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Are the Autism and Positive Schizotypy Spectra Diametrically Opposed in Local Versus Global Processing?

Suzanna N. Russell-Smith · Murray T. Maybery · Donna M. Bayliss

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Abstract Crespi and Badcock (2008) proposed that autism and psychosis represent two extremes on a cognitive spectrum with normality at its center. Their specific claim that autistic and positive schizophrenia traits contrastingly affect preference for local versus global processing was investigated by examining Embedded Figures Test performance in two groups of students separated on autistic-like traits but matched on positive schizotypy traits, and two groups separated on positive schizotypy traits but matched on autistic-like traits ($n = 20$ per group). Consistent with their theory, higher levels of autistic-like traits were associated with faster identification of hidden figures, whereas higher levels of positive schizotypy traits were associated with slower identification.

Keywords Autism · Schizotypy · Local–global processing · Visual search · Embedded figures

Introduction

Before the establishment of autism and schizophrenia as distinct disorders (see Rutter 1972), Kanner (1949) initially considered autism to be an early manifestation of schizophrenia. While it is now generally accepted that the two disorders are distinct (American Psychiatric Association 2000), some researchers have continued to posit that the disorders are in some way related (Crespi and Badcock 2008; Hurst et al. 2007; Rawlings and Locarnini 2008; Tordjman 2008). We refer particularly to Crespi and Badcock (2008), who make the novel claim that the autism and positive schizophrenia spectra are diametrically opposed. They argue that individuals with autistic traits and individuals with positive symptoms of schizophrenia (e.g., magical ideation, unusual perceptual experiences and paranoia) should exhibit opposite cognitive profiles. The current investigation focuses specifically on their claim that autistic and positive schizophrenia traits contrastingly affect preference for local (i.e., piecemeal) versus global (i.e., integrative) processing.

Crespi and Badcock (2008) argue that while autistic traits are associated with a preference for local over global processing, positive schizophrenia traits are associated with a preference for global over local processing. That is, these authors claim that while individuals with autism show a tendency to focus on detail or process features in their isolation, individuals with traits of positive schizophrenia show a tendency to look at the 'bigger picture' or process features as an integrated whole. Although a preference for local processing fits theoretically with the tendency of individuals with autism to notice minor features or changes to the environment that are often overlooked by others (Hayes 1987), the link between traits of positive schizophrenia and a preference for global processing is less obvious. It is hypothesised though, that a global processing style could contribute to the complex delusions and enhanced creativity for individuals with positive schizophrenia (Nettle 2006; Oberman and Pascual-Leone 2008), as well as the tendency of these individuals to make "loose" associations between words and between aspects of the environment (Maher 1983; Spitzer 1997; Spitzer et al. 1993). Importantly, the effect of such loose associations is that one thought does not logically relate to the next, and thus these associations may be strongly linked to

S. N. Russell-Smith (✉) · M. T. Maybery · D. M. Bayliss
Neurocognitive Development Unit, School of Psychology, University of Western Australia, 35 Stirling Highway, Crawley 6009, Perth, WA, Australia
e-mail: russes03@student.uwa.edu.au

the hallucinations and delusions experienced by individuals with positive schizophrenia. However, while there are potential links of local and global processing to features of autism and positive schizotypy, the preferred processing styles for individuals with autistic and schizophrenic traits are yet to be examined together in the one investigation. Therefore, the current study aims to provide the first complete empirical test of Crespi and Badcock's claim regarding local–global processing.

The contrasting preferences for local versus global processing are part of a broader set of functional differences proposed by Crespi and Badcock (2008) to distinguish autism and positive schizophrenia, including differences in mechanistic and mentalistic cognition. These functional differences are explained with reference to neuroanatomical differences, such as in the rate of brain growth, in the size of certain structures (e.g., the corpus collosum and amygdala), and in hemispheric asymmetry. The contrasting preferences for local versus global processing are identified with differences in brain connectivity in particular (Crespi and Badcock 2008). Reference is made to both structural (intrahemispheric and interhemispheric) and functional connectivity. Specifically, Crespi and Badcock argue that the preference for local over global processing displayed by individuals with autistic traits, compared to controls or individuals low on autistic traits, is a result of increased connectivity within neural regions relative to decreased connectivity across regions (Courchesne and Pierce 2005a, b; Happé and Frith 2006). Crespi and Badcock then argue that schizophrenia is associated with decreased connectivity within neural regions relative to an increased connectivity across brain regions (Colger and Serafetinides 1990; Siekmeier and Hoffman 2002), leading individuals with traits of positive schizophrenia to favor a global (over local) processing style, compared to controls or people low on these traits. These differences in brain connectivity for autism and positive schizophrenia are said to be mediated, at least in part, by genomic imprinting.

Importantly though, Crespi and Badcock (2008) suggest that a pathological level of autistic or positive schizophrenia traits can disorder behavior to the extent that identifying the underlying effects of these traits can then be difficult. These authors therefore recommend that their theory is best evaluated with reference to milder levels of traits. In accord with this, the current study draws on the notion that autistic and schizophrenic traits are continuously distributed in the population; that is, the notion that these traits blend from clinical populations into the general population on a continuum from a disordering level of the traits to a total absence of the traits (Constantino and Todd 2003, 2005; Spiker et al. 2002). Moving along the continuum of autistic traits, from individuals diagnosed with autism toward normal functioning, are healthy individuals who score highly on measures such as the Autism Spectrum Quotient (AQ; Baron-Cohen et al. 2001), a measure of autistic-like traits in the general population. Similarly, further along the continuum from individuals diagnosed with schizophrenia (toward normal functioning), are healthy individuals who demonstrate personality traits that reflect a latent liability for schizophrenia (Chapman et al. 1994). This constellation of traits, known as schizotypy, has been shown to be phenomenologically and genetically related to schizophrenia, and as such, schizotypy is often referred to as a 'milder' manifestation of psychosis (Claridge 1987; Kendler and Hewitt 1992). Importantly, the three symptom dimensions associated with schizophrenia (positive, negative and disorganized) are mirrored in schizotypy (Mason and Claridge 2006).

A task often used to determine whether an individual has a preference for local or global processing is the Embedded Figures Test (EFT; Witkin et al. 1971), which requires participants to detect hidden shapes within complex figures. It is argued that a local processing style is an advantage for successful completion of the EFT, as the test requires one to resist experiencing an integrated visual stimulus or gestalt in favor of seeing a composition of single elements (Bolte et al. 2007). While there is conjecture over whether skilled performance on this test results from superior local or reduced global processing (Almeida et al. 2010; Bolte et al. 2007; Grinter et al. 2009a, b), it is reasonable to assume that a preference or advantage for local processing over global processing would facilitate test performance and vice versa. Accordingly, from Crespi and Badcock's (2008) theory, one would expect that relative to individuals with low levels of these traits, individuals with high levels of autistic-like traits should perform better on the EFT, while individuals with high levels of positive schizotypy traits should perform worse.

The notion that individuals with autism or high levels of autistic-like traits perform better on the EFT is well supported in the literature (Almeida et al. 2010; Bolte and Poustka 2006; Bolte et al. 2007; Grinter et al. 2009a, b; Jolliffe and Baron-Cohen 1997; Morgan et al. 2003; Pellicano et al. 2005, 2006; Shah and Frith 1983). However, not all studies have reported significant EFT differences when comparing autism and control samples (Brian and Bryson 1996; Ozonoff et al. 1991), or groups which differ in levels of autistic-like traits (Kunihira et al. 2006). In addition, none of the studies that have reported significant EFT differences have controlled for schizotypy traits, both those on the positive dimension that are of relevance to Crespi and Badcock's (2008) theory, and those on other schizotypy dimensions that correlate with autistic traits (as will be demonstrated in this study). Accordingly, the relationship between autistic traits and performance on the EFT deserves further attention.

Few studies have looked at EFT performance in individuals with traits of positive schizotypy. Furthermore, of the few conducted thus far, none has found a significant association between positive schizotypy traits and performance on the EFT or on the similar Hidden Figures Test (Schuldberg and London 1989; Tsakanikos and Reed 2003). Loas (2004), who investigated EFT performance in patients with schizophrenia, also failed to find a significant association between the positive symptoms and performance on this task. However, Cohler et al. (1977) did find evidence of poorer EFT performance for individuals with a general diagnosis of schizophrenia, relative to controls (Cohler et al. 1977). While the poorer EFT performance reported by Cohler et al. (1977) cannot particularly be attributed to the positive dimension of schizophrenia, Franco and Magaro (1977) found inpatients with paranoid schizophrenia to show slower performance on the EFT than inpatients with non-paranoid schizophrenia. Further research is therefore required to establish whether higher levels of positive schizotypy traits are associated with a greater preference for global over local processing, as predicted based on Crespi and Badcock's theory.

The present study aims to investigate preference for local versus global processing in both the autism and positive schizotypy spectra, and thus provide the first empirical test of Crespi and Badcock's (2008) theory. As Crespi and Badcock suggest that their theory can be best examined by looking at non-pathological individuals, individuals who display high and low levels of positive schizotypy traits, along with individuals who display high and low levels of autistic-like traits, should be ideal samples for assessing Crespi and Badcock's theory, and thus have been used in the current study. These individuals were selected from a screening process, where the AQ was used as a measure of autistic-like traits and the 'Unusual Experiences' subscale of the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE:UE; Mason et al. 2005) was used as a measure of positive schizotypy traits. Specifically, this study examined two pairs of groups: High and Low AQ groups and High and Low O-LIFE:UE groups. The AQ groups were matched on positive schizotypy traits but were selected to differ substantially in autistic-like traits, while the O-LIFE:UE groups were matched on autistic-like traits but were selected to differ substantially in positive schizotypy traits. Based on Crespi and Badcock (2008), it was predicted that while the High AQ group would be faster to detect embedded figures on the EFT than the Low AQ group, the High O-LIFE:UE group would be slower to detect the embedded figures than the Low O-LIFE:UE group.

Since IQ has been found to affect performance on the EFT and other similar tests that require participants to detect hidden shapes within complex figures (Grinter et al. 2009b; McKenna 1984; Tsakanikos and Reed 2003), IQ differences across these pairs of groups were also examined. The inclusion of a test of participants' IQ also allowed for limited assessment of another of Crespi and Badcock's (2008) claims—that autism and positive schizophrenia are characterized by contrasting patterns of difference in verbal and non-verbal ability. Based on this claim it can be argued that, relative to individuals with low levels of these traits, individuals with high levels of autistic traits should have higher non-verbal relative to verbal ability, whereas individuals with high levels of positive schizotypy traits should have lower non-verbal relative to verbal ability. A secondary aim of the current study was to provide a preliminary assessment of these predictions.

Method

Participants

Participants were selected from a screening process in which 318 undergraduate students (237 females, 81 males) completed the AQ and O-LIFE. These students were studying psychology as part of a broader degree (e.g., a BSc or BA). The mean age of the students was 18.6 years (SD = 3.0 years). A mean score of 15.74 (SD = 5.70) was obtained for the AQ and a mean of 3.93 (SD = 2.40) was obtained for the O-LIFE:UE subscale, the measure of positive schizotypy traits. These means are similar to those reported by the creators of these measures (Baron-Cohen et al. 2001; Mason et al. 2005). While males scored only very marginally higher than females on the AQ, $F(1, 316) = 3.03$, $p = .083$, $\eta_p^2 = .009$, in line with previous reports of a greater incidence of positive schizotypy traits in females (Mata et al. 2000; Raine 1992), females in the current sample tended to score higher than males on the Unusual Experiences subscale of the O-LIFE, $F(1, 316) = 6.30$, $p = .013$, $\eta_p^2 = .020$.

From the 318 students screened, two pairs of groups (i.e. four groups in total) were formed, such that each group contained 20 participants. One of these pairs consisted of High and Low AQ groups. These groups were selected such that they were separated substantially in their AQ scores, $F(1, 38) = 335.42$, $p < .001$, $\eta_p^2 = .898$ (Cohen's $d = 5.80$), but matched as closely as possible on their O-LIFE:UE scores, $F(1, 38) = 1.45$, $p = .237$, $\eta_p^2 = .037$. The other pair of groups, the High and Low O-LIFE:UE groups, were selected such that they were separated in their O-LIFE:UE scores, $F(1, 38) = 419.16$, $p < .001$, $\eta_p^2 = .917$ (Cohen's $d = 6.47$), but matched as closely as possible on their AQ scores, $F(1, 38) = 1.92$, $p = .174$, $\eta_p^2 = .048$. Because there were substantially more females than males in the screened sample, it was not possible to have an equal number of males and females in each group

Table 1 Psychometric characteristics of the high and low AQ groups and the high and low O-LIFE:UE groups ($n = 20$ per group)

	High AQ group	Low AQ group	High O-LIFE:UE	Low O-LIFE:UE
Age (in years)	18.10	17.85	18.25	17.70
SD (in years)	1.29	0.99	1.41	1.17
Number of females	15	13	15	15
AQ				
Mean	25.20	8.90	16.65	14.30
SD	3.17	2.40	6.80	3.39
Range	20–33	6–14	7–28	7–22
O-LIFE:UE				
Mean	5.04	4.00	7.41	0.90
SD	2.80	2.68	1.35	0.45
Range	0–9	1–10	5–11	0–2

yet also maintain substantial separation between the pairs of groups on either their AQ or O-LIFE:UE scores. Nevertheless, while there were more females than males in each group, the gender ratio was matched closely across the four groups. Groups were also selected to be closely matched on age. Descriptive statistics for the four groups are presented in Table 1.

Screening Measures

The *Autism Spectrum Quotient* (AQ; Baron-Cohen et al. 2001) is a 50-item self-report measure used to assess levels of autistic-like traits in the general population. In accordance with Baron-Cohen et al.'s (2001) scoring system, items were scored as one for a response in the 'autistic' direction and zero for a response in the 'non-autistic' direction.

A brief 33-item version of the *Oxford-Liverpool Inventory of Feelings and Experiences* (O-LIFE; Mason et al. 2005) was used as a measure of schizotypy traits. This measure was designed to assess the presence of these traits in healthy individuals (Mason et al. 1995). Items are scored one for the endorsement of a trait and zero otherwise. The three subscales from Mason et al.'s (2005) short-form of the O-LIFE that correspond to the major symptom dimensions associated with schizophrenia were used to index distinct facets of schizotypy. The positive symptoms of schizotypy were measured using the 'Unusual Experiences' (UE) subscale, which contains 12 items that relate to perceptual aberrations, hallucinations, and magical thinking. The 'Introvertive Anhedonia' (IA) subscale (10 items) taps negative schizotypy symptoms, while the 'Cognitive Disorganisation' (CD) subscale (11 items) reflects the disorganised aspect of schizotypy.

Experimental Measures

Form A of the *Embedded Figures Test* (EFT; Witkin et al. 1971), which requires participants to detect hidden shapes within complex figures, was used to assess participants' ability to process local information in the context of ignoring global information. The measure of performance was the time required to accurately locate the embedded figures, averaged across the 12 test items. Participants were given a maximum of 180 s to locate each shape. If a shape other than the correct shape was located, the participant was informed of the error, and asked to continue searching, with the timing continuing. If a participant could not locate the target shape within the time limit, 180 s was recorded as the response time for that trial. This was in accord with the procedure set out in the test manual.

The two-subtest form of the *Wechsler Abbreviated Scale of Intelligence* (WASI; Wechsler 1999) was also administered. The two-subtest form includes the Vocabulary and Matrix Reasoning subtests, which assess verbal and non-verbal ability, respectively. In accordance with the test manual, estimates of Verbal IQ (VIQ) and Performance IQ (PIQ) were derived by pro-rating (doubling) the *T* scores.

Procedure

The screening was conducted in groups of 20–30 students. Participants who were recruited for the experimental phase of the experiment were tested individually, first on the WASI followed by the EFT. Participants were informed that the study related to autism and positive schizotypy only at the end of the experimental session.

Results

Prior to analysis, the experimental data were screened for univariate outliers (scores more than three standard deviations from the corresponding group mean). No outliers were identified for any of the four groups, and all variables were found to be sufficiently normal; skew was less than two and kurtosis less than four.

Comparisons of the High and Low AQ Groups

To test the prediction that higher levels of autistic-like traits are associated with better EFT performance, the High and Low AQ groups were compared in terms of their mean response time to accurately locate the embedded figures for the EFT. The mean response times for the two AQ groups are displayed in Table 2. EFT responses were significantly faster for the High AQ group compared to the Low AQ group, $F(1, 38) = 8.61$, $p = .006$, $\eta_p^2 = .185$.[1] This is consistent with Crespi and Badcock's (2008) claim and with the results obtained by Grinter et al. (2009a, b).

To ensure the difference in EFT performance for the High and Low AQ groups was not confounded by differences in general ability, the two groups were also compared in terms of IQ. A 2 × 2 mixed design ANOVA (where AQ group was entered as a between-subjects factor and IQ domain—Verbal versus Performance—was entered as a within-subjects factor) was performed on the IQ scores. While a main effect of IQ domain was found, $F(1, 38) = 9.49$, $p = .004$, $\eta_p^2 = .200$, with participants obtaining higher VIQ scores ($M = 116.30$, SD = 13.75) than PIQ scores ($M = 108.70$, SD = 11.24), there was no main effect of AQ group, $F(1, 38) = 1.13$, $p = .294$, $\eta_p^2 = .029$. There was also no interaction between AQ group and IQ domain, $F(1, 38) = 1.03$, $p = .317$, $\eta_p^2 = .026$. Therefore, it is unlikely that the difference in EFT performance found is a result of a difference in IQ between the groups. In addition, the lack of interaction between AQ group and IQ domain indicates that the High AQ group did not display greater superiority in non-verbal ability relative to verbal ability than the Low AQ group, contrary to what would be expected based on Crespi and Badcock's (2008) position.

While the AQ groups were balanced on O-LIFE:UE scores (see Table 1), they were found to be separated in their O-LIFE:CD scores, $F(1, 38) = 25.98$, $p < .001$, $\eta_p^2 = .406$, and in their O-LIFE:IA scores, $F(1, 38) = 21.01$, $p < .001$, $\eta_p^2 = .356$. The means for the High and Low AQ groups on these two O-LIFE subscales are presented in Table 2. In each case, the High AQ group endorsed more schizotypy traits than did the Low AQ group. However, the time taken to complete the EFT did not correlate significantly with scores on either of these two subscales. Therefore, the advantage for the High AQ group over the Low AQ group on the EFT is unlikely to be due to the differences in O-LIFE:CD or O-LIFE:IA traits.

Table 2 Means and standard deviations for the high and low AQ groups for the EFT, IQ measures and O-LIFE:CD and O-LIFE:IA subscales

	High AQ group		Low AQ group	
	Mean	SD	Mean	SD
EFT (s)	20.34	7.11	31.77	15.91
Verbal IQ	114.40	14.12	119.20	13.07
Performance IQ	108.30	12.64	109.10	9.95
O-LIFE:CD	7.50	3.09	2.98	2.50
O-LIFE:IA	3.01	1.94	.85	.81

Comparisons of the High and Low O-LIFE:UE Groups

EFT performance was compared for the Low and High O-LIFE:UE groups to test the prediction that the High O-LIFE:UE group would perform worse on this task than the Low O-LIFE:UE group. The mean EFT scores for these groups are displayed in Table 3. Consistent with Crespi and Badcock's (2008) prediction, EFT response times were significantly longer for the High O-LIFE:UE group compared to the Low O-LIFE:UE group, $F(1, 38) = 10.27$, $p = .003$, $\eta_p^2 = .213$.[2]

The High and Low O-LIFE:UE groups were then compared in terms of IQ to ensure the difference in EFT performance found for these groups was not confounded by differences in general ability. As was observed for the AQ groups, a main effect of IQ domain was found, $F(1, 38) = 11.60$, $p = .002$, $\eta_p^2 = .234$, with VIQ scores ($M = 116.18$, SD = 14.38) higher than PIQ scores ($M = 106.15$, SD = 11.36) across the two O-LIFE:UE groups. However, there was no main effect of O-LIFE:UE group on IQ scores, $F(1, 38) = 2.98$, $p = .092$, $\eta_p^2 = .073$. There was also no significant interaction between O-LIFE:UE group and IQ domain, $F(1, 38) = 1.43$, $p = .239$, $\eta_p^2 = .036$. These results again suggest that the EFT difference observed for the O-LIFE groups is not due to a difference in IQ. Further, the lack of a significant interaction does not support the prediction developed from Crespi and Badcock (2008) that, relative to individuals with low levels of positive schizotypy traits, individuals with high levels of positive schizotypy traits should display lower non-verbal ability relative to verbal ability. However, the pattern of results obtained was in the expected direction; while the Low O-LIFE group scored only six IQ

[1] Although ANOVA is generally considered to be relatively robust to violations of homogeneity, especially when the sample sizes are equal (Ferguson and Takane 2005; Kao and Green 2008), since Levene's Test of Equality of Error Variances was violated, the Mann–Whitney U Test was also conducted. This test indicated a significant difference in EFT performance between the High and Low AQ groups, $U = 103.50$, $z = 2.61$, $p = .008$, $r = .413$.

[2] As the assumption of homogeneity of variance was violated, the Mann–Whitney U Test was conducted. A significant difference in EFT performance between the High and Low O-LIFE:UE groups was again found, $U = 98.00$, $z = 2.76$, $p = .005$, $r = .436$.

Table 3 Means and standard deviations for the high and low O-LIFE:UE groups for the EFT, IQ measures and O-LIFE:CD and O-LIFE:IA subscales

	High O-LIFE:UE group		Low O-LIFE:UE group	
	Mean	SD	Mean	SD
EFT (s)	42.50	34.88	27.27	11.28
Verbal IQ	115.55	15.08	116.80	14.01
Performance IQ	102.00	12.84	110.30	8.00
O-LIFE:CD	6.08	3.03	5.08	2.39
O-LIFE:IA	1.05	1.36	1.01	1.03

points lower for PIQ than VIQ, the High O-LIFE:UE group scored 13 points lower for PIQ than VIQ (see Table 3). Thus, while not statistically significant, the High O-LIFE:UE group did have somewhat lower non-verbal ability, relative to verbal ability, than the Low O-LIFE:UE group.[3]

While the High and Low O-LIFE:UE groups were created such that they were matched on autistic-like traits (see Table 1), two further ANOVAs were conducted to check that the groups did not differ in terms of their scores on the other scales of the O-LIFE. The groups were found to be matched on O-LIFE:CD scores, $F(1, 38) = 1.35$, $p = .253$, $\eta_p^2 = .034$, and O-LIFE:IA scores, $F(1, 38) = .01$, $p = .909$, $\eta_p^2 = .000$. The means for the High and Low O-LIFE:UE groups on the O-LIFE:CD and O-LIFE:IA subscales are presented in Table 3.

Discussion

The aim of this study was to test predictions derived from Crespi and Badcock's (2008) claim that autism and positive schizophrenia are associated with contrasting preferences for local versus global processing. It was found that individuals with high levels of autistic-like traits showed more skilled performance on the EFT than individuals with few autistic-like traits, consistent with a preference or advantage for local over global processing. In contrast, individuals with high levels of positive schizotypy traits showed less skilled performance on the EFT than individuals with low levels of these traits, consistent with a preference or advantage for global over local processing. Therefore, these results offer support for Crespi and Badcock's claim that autistic and positive schizophrenia traits are diametrically opposed with regard to their effect on local versus global processing. As Crespi and Badcock suggest, these contrasting outcomes may be the result of an increased connectivity within neural regions compared to a decreased connectivity across regions similar to what has been observed for individuals with autism (relative to controls), and a decreased connectivity within neural regions relative to an increased connectivity across regions similar to what has been observed for individuals with positive schizophrenia (Courchesne and Pierce 2005a, b; Happé and Frith 2006; Siekmeier and Hoffman 2002).

The contrasting patterns of performance reported for individuals with autism and schizophrenia on tasks where attention is divided between local and global levels (Bellgrove et al. 2003; Rinehart et al. 2001; White et al. 2009) are broadly consistent with the current results, and suggest a particular interpretation of them. The Rinehart et al. and White et al. studies provide evidence that when target stimuli can be present at either local or global levels, performance is slowed for individuals with autism relative to controls when the target shifts from the local to the global level. Contrasting results have been reported for schizophrenia or schizotypal personality disorder in that, relative to controls, there is evidence either of slowed performance when targets shift from the global to the local level, or of an exaggerated general advantage in processing global targets (Carter et al. 1996; Granholm et al. 2002, 1999). Interpretations of these results provided by Rinehart et al. and Bellgrove et al. are in terms of "sluggish" shifts of the scale of spatial attention, with autism carrying a difficulty in "zooming out" from a local to global scale, and schizophrenia carrying a difficulty in "zooming in" from a global to a local scale. Since successful completion of the EFT may involve some attentional shifts, it is possible that differences in the ease of making the transition to the local level in order to detect the hidden shape could explain the differences in EFT performance for the AQ groups and the O-LIFE:UE groups.

However, findings from other studies indicate that perhaps the atypical processing relating to autism is not limited to shifts in spatial attention, with the performance of groups of high and low AQ scorers differing on tasks which do not require any shifts in attention to be made. For example, high AQ scorers have been found to outperform low AQ scorers on a visual search task (Almeida et al. 2010), suggesting that autistic traits are associated with an advantage in local processing which does not arise from an enhanced ability to "zoom in." In addition, worse performance on the Glass pattern detection and Global Dot Motion tasks found for high AQ scorers, relative to low AQ scorers (Grinter et al. 2009a), suggests a limitation at the global level of attention for individuals with high levels of

[3] Since there was a difference in PIQ (although non-significant) between the O-LIFE:UE groups, PIQ was entered in an analysis of covariance (ANCOVA) to further rule out the possibility that participants with higher levels of positive schizotypy traits performed slower on the EFT due to a lower PIQ. The difference in EFT response times between the High and Low O-LIFE:UE groups remained significant with this control for PIQ, $F(1, 38) = 6.03$, $p = .019$, $\eta_p^2 = .140$.

autistic traits which is not the result of a poorer ability to "zoom out" from a more local level of attention. Together, the findings from these two studies suggest that the superior EFT performance displayed by higher AQ scorers in the current study is not the result of an enhanced ability to "zoom in" from a global to a local scale, or a difficulty in "zooming out" from a local to a global scale, but rather a superior capacity to process stimuli at a local level coupled with a reduced capacity to process stimuli at a global level.

With these other studies suggesting several possible processing differences that may contribute to the group differences in EFT performance, further research investigating particular processes is warranted. For instance, it would be useful to assess the performance of groups similar to those used in the present study on a task that demands only local processing and another task that demands only global processing. A study such as this would provide greater insight into the extent to which each level of processing is affected by the presence of autistic and positive schizotypy traits, and thus provide a test of the notion that the pattern of results obtained in the current study is the result of differences within the local and/or global levels of attention, rather than differences in the ease with which individuals are able to shift along the scale of spatial attention. In addition, as there is some contention as to whether skilled performance on the EFT results from superior local or reduced global processing, future research could also consider the inclusion of a task that requires participants to process global information while ignoring local information (as a balance to the EFT).

Nevertheless, the current study extends on previous findings of superior EFT performance for individuals with autistic or autistic-like traits, by showing that this association is not confounded by levels of schizotypy traits. The current findings therefore allow a stronger link to be drawn between higher levels of autistic traits and superior performance on this task, and hence provide additional evidence of a preference for local over global processing in individuals with autism. Furthermore, this is the first study to have found any association between positive schizotypy traits and performance on the EFT (or any other similar measure). This may be because previous studies have failed to control for autistic or autistic-like traits while examining the effect of positive schizotypy traits on preference for local versus global processing, a confound the present study has addressed. However, as schizophrenia has been associated with generally slowed processing (Brebion et al. 2000; Salame et al. 1998), it is important to consider the possibility that the poorer EFT performance found for those with high (versus low) levels of positive schizotypy traits is not specifically related to a preference for global over local processing, but rather is the result of generally slowed processing. This being said, slowed processing has been more strongly associated with the negative symptoms of schizophrenia than with the positive symptoms (Berman et al. 1997; Braff 1989; Cadenhead et al. 1997; Green and Walker 1984), and so generally slowed processing does not readily account for the pattern of results observed in the current study. This is especially the case since autistic-like traits have been found to correlate with negative traits of schizotypy both in the current study and by Hurst et al. (2007b), yet individuals with high levels of autistic-like traits are found to do especially well on the EFT. It should also be noted that a general speed of processing advantage for individuals with high (versus low) levels of autistic-like traits is unlikely to account for their faster performance on the EFT since, to our knowledge, there is no current literature which suggests that individuals with higher levels of autistic or autistic-like traits have a general speed of processing advantage when compared with controls or individuals with low levels of these traits. In fact, when compared to typically developing children, children with autism have commonly been found to perform poorly on measures of processing speed (Calhoun and Mayes 2005; Mayes and Calhoun 2003, 2004, 2007). While some studies have reported a processing speed advantage for individuals with autism relative to that expected from their levels of IQ, these findings are more consistent with intact speed of processing (i.e., speed of processing equivalent to controls), rather than a speed of processing advantage (Scheuffgen et al. 2000; Wallace et al. 2009).

In order to assess Crespi and Badcock's (2008) theory, the current investigation considered autistic traits to represent a unitary continuum. However, there is evidence that autism may comprise somewhat independent dimensions (Dworzynski et al. 2009) and that these dimensions are represented in the AQ (Austin 2005; Stewart and Austin 2009; Hurst et al. 2007a). Further research is required to ascertain precisely which dimensions of autism are associated with a preference or superiority in local processing, and to examine any relationships between these dimensions and schizotypy dimensions.

Since the High and Low AQ groups and the High and Low O-LIFE:UE groups did not differ in terms of IQ, we can be confident that the group differences identified for the EFT were not the result of differing levels of general ability (see also Grinter et al. 2009b). However, the fact that the relative difference between Verbal IQ and Performance IQ was consistent across individuals with high and low levels of these traits contradicts one of Crespi and Badcock's (2008) other claims. In line with their theory that autism and positive schizophrenia are diametrically opposed, Crespi and Badcock also argued for contrasting patterns of non-verbal relative to verbal ability for autism

and positive schizophrenia. While visual inspection of the mean Verbal and Performance IQ scores for the O-LIFE:UE groups reveals a trend consistent with what would be expected based on Crespi and Badcock's claim, statistical support for this claim was not found. It should be pointed out, however, that the use of a student sample may have led to a restriction in the range of IQ scores (particularly with reference to VIQ), and so a more powerful test of this aspect of Crespi and Badcock's theory using community-based (and perhaps larger) samples is warranted. Additionally, as the Vocabulary and Matrix Reasoning subtests were the sole measures of verbal and non-verbal ability in the current study, a more extensive battery of verbal and non-verbal measures would offer a more complete assessment of this aspect of Crespi and Badcock's theory.

Concluding Remarks

This is the first study to examine local versus global processing in the autism and positive schizotypy spectra together in the one study, and the first to find an association between positive schizotypy traits and EFT performance. The results offer support for the claim of a contrasting preference for local versus global processing in individuals with autistic-like and positive schizotypy traits. However, as the autism and positive schizotypy spectra did not show opposite patterns with regard to non-verbal relative to verbal ability, this study does not offer converging evidence for Crespi and Badcock's (2008) wider claim that autism and positive schizophrenia are diametrically opposed. However, as this is the first study to examine the effects of autistic-like and positive schizotypy traits on cognition in the one study, more research is required to further investigate the validity of Crespi and Badcock's theory.

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References

Almeida, R., Dickinson, J., Maybery, M., Badcock, J., & Badcock, D. (2010). A new step towards understanding Embedded Figures Test performance in the autism spectrum: The radial frequency search task. *Neuropsychologia, 48*, 374–381.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM IV*. Washington, DC: American Psychiatric Publishing.

Austin, E. (2005). Personality correlates of the broader autism phenotype as assessed by the autism spectrum quotient (AQ). *Personality and Individual Differences, 38*, 174–183.

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*, 5–17.

Bellgrove, M., Vance, A., & Bradshaw, J. (2003). Local-global processing in early-onset schizophrenia: Evidence for an impairment in shifting the spatial scale of attention. *Brain and Cognition, 51*, 48–65.

Berman, I., Viegner, B., Merson, A., Allen, E., Pappas, D., & Green, A. (1997). Differential relationship between positive and negative symptoms and neurological deficits in schizophrenia. *Schizophrenia Research, 25*, 1–10.

Bolte, S., Holtmann, M., Poustka, F., Scheurich, A., & Schmidt, L. (2007). Gestalt perception and local-global processing in high-functioning autism. *Journal of Autism and Developmental Disorders, 37*, 1493–1504.

Bolte, S., & Poustka, F. (2006). The broader cognitive phenotype of autism in parents: How specific is the tendency for local processing and executive function. *Journal of Child Psychology and Psychiatry, 47*, 639–645.

Braff, D. (1989). Sensory input deficits and negative symptoms in schizophrenia patients. *American Journal of Psychiatry, 146*, 1006–1011.

Brebion, G., Smith, M., Gorman, J., Maslaspina, D., Sharif, Z., & Amador, X. (2000). Memory and schizophrenia: Differential link of processing speed and selective attention with two levels of encoding. *Journal of Psychiatric Research, 34*, 121–127.

Brian, J., & Bryson, S. (1996). Disembedding performance and recognition memory in autism/PDD. *Journal of Child Psychology and Psychiatry, 37*, 865–872.

Cadenhead, K., Geyer, M., Butler, R., Perry, W., Sprock, J., & Braff, D. (1997). Information processing deficits of schizophrenia patients: Relationship to clinical ratings, gender and medication status. *Schizophrenia Research, 28*, 51–62.

Calhoun, S., & Mayes, S. (2005). Processing speed in children with clinical disorders. *Psychology in the Schools, 42*, 333–343.

Carter, C., Robertson, L., Nordahl, T., Chaderjian, M., & Oshora-Celaya, L. (1996). Perceptual and attentional asymmetries in schizophrenia: Further evidence for a left hemisphere deficit. *Psychiatry Research, 62*(2), 111–119.

Chapman, L., Chapman, J., Kwapil, T., Eckblad, M., & Zinser, M. (1994). Putatively psychosis-prone subjects 10 years later. *Journal of Abnormal Psychology, 103*, 171–183.

Claridge, G. (1987). The schizophrenias as nervous types, revisited. *British Journal of Psychiatry, 151*, 735–743.

Cohler, B., Grunebaum, H., Weiss, J., Gamer, E., & Gallant, D. (1977). Disturbance of attention among schizophrenic, depressed, and well mothers and their young children. *Journal of Child Psychology and Psychiatry, 18*, 115–135.

Colger, R., & Serafetinides, E. (1990). Schizophrenia, corpus callosum, and interhemispheric communication: A review. *Psychiatry Research, 34*, 163–184.

Constantino, J., & Todd, R. (2003). Autistic traits in the general population: A twin study. *Biological Psychiatry, 60*, 524–530.

Constantino, J., & Todd, R. (2005). Intergenerational transmission of subthreshold autistic traits in the general population. *Biological Psychiatry, 57*, 655–660.

Courchesne, E., & Pierce, K. (2005a). Why the frontal cortex in autism might be talking only to itself: Local over-connectivity but long-distance disconnection. *Current Opinion in Neurobiology, 15*, 225–230.

Courchesne, E., & Pierce, K. (2005b). Brain overgrowth in autism during a critical time in development: Implications for frontal pyramidal neuron and interneuron development and connectivity. *International Journal of Developmental Neuroscience, 23*, 153–170.

Crespi, B., & Badcock, C. (2008). Psychosis and autism as diametrical disorders of the social brain. *Behavioral and Brain Sciences, 31*, 241–261.

Dworzynski, K., Happe′, F., Bolton, P., & Ronald, A. (2009). Relationship between symptom domains in autism spectrum disorders: A population based twin study. *Journal of Autism and Developmental Disorders, 39*, 1197–1210.

Ferguson, G., & Takane, Y. (2005). *Statistical analysis in psychology and education* (6th ed.). Montreal, Quebec: McGraw Hill Ryerson Limited.

Franco, E., & Magaro, P. (1977). The relationship of A-B, field dependency, and emotional openness in paranoid and non-paranoid schizophrenics. *Journal of Clinical Psychology, 33*, 39–42.

Granholm, E., Cadenhead, K., Shafer, K., & Filoteo, J. (2002). Lateralized perceptual organization deficits in the global-local task in schizotypal personality disorder. *Journal of Abnormal Psychology, 111*, 42–52.

Granholm, E., Perry, W., Filoteo, J., & Braff, D. (1999). Hemispheric and attentional contributions to perceptual organization deficits on the global-local task in schizophrenia. *Neuropsychology, 13*(2), 271–281.

Green, M., & Walker, E. (1984). Susceptibility to backward masking in schizophrenia patients with positive and negative symptoms. *Journal of American Psychiatry, 141*, 1275–2723.

Grinter, E., Maybery, M., Van Beek, P., Pellicano, E., Badcock, J., & Badcock, D. (2009a). Global visual processing and self-rated autistic-like traits. *Journal of Autism and Developmental Disorders, 39*, 1278–1290.

Grinter, E., Van Beek, P., Maybery, M., & Badcock, D. (2009b). Brief report: Visuospatial analysis and self-rated autistic-like traits. *Journal of Autism and Developmental Disorders, 39*, 670–677.

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 36*, 5–25.

Hayes, R. (1987). Training for work. In D. Cohen & P. Donnellan (Eds.), *Handbook of autism and pervasive developmental disorders*. Silversprings: Winston.

Hurst, R., Mitchell, J., Kimbrel, N., Kwapil, T., & Nelson-Gray, R. (2007a). Examination of the reliability and factor structure of the Autism Spectrum Quotient (AQ) in a non-clinical sample. *Personality and Individual Differences, 43*, 1938–1948.

Hurst, R., Nelson-Gray, R., Mitchell, J., & Kwapil, T. (2007b). The relationship of Asperger's characteristics and schizotypal personality traits in a non-clinical adult sample. *Journal of Autism and Developmental Disorders, 37*, 1711–1720.

Jolliffe, T., & Baron-Cohen, S. (1997). Are people with autism and Asperger Syndrome faster than normal on the embedded figures test? *Journal of Child Psychology and Psychiatry, 38*, 527–534.

Kanner, L. (1949). Problems of nosology psychodynamics in early infantile autism. *American Journal of Orthopsychiatry, 19*, 416–426.

Kao, L., & Green, C. (2008). Analysis of variance: Is there a difference in means and what does it mean? *Journal of Surgical Research, 144*, 158–170.

Kendler, K., & Hewitt, J. (1992). The structure of self-report schizotypy in twins. *Journal of Personality Disorders, 6*, 1–17.

Kunihira, Y., Senju, A., Dairoku, H., Wakabayashi, A., & Hasegawa, T. (2006). 'Autistic' traits in non-autistic Japanese populations: Relationships with personality traits and cognitive ability. *Journal of Autism and Developmental Disorders, 36*, 533–566.

Loas, G. (2004). Visual-spatial processing and dimensions of schizophrenia: A preliminary study on 62 schizophrenic subjects. *European Psychiatry, 19*, 370–373.

Maher, B. A. (1983). A tentative theory of schizophrenic utterance. In B. A. Maher & W. B. Maher (Eds.), *Progress in experimental personality research: Vol. 12. Psychopathology* (pp. 1–52). New York: Academic Press.

Mason, O., & Claridge, G. (2006). The Oxford–Liverpool inventory of feelings and experiences (O-LIFE): Further description and extended norms. *Schizophrenia Research, 82*, 203–211.

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences, 18*, 7–13.

Mason, O., Linney, Y., & Claridge, G. (2005). Short scales for measuring schizotypy. *Schizophrenia Research, 78*, 293–296.

Mata, I., Sham, P., Gilvarry, C., Jones, P., Lewis, S., & Murray, R. (2000). Childhood schizotypy and positive symptoms in schizophrenic patients predict schizotypy in relatives. *Schizophrenia Research, 44*(2), 129–136.

Mayes, S., & Calhoun, S. (2003). Analysis of WISC-III, Stanford-Binet-IV, and academic achievement test scores in children with autism. *Journal of Autism and Developmental Disorders, 33*, 329–341.

Mayes, S., & Calhoun, S. (2004). Similarities and differences in WISC-III profiles: Support for subtest analysis in clinical referral. *Clinical Neuropsychologist, 18*, 559–572.

Mayes, S., & Calhoun, S. (2007). Learning, attention, writing, and processing speed in typical children with ADHD, autism, anxiety, depression, and oppositional-defiant disorder. *Child Neuropsychology, 13*(6), 469–493.

McKenna, F. (1984). Measures of field dependence: Cognitive style or cognitive ability. *Journal of Personality and Social Psychology, 47*, 593–603.

Morgan, B., Maybery, M., & Durkin, K. (2003). Weak central coherence, poor joint attention, and low verbal IQ: Independent deficits in early autism. *Developmental Psychology, 39*, 646–656.

Nettle, D. (2006). Schizotypy and mental health amongst poets, visual artists, and mathematicians. *Journal of Research in Personality, 40*, 876–890.

Oberman, L., & Pascual-Leone, A. (2008). Cortical plasticity: A proposed mechanism by which genomic factors lead to the behavioural and neurological phenotype of autism spectrum and psychotic-spectrum disorders [Peer commentary on the journal article "Psychosis and autism as diametrical disorders of the social brain"]. *Behavioral and Brain Sciences, 31*, 241–261.

Ozonoff, S., Pennington, B., & Rogers, S. (1991). Executive function deficits in high-functioning autistic individuals: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry, 32*, 1081–1105.

Pellicano, E., Gibson, L., Maybery, M., Durkin, K., & Badcock, D. (2005). Abnormal processing along the dorsal visual pathway in autism: A possible mechanism for weak visuospatial coherence. *Neuropsychologia, 43*, 1044–1053.

Pellicano, E., Maybery, M., Durkin, K., & Maley, A. (2006). Multiple cognitive capabilities/deficits in children with an autism spectrum disorder: 'Weak" central coherence and its relationship to theory of mind and executive control. *Development & Psychopathology, 18*, 77–98.

Raine, A. (1992). Sex differences in schizotypal personality in a nonclinical population. *Journal of Abnormal Psychology, 101*(2), 361–364.

Rawlings, D., & Locarnini, A. (2008). Dimensional schizotypy, autism, and unusual word associations in artists and scientists. *Journal of Research in Personality, 42*, 465–471.

Rinehart, N., Bradshaw, J., Moss, S., Brereton, A., & Tonge, B. (2001). A deficit in shifting attention present in high-functioning autism but not Asperger's disorder. *Autism, 5*, 67–80.

Rutter, M. (1972). Childhood schizophrenia reconsidered. *Journal of Autism Childhood Schizophrenia, 2*, 315–337.

Salame, P., Danion, J., Peretti, S., & Cuervo, C. (1998). The state of functioning of working memory in schizophrenia. *Schizophrenia Research, 30*, 11–29.

Scheuffgen, K., Happe, F., Anderson, M., & Frith, U. (2000). High "intelligence", low "IQ"? Speed of processing and measured IQ in children with autism. *Development and Psychopathology, 12*, 83–90.

Schuldberg, D., & London, A. (1989). Psychological differentiation and schizotypal traits: Negative results with the group embedded figures test. *Perceptual and Motor Skills, 35*, 703–712.

Shah, A., & Frith, U. (1983). An islet of ability in autistic children: A research note. *Journal of Child Psychology and Psychiatry, 24*, 613–620.

Siekmeier, P., & Hoffman, R. (2002). Enhanced semantic priming in schizophrenia: A computer model based on excessive pruning of local connections in association cortex. *British Journal of Psychiatry, 180*, 345–350.

Spiker, D., Lotspeich, L., Dimiceli, S., Myers, R., & Risch, N. (2002). Behavioural phenotypic variation in autism multiplex families: Evidence for a continuous severity gradient. *American Journal of Medical Genetics, 114*, 129–136.

Spitzer, M. (1997). A cognitive neuroscience view of schizophrenic thought disorder. *Schizophrenia Research, 23*, 29–50.

Spitzer, M., Braun, U., Hermle, L., & Maier, S. (1993). Associative semantic network dysfunction in thought-disordered schizophrenic patients: Direct evidence from indirect semantic priming. *Biological Psychiatry, 34*, 864–877.

Stewart, M., & Austin, E. (2009). The structure of the autism-spectrum quotient (AQ): Evidence from a student sample in Scotland. *Personality and Individual Differences, 47*, 224–228.

Tordjman, S. (2008). Reunifying autism and early-onset schizophrenia in terms of social communication disorders [Peer commentary on the journal article "Psychosis and autism as diametrical disorders of the social brain"]. *Behavioral and Brain Sciences, 31*, 241–261.

Tsakanikos, E., & Reed, P. (2003). Visuo-spatial processing and dimensions of schizotypy: Figure-ground segregation as a function of psychotic-like features. *Personality and Individual Differences, 35*, 703–712.

Wallace, G., Anderson, M., & Happe, F. (2009). Brief report: Information processing speed is intact in autism but not correlated with measures of intelligence. *Journal of Autism and Developmental Disorders, 39*, 809–814.

Wechsler Abbreviated Scale of Intelligence. (1999). *San Antonio*. TX: Psychological Corp.

White, S., O'Reilly, H., & Frith, U. (2009). Big heads, small details and autism. *Neuropsychologia, 47*, 1274–1281.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. S. (1971). *A manual for the embedded figures test*. Palo Alto, CA: Consulting Psychologists Press.