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BRIEF REPORT

Brief Report: Local–Global Processing and Co-occurrence of Anxiety, Autistic and Obsessive–Compulsive Traits in a Non-clinical Sample

Chris Retzler[1] · Jenny Retzler[1]

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Abstract

Purpose Increased local-to-global interference has been found in those with ASD, AD and OCD, and as such, may represent a transdiagnostic marker. As a first step to investigating this, we aimed to assess the overlap in traits of these disorders in a non-clinical sample, and whether local–global processing relates to the traits of the three conditions.
Methods Participants (n = 149) completed questionnaires including the Autism Quotient (AQ), the Obsessive–Compulsive Inventory (OCI-R) and the Zung Self-rating Anxiety Scale (SAS) and an online version of the Navon task. Behavioural metrics of interference and precedence were extracted from the task and correlated with trait scores.
Results We found moderate to strong correlations between the total scores for ASD, anxiety and OCD. Most local–global processing indices did not relate to traits.
Conclusion The study found evidence for an overlap in autism, anxiety and obsessive–compulsive traits in a non-clinical sample. However, local–global processing, as measured by the Navon task, did not appear to underpin symptomatology in the sample and could not be considered a transdiagnostic marker. Future research should investigate the value of alternate metrics.

Keywords Autism spectrum disorder · Obsessive compulsive disorder · Anxiety · Local–global · Interference · Transdiagnostic marker

Introduction

Anxiety disorders (ADs), including obsessive compulsive disorder (OCD), are thought to co-occur in around 40% of individuals with autistic spectrum disorder (ASD; van Steensel et al., 2011). All three disorders are characterised by repetitive behaviours and difficulty with social interaction (Wood & Gadow, 2010), with evidence suggesting repetitive behaviours may alleviate anxiety in both ASD and OCD, but may also impair social interactions due to their intrusive nature (see Jiujias et al., 2017 for a comparative review). Those affected are often described as having an attentional focus biased towards details and, at times, difficulties distinguishing relevant from irrelevant information (Cath et al., 2008). It may be that a locally-oriented perceptual processing style, or greater local-to-global interference, gives rise to some of the shared characteristics. This study examined associations between traits of anxiety, OCD and ASD within a non-clinical sample, as well as how these related to local–global perceptual style, to ascertain whether this holds potential as a transdiagnostic marker worthy of further investigation.

To perceive the world around us, we must be able to organise local information into a coherent global gestalt. Disruption to this process, and an exaggerated focus on details may cause an individual to be highly sensitive to things within a scene that others disregard. This may be both attentionally demanding, drawing resources away from processing other contextually important information, as well as anxiety provoking, if the detail drawing attention is distressing. In this way, locally-oriented perceptual processing may give rise to some of the traits and behaviours associated with AD, ASD and OCD.

While typically developing individuals generally show a preference for perceiving global stimuli over local stimuli (Boer & Keuss, 1982), influential theories of ASD have proposed that individuals with ASD either have difficulties integrating information into a global picture (the Weak Central Coherence account; WCC; Frith, 2003), or have enhanced

✉ Chris Retzler
c.retzler@hud.ac.uk

[1] Department of Psychology, School of Human and Health Sciences, University of Huddersfield, Huddersfield, UK

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processing of local information (the Enhanced Perceptual Functioning accounts; EPF; Mottron et al., 2006). Despite variability between studies in the consistency with which global processing deficits are observed in ASD samples, a meta-analysis concluded that the disorder is characterised by slower (but still effective) global processing, particularly in the presence of incongruent (interfering) local information.

Local-to-global interference has also been examined in relation to OCD and AD. For example, Rankins et al. (2005) found that those with OCD were distracted by local information and showed poor performance when asked to identify the global features of a modified Navon task, compared to controls. Similarly, higher trait anxiety was associated with greater interference of local information in global Navon and other perceptual judgement tasks (Basso et al., 1996; Shilton et al., 2019; Tyler & Tucker, 1982), and has even been implicated as mediating detail-oriented biases in eating disordered patients (Becker et al., 2017). Indeed, it has been proposed that anxiety itself, as well as other negative mood states, may narrow the focus of attention to promote better detection of potential threats, and subsequently prime the perception of local, rather than global, information (Basso et al., 1996; Fockert & Cooper, 2014), although this view is not borne out in Shilton et al. (2019), where acute stress inductions did not impact the level of local interference in a global task.

Increased local-to-global interference measured using the Navon task, may reflect a transdiagnostic marker of symptomatology, and as such, may provide an important target for future research into endophenotypes and interventions. This study therefore had two aims; (i) to measure the association of traits of autism, OCD and anxiety in a non-clinical sample; and (ii) to assess the relationship between local–global processing indices of the Navon task, particularly local-to-global interference, and traits of the three disorders.

Methods

Participants

Ethical approval for the study was granted by the host institution's ethics committee. Participants aged 18 years and above with normal or corrected-to-normal vision and the ability to play basic computer games were eligible to take part. 186 participants were recruited to the study of which 149 completed all measures. Of this final sample, 123 were female, and the mean age was 22.69 years (SD = 8.81, range 18 to 76).

Procedure and Measures

Clinical Characteristics

Consenting participants completed the study on a desktop computer, and were first presented with an online questionnaire hosted on the Qualtrics platform (https://qualtrics.com). The questionnaire asked participants to respond to socio-demographic questions about their age and sex, before progressing to questions to assess their traits. First, they were presented with the Autism Quotient (AQ; Baron-Cohen et al., 2001). This 50-item self-report questionnaire measures behaviours relating to ASD traits in adults, on a scale of 0 (definitely agree) to 3 (definitely disagree). Following the AQ, participants were presented with the 18-item Obsessive–Compulsive Inventory (OCI-R: Foa et al., 2002) which measures the level of concern participants feel with regard to their own obsessive and compulsive behaviours on a scale of 0 (not at all) to 4 (extremely). The final part of the questionnaire was the Zung Self-rating Anxiety Scale (SAS; Zung, 1971), which comprises 20 items measuring the anxiety symptoms experienced on a scale of 1 (a little of the time) to 4 (most of the time).

Behavioural Task

Following completion of the survey, participants were automatically redirected to a modified online version of the Navon task (Navon, 1977), which was created using Psychopy (Peirce et al., 2019) and administered online using Pavlovia (https://pavlovia.org). The traditional Navon task presents participants with compound (global) letter stimuli which are made up of small (local) letters. Figure 1 B depicts a global letter "H" made up from the local letter "S". On individual trials, the smaller letters may be congruent (matching) or incongruent to the global letter (as in Fig. 1 A and B). Instructions across blocks direct participants to either respond to the local letter or the global letter. Indices of perceptual processing can be calculated from response time and accuracy on different trial types.

In our task, participants completed 16 practice trials during which feedback was provided to familiarise them with the task. Choices were be made using the 's' or 'h' keyboard keys. The main task included a total of 192 trials in 4 × 48-trial blocks. Blocks alternated between instructing participants to identify the global or the local letter as quickly and accurately as they could, with the instruction (global vs. local) for the first block randomised across participants. Within blocks, 50% trials presented congruent

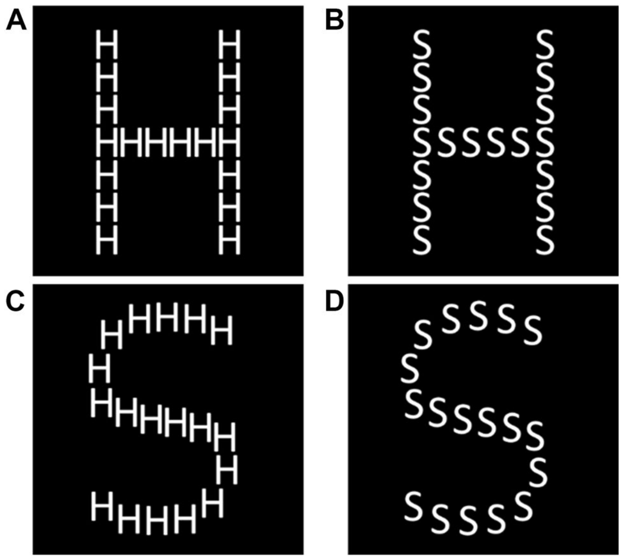


Fig. 1 Stimuli used in the Navon task. Stimuli are made up of global and local components. **A** and **D** show congruent trials where the global and local stimuli match. **B** and **C** are incongruent where the global and local information does not match

stimuli and 50% incongruent stimuli. On each trial a fixation cross appeared in the centre of the screen for 1000 ms before stimulus onset. The stimulus was shown for 200 ms, after which a mask covered the stimulus until the end of the trial. Participants had a maximum of 7000 ms to respond. If they did so the trial would terminate but if there was no response then the next trial proceeded at the end of this period. The stimuli appeared in different quadrants of the screen on each trial (counterbalanced across the task) as recommended by Chamberlain et al., (2017) to avoid any confounds of task-induced bias toward local processing. The task took around 15 min to complete.

Analysis

To assess the severity of symptom expression, total and (for the AQ) subscale scores for the questionnaire measures were computed in line with the published scoring instructions. For all measures, higher scores reflected higher symptom expression.

RTs of under 200 ms or over 1500 ms were considered anticipatory or reflective of lapses in attention and removed from further analysis (in total 0.66% of trials). To assess task performance, for each individual, mean response time to correct trials and proportion accuracy were calculated for each trial type (global-congruent, global-incongruent, local-congruent, local-incongruent).

Standardised indices were computed to measure global–local precedence (the extent to which participants perceive global information faster than local information),

Table 1 Descriptive statistics for symptom scores (N = 148)

Measure	Mean (SD)	Range
OCI-R	19.63 (13.15)	0 to 61
SAS total	37.88 (10.07)	22 to 72
AQ total	19.57 (6.39)	6 to 46
AQ social skills	3.79 (2.56)	0 to 10
AQ attention to detail	5.32 (2.26)	0 to 10
AQ attention switching	5.24 (2.09)	0 to 10
AQ communication	2.99 (2.20)	0 to 10
AQ imagination	2.66 (1.82)	0 to 10

local-to-global interference (the amount that incongruent local information interrupts processing on global trials), and global-to-local interference (the amount that incongruent global information interrupted processing on local trials; Gerlach & Poirel, 2020). For each participant, the mean difference between RTs on relevant trial types (congruent global vs. congruent local; congruent global vs. incongruent global; and congruent local vs. incongruent local respectively) was divided by the pooled sample average of standard deviations for both trial types. A positive score on each index indicates a precedence or interference effect in the expected direction. A negative score on the precedence index indicates faster local than global processing, while on an interference index it indicates faster performance on trials with incongruent information.

To assess associations between clinical characteristics, Pearson's correlation analyses were performed between the scores on the symptom scales. To assess whether the pattern of task performance was in line with other implementations of the Navon paradigm (i.e. global precedence, better performance on congruent trials, and greater impact of congruency on local than global trials; Gerlach & Poirel, 2020), we conducted two (global vs. local) by two (congruent vs. incongruent) ANOVAs on both RT and accuracy data. To assess whether processing precedence or interference effects related to traits, we performed Pearson's correlation analyses between the task-performance indices measured and the scores on the symptom scales.

Results

Clinical Characteristics

Symptom scores for the sample are summarised in Table 1, with individuals showing a wide range of scores on all measures.

To assess the relationships between the symptom scores from the AQ, OCI-R and SAS we ran Pearson correlations (see Table 2). Moderate-strong positive correlations were

Table 2 Pearson's correlations between the symptom scores from the AQ, OCI-R and SAS (n = 148)

	1	2	3	4	5	6	7	8	9	10
1. OCI-R	–									
2. SAS Total	.56*** [.43, .67]	–								
3. AQ Total	.40*** [.25, .52]	.37*** [.22, .50]	–							
4. AQ social skills	.12 [− .05, .28]	.23** [.06, .38]	.75*** [.68, .82]	–						
5. AQ attention to detail	.32*** [.17, .45]	.11 [− .04, .26]	.34*** [.22, .46]	-.10 [−−.25, .06]	–					
6. AQ attention switching	.39*** [.19, .56]	.32*** [.17, .45]	.68*** [.58, .76]	.43*** [.28,.56]	.08 [− .09, .23]	–				
7. AQ communication	.34*** [.18, .47]	.36*** [.21, .48]	.79*** [.71, .85]	.67*** [.56, .75]	< .01 [− .15, .16]	.51*** [.40, .61]	–			
8. AQ imagination	< .01 [− .17, .18]	.10 [− .06, .29]	.45*** [.28, .59]	.28** [.12, .43]	-.03 [− .19, .13]	.04 [− .13, .22]	.18* [.02, .33]	–		
9. Global–local precedence	-.09 [− .25, .06]	-.06 [− .22, .08]	-.07 [− .21, .08]	-.08 [− .23, .06]	-.06 [− .18, .06]	-.05 [− .21, .12]	-.01 [− .16, .14]	-.01 [− .14, .13]	–	
10. Global-to-local interference [a]	.07 [− .09, .23]	.05 [− .08, .18]	-.04 [− .18, .10]	.00 [− .17, .17]	-.04 [− .17, .08]	-.03 [− .20, .14]	-.02 [− .15, .12]	-.02 [− .17, .16]	-.01 [− .25, .24]	–
11. Local-to-global interference [a]	.14 [− .17, .44]	.18* [.01, .36]	-.03 [− .38, .32]	-.08 [− .31, .18]	.07 [− .11, .31]	.13 [− .15, .42]	.01 [− .31, .32]	-.25** [− .49, .03]	.01 [− .18, .18]	.08 [− .10, .25]

95% CIs calculated using bias corrected bootstrap analyses with 1000 samples. ***p < .001 and meets Bonferroni-corrected alpha rate, **p < .01, *p < .05

[a]Coefficients involving this variable included only n = 146 due to a 100% error rate on local incongruent trials for 2 participants

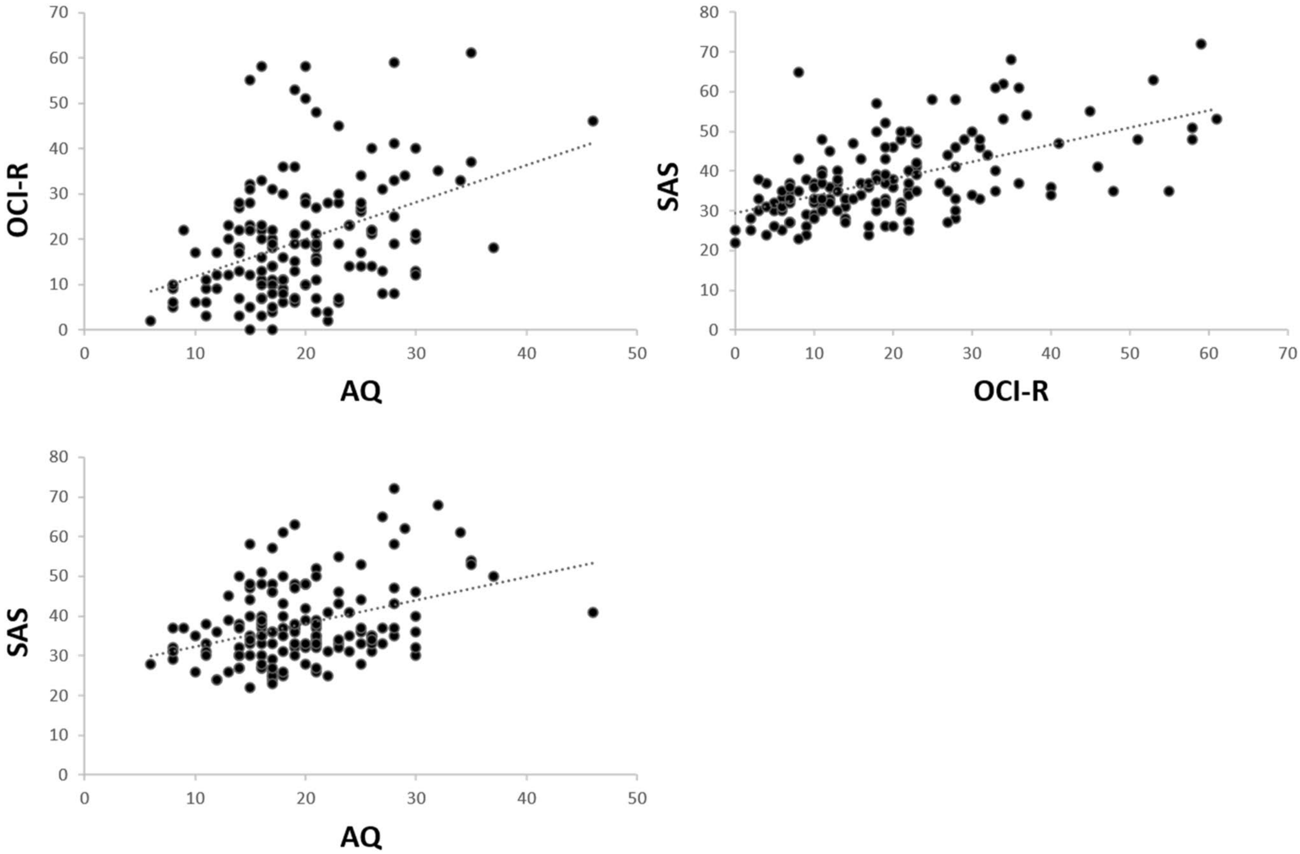


Fig. 2 Correlations between symptom scores from the AQ, OCI-R and SAS

observed between OCI-R, SAS and total AQ symptom scores (r's ≥ 0.37) suggesting overlap in the traits of these disorders (see Fig. 2). The AQ imagination subscale correlated only with other AQ subscales, AQ attention switching and communication correlated with both OCI-R and SAS scores. Of note, the AQ social skills subscale correlated only with SAS, and not OCI-R scores, while the AQ attention to detail subscale correlated only with OCI-R, and not SAS, scores.

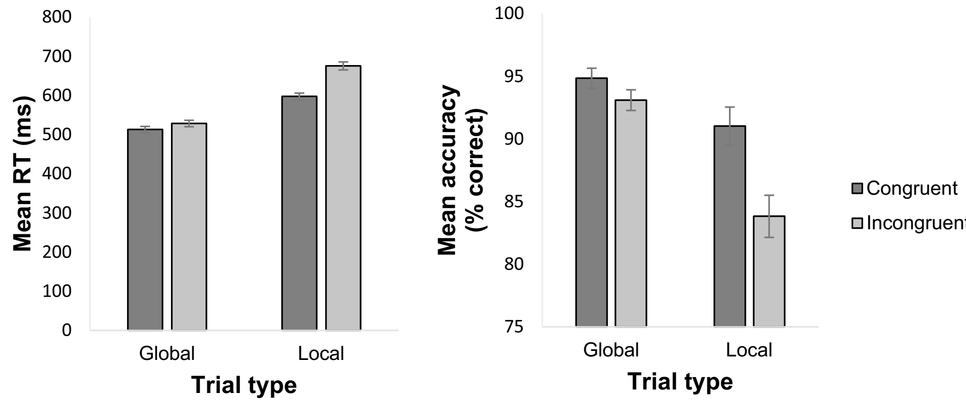
Task Performance

Scores on the global–local precedence index were positive for the majority of the sample (n = 133, 89.9%), with a mean of 0.77 (SD = 0.75, range − 1.35 to 4.05), indicating most people processed global stimuli more quickly than local. Similarly, the global-to-local interference index was positive for 135 (92.5%) individuals, with a mean of 0.66 (SD = 0.49, range − 1.42 to 2.48), indicating incongruent global information slowed responding on local trials for most people. Scores on the local-to-global interference index were lower, with a mean of 0.14 (SD = 0.31, range − 1.84 to 1.14) although the majority were positive (n = 110, 74%), indicating that on average, the interference of incongruent local information on global trials was not so high. Patterns of task performance were consistent with the findings expected when implementing the Navon task (see Fig. 3 for descriptive statistics for each trial type).

Two separate two (global vs. local) by two (congruent vs. incongruent) ANOVAs were conducted to assess the impact of trial type on mean RT and accuracy respectively. Responses were significantly faster and more accurate when participants were identifying the global rather than the local letter (RT $F(1,145) = 253.77$, $p < 0.001$, $\eta_p^2 = 0.64$; accuracy $F(1,147 = 24.76$, $p < 0.001$, $\eta_p^2 = 0.14$), and for trials where stimuli were congruent rather than incongruent (RT $F(1,145) = 268.03$, $p < 0.001$, $\eta_p^2 = 0.65$; accuracy $F(1,147) = 17.36$, $p < 0.001$, $\eta_p^2 = 0.11$). There were also significant interactions (RT $F(1,145) = 137.91$, $p < 0.001$, $\eta_p^2 = 0.49$; accuracy $F(1,147) = 7.88$, $p = 0.006$, $\eta_p^2 = 0.05$).

Pairwise comparisons with Sidak adjustments demonstrated significant differences by congruency at both global and local levels, as well as significant differences by level for both congruent and incongruent trial types ($p < 0.05$ for all comparisons), but examination of Fig. 3 shows that the RT and accuracy cost of incongruent information

Fig. 3 Charts showing mean response time (left panel) and accuracy (right panel) for different trial types. Error bars show standard error of the mean



was bigger on local trials (RT $m_{diff} = 78.04$ ms, $p < 0.001$; accuracy $m_{diff} = 9.26\%$, $p < 0.001$) than it was global trials (RT $m_{diff} = 15.30$ ms, $p < 0.001$; accuracy $m_{diff} = 3.82\%$, $p = 0.023$).

To assess the relationships between indices of processing and the symptom scores from the AQ, OCI-R and SAS we ran Pearson correlations (see Table 2). There were no significant correlations between either the global–local precedence index or the global-to-local interference index and any of the symptom scores (r's ≤ 0.1). However, higher scores on the local-to-global interference index were associated with significantly higher scores on the SAS ($r = 0.18$, $p = 0.030$), and significantly lower scores on the AQ imagination subscale ($r = -0.25$, $p = 0.002$).

Discussion

As expected, we found moderate to strong correlations between the total scores for ASD, anxiety and OCD suggesting there was overlap in the traits even in a non-clinical sample. The Navon paradigm elicited the pattern of task performance found in previous studies (e.g. Gerlach & Poirel, 2020), however, most local–global processing indices did not relate to traits, with only the local-to-global interference index weakly associated with anxiety scores and the AQ imagination subscale. This suggests that the aspects of local processing as measured in a Navon task are not well suited as transdiagnostic markers, and that future research should focus on alternate metrics.

Clinical Characteristics

While the sample recruited were from the general population, there was a good spread of trait scores across the three scales (see Fig. 2). Previous literature has commonly assessed the prevalence of anxiety and OCD in those with ASD (see Zaboski & Storch, 2018) for a review) but within the general population a number of studies have also identified positive correlations between ASD traits and anxiety (Baiano et al., 2022; Freeth et al., 2013; Kanne et al., 2009; Liew et al., 2015; White et al., 2012) and between ASD, anxiety and OCD traits (Kunihira et al., 2006; Zhou et al., 2018). The finding of strong correlations between traits of the three disorders, therefore, supports the idea that investigation into transdiagnostic endophenotypes could help to further understand the causal pathways to these disorders and their co-occurrence.

With regard to AQ subscales, problems with switching and communication were moderately related to both obsessive–compulsive and anxiety traits, while imagination problems were unrelated to either disorder. Of interest, problems with social skills related to anxiety scores only, while attention-to-detail related to obsessive–compulsive scores only. These findings are only partly consistent with previous work both in clinical and general populations. While both Cath et al. (2008) and Baiano et al. (2022) found similar correlations between social ASD traits and anxiety, our findings are at odds with evidence of limited overlap between social ASD traits and types of anxiety in another community sample (Hallett et al., 2011), as well as findings from Doi et al., (2021) that all subscales of the AQ, apart from attention to detail, were correlated with OCD traits. With mixed findings in the literature, future investigation of transdiagnostic markers for these disorders would benefit from more detailed clarification of the characteristics that are most likely to co-occur.

Relations Between Processing and Clinical Characteristics

Neither the global–local precedence index, nor the global-to-local interference index related to any traits, although higher scores on the local-to-global interference index were weakly associated with higher anxiety scores (as hypothesised), and, (unexpectedly) to lower scores on the AQ imagination subscale. Speculatively, the unexpected association between stronger local-to-global interference and a reduced likelihood of problems with imagination could reflect a tendency for those with a better imagination and perspective-taking ability to process details in scenes around them even when these are not directly relevant to the task. While these findings suggest some clinical traits may have more to do with differing ability to suppress irrelevant local information than problems processing global information per se, in line with the EPF account of ASD (Mottron et al., 2006), these correlations do not withstand correction for multiple comparisons and should be treated with caution. Together, these findings support and extend work from Van Eylen et al. (2018) who, focussing solely on ASD, concluded that neither complex figure nor coherent motion performance-based measures of local–global processing were good candidate endophenotypes.

One might expect the AQ subscale 'attention-to-detail' to correspond to cognitive indices of local processing or interference, yet higher scores on this subscale were unrelated to difficulty suppressing irrelevant local information (as measured by the local-to-global interference index), or any other cognitive processing index, indicating these do not tap into the same construct. Van Eylen et al. (2018) saw similar misalignment between cognitive measures of local–global processing—which did not discriminate relatives of those with ASD from typically developing samples—and questionnaire measures of an enhanced detail focus—which did. Of interest, while greater difficulty suppressing irrelevant local information was related to higher anxiety scores, consistent with studies finding higher levels of local interference associated with higher trait anxiety (Basso et al., 1996; Shilton et al., 2019; Tyler & Tucker, 1982), it was not related to overall autistic or obsessive–compulsive traits. Meanwhile, the attention-to-detail AQ subscale related to obsessive–compulsive, but not anxiety symptomatology. Although there is face validity in the similarity between detail-orientated processing within the disorders, this pattern of results could indicate subtle differences in their underpinning mechanisms that may be captured by different metrics. Further research looking at alternative measures of local processing may be useful to help unpick whether there is indeed a transdiagnostic marker, or whether there are distinct pathways unique to each disorder.

It should be noted that the correlational design of this study does not allow causal inferences to be made, and that our Navon task was modified to reduce possible biases towards local processing that can be introduced in traditional Navon tasks by presenting local stimuli in line with the fixation cross (Chamberlain et al., 2017). It could be that relative to other implementations of Navon paradigms, reduction of biases here also reduced the amount of local interference as a whole. Given that processing for different types of stimuli may be affected in disorders such as ASD (e.g. Bird et al., 2006) it would be interesting to examine whether the findings would differ when using a local–global processing task that includes more abstract or social stimuli. It is also possible that use of a sample with a higher proportion of males and/or clinical diagnoses, may have elicited a different pattern of results. Indeed, a more targeted sampling method with exclusion criteria could have minimised the risk of confounding variables, and collection of data regarding the proportion of participants with formal diagnoses would have allowed comparison between diagnosed and undiagnosed subgroups. Yet the alignment of our findings to those from other studies investigating the value of other local–global processing indices as candidate endophenotypes for ASD specifically (Van Eylen et al., 2018), suggest the benefits of such metrics for these purposes may be limited.

Conclusion

In conclusion, we found evidence for an overlap in autism, anxiety and obsessive–compulsive traits in a non-clinical sample but little evidence that local–global processing of any sort underpins this. Our findings highlight the value of (i) examining the role of local–global processing in clinical groups and (ii) assessing other candidate transdiagnostic markers that may better explain the crossover between these disorders.

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Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

Ethical Approval The study was approved by the University of Huddersfield ethics panel and the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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