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Letter to the Editor

Increased positive and disorganised schizotypy in synaesthetes who experience colour from letters and tones

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Synaesthesia is a condition in which one property of a stimulus induces a conscious experience of an additional attribute. For example, in grapheme-colour synaesthesia, a visually presented grapheme results in synaesthetic experiences of colour. These experiences occur in approximately 4% of the population (Simner et al., 2006) and the authenticity of the condition is well established (Cohen Kadosh and Henik, 2007). Despite this, our understanding of the neuropsychiatric profiles of synaesthetes remains limited and surprisingly few studies have addressed whether synaesthesia is linked to more widespread abnormalities in perception that extend beyond the synaesthetic experience itself. There is, however, growing evidence to suggest that synaesthesia may be linked to a broader phenotype. For example, synaesthetes who experience colour show early processing differences to stimuli which do not evoke synaesthesia (Barnett et al., 2008); and the presence of synaesthesia has been linked with other phenotypic manifestations including out-of-body experiences (Terhune, 2009), creativity (Ward et al., 2008), mental imagery (Barnett and Newell, 2008), and mitempfindung (Burrack et al., 2006). Here, we examined the relationship between synaesthesia involving colour and the abnormal perceptions observed in schizophrenia by assessing levels of schizotypy in synaesthetes and non-synaesthetes. We report that synaesthesia for colour is associated with greater levels of positive and disorganised schizotypy (Fig. 1A), suggesting widespread perceptual differences in synaesthesia that extend beyond the synaesthetic concurrent.

Thirty synaesthetes who experience colour as their evoked sensation (29 females; 1 male; mean age $\pm$ s.e.m $= 41.5 \pm 1.91$ years) and thirty age and gender matched controls (29 females; 1 male; mean age $\pm$ s.e.m $= 41 \pm 1.93$ years) took part in this study. Cases of synaesthesia were randomly selected from our own database of synaesthetes recruited via self-referral and screening of undergraduates/members of the public. All cases were confirmed using tests of consistency over time, with subjects demonstrating test–retest consistency of 85% or a score of ≤ 1 on the Eagleman Synaesthesia Test Battery (Eagleman et al., 2007).

Participants were administered the Oxford–Liverpool Inventory of Feelings and Experiences (O-Life; Mason and Claridge, 2006). This is a standardized measure of schizotypy, which is designed to measure sub-clinical schizophrenic-like symptoms in the general population (Cochrane et al., 2010; Mason and Claridge, 2006). The questionnaire has been normed in typical and schizophrenic groups (Cochrane et al., 2010; Mason and Claridge, 2006) and shown to be a sensitive and valid tool for examining schizotypy in both groups (Cochrane et al., 2010). The measure has four scales that are examined by forced-choice responses (yes/no responses): Unusual Experiences (UnEx), Introvertive Anhedonia (IntAn), Cognitive Disorganisation (CogDis), and Impulsive Non-Conformity (ImpNon). The UnEx scale measures traits related to the positive symptoms of psychosis (e.g., unusual perceptual experiences and hallucinations). IntAn examines negative aspects of schizotypy (e.g., lack of enjoyment of social activities). The CogDis scale is consistent

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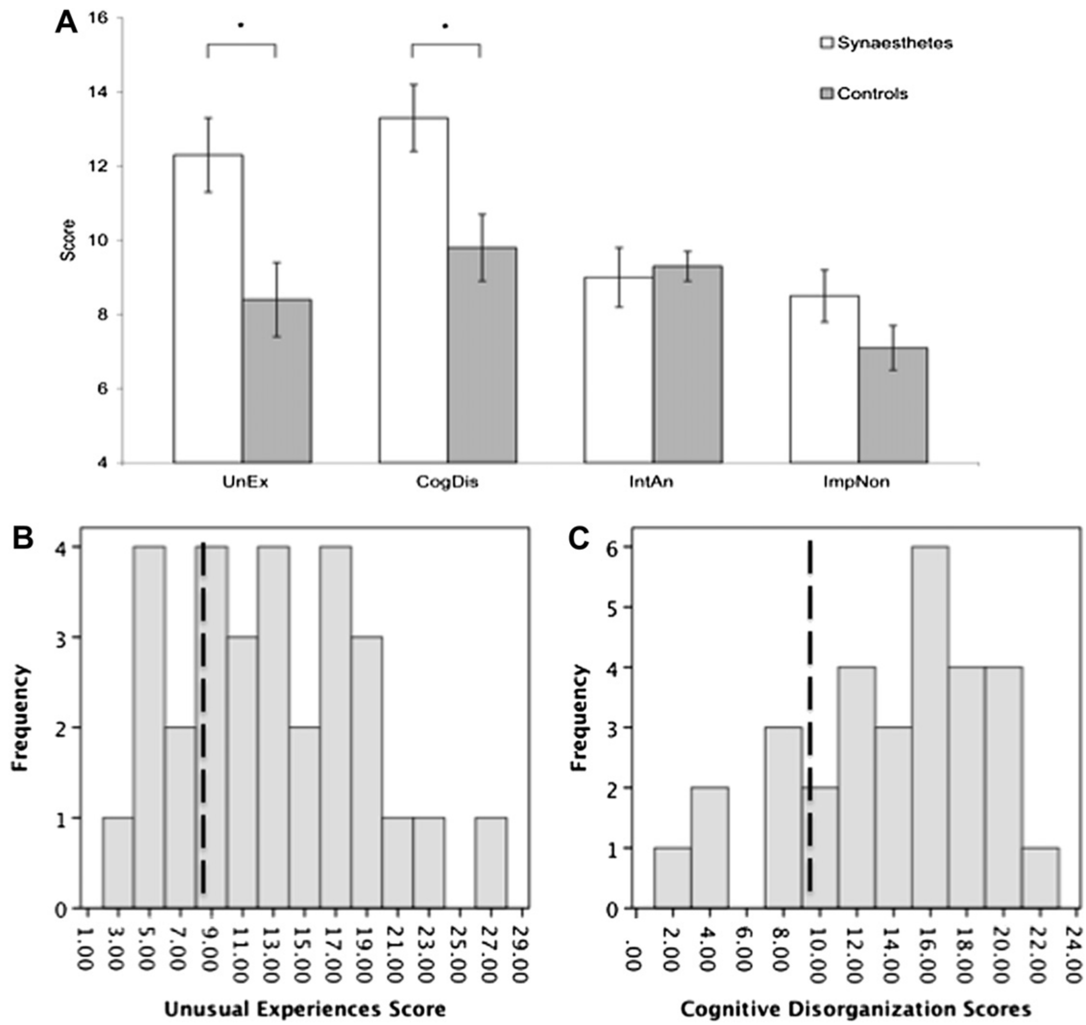

Fig. 1 – (A) Synaesthetes showed higher levels of positive (UnEx) and disorganised schizotypy (CogDis) relative to matched control participants, but did not significantly differ on negative schizotypy (IntAn) or ImpNon. ± s.e.m. * = $p < .05$. (B) Frequency of scores on the UnEx scale for synaesthetes (control mean shown as dashed line). (C) Frequency of scores on the CogDis scale for synaesthetes (control mean shown as dashed line).

with thought disorder and disorganised aspects of psychosis, it is comprised of items measuring problems with decision-making and social anxiety. Finally, the ImpNon scale examines impulsive, antisocial and eccentric forms of behaviour (Cochrane et al., 2010; Mason and Claridge, 2006).

A 2 (Group) × 4 (Schizotypal Factor) mixed ANOVA was used to explore differences on each component of schizotypy between the groups. A main effect of group was observed [$F(1, 58) = 7.49$, $p = <.01$], with synaesthetes scoring higher overall compared to controls. There was also a significant interaction [$F(3, 174) = 3.37$, $p = <.05$]. Bonferroni corrected post-hoc t-tests revealed that this was because synaesthetes showed significantly higher levels of positive (UnEx) [$t(58) = 2.58$, $p = <.05$, $d = .68$] and disorganised schizotypy (CogDis) [$t(58) = 2.65$, $p = <.05$, $d = .70$] relative to the matched control group (Fig. 1A). No significant differences were found between the groups in their levels of negative schizotypy (IntAn) [$t(58) = .289$, $p =$ n.s, $d = .08$] or their ImpNon (Fig. 1A) [$t(58) = 1.53$, $p =$ n.s, $d = .40$]. Synaesthetes and controls also showed significant positive correlations between UnEx scores and CogDis scores (synaesthetes: $r = .490$, $p = <.01$; controls: $r = .486$, $p = <.01$). Synaesthetes, but not controls, showed a significant positive correlation between UnEx scores and ImpNon scores ($r = .367$, $p = <.05$).

These findings show that synaesthesia for colour is linked to an increase in positive and disorganized schizotypy, implying that the presence of synaesthesia is associated with widespread differences in cognition that extend beyond the synaesthetic experience itself. There are at least two potential mechanisms that may contribute to this effect: (i) the effect is modulated by co morbidity between synaesthesia and other cognitive traits that are related to schizotypy; (ii) there maybe similarities in the underlying mechanisms that give rise to the perceptual reports associated with schizotypy and synaesthesia. In relation to cognitive traits, previous findings have linked heightened positive schizotypy to creativity (Nelson and Rawlings, 2010) and mental imagery vividness (Oertel et al., 2009). Synaesthesia has also been linked to higher levels of these cognitive manifestations (e.g., Barnett and Newell, 2008; Ward et al., 2008). Therefore, in conjunction with mental imagery and creativity, increased positive and disorganised schizotypy may reflect a constellation of trait markers that are linked to synaesthesia. In this context, it is interesting to note that one mechanism that has been suggested to explain the relationship between increased schizotypy and both creativity and mental imagery is a difference in levels of inhibition/excitation (e.g., Grossberg, 2000; Nelson and Rawlings, 2010). A similar hypothesis has been suggested as a mechanism contributing towards synaesthesia (Grossenbacher and Lovelace, 2001; Brang and Ramachandran, 2008). While, as yet, there is a lack of direct evidence examining differences in cortical inhibition in synaesthesia, this offers one plausible mechanism of neural development that may associate synaesthesia, schizotypy, creativity and mental imagery. Delineating the relative contributions that extended cognitive manifestations and alterations in neural development have on the relationship between synaesthesia and schizotypy will provide important insights into the mechanisms that mediate the developmental of typical and atypical perceptual experiences.

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