
Local bias	-0.120	-	-

* $p < 0.05$; ** $p < 0.01$; no correlations were significant after Bonferroni correction ($p < 0.002$).

Table 4. Correlations between general autistic-like traits (ALTs), local processing style, and emotion recognition (ER)

	Deese-Roediger-McDermott (DRM) lure	**Local**	**General ALT**
ER	0.101	0.011	-0.283***[a]
Worried	0.088	-0.010	-0.147
Surprised	0.293	0.084	0.240
Bored	0.062	-0.220*	0.166
Angry	0.221	-0.299**	0.164
OK	-0.026	-0.111	0.199
General ALT	-0.013	0.023	-
Local	-0.120		-

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; [a] significant after Bonferroni correction ($p < 0.002$).

List of Table and Figure captions

Table 1. Abbreviations used in the article

Table 2. Descriptive statistics for Autism Spectrum Quotient (AQ), processing, and emotion recognition (ER) tasks

Table 3. Correlations between "Attention to Detail" (ATD) subscale, local processing style, and emotion recognition (ER)

Table 4. Correlations between general autistic-like traits (ALTs), local processing style, and emotion recognition (ER)

Figure 1. Model 1 measurement models for emotion recognition (ER) and "Attention to Detail" (ATD) subscale

Note. In the ER model, EMO = general emotion recognition; WOR = worried; SUR = surprised; BOR = bored; and ANG = angry. In the indicator labels, MC = more context, and LC = less context. In the ATD model indicator labels, AQ = Autism Spectrum Quotient, and the numbers refer to AQ item numbers from Baron-Cohen et al. (2001).

Figure 2a. Measurement model for general autistic-like traits (ALTs) from Model 2

Figure 2b. Measurement model for emotion recognition (ER) from Model 2

Note. ALT = general ALTs; ATTS = attention switching; IMAG = imagination; and COMM = communication.