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Letter to the editor

High schizotypy traits associated with atypical processing of negative emotions with low spatial frequencies

Dear Editor

Deficiencies in processing facial emotion have proven to be a robust finding in patients with schizophrenia (Bortolon et al., 2015). Skillful perception and interpretation of facial emotions first requires rapid and intact visual processing before higher-order cognitive-social processing can proceed. Indeed, there is evidence for visual processing anomalies in schizophrenia in the magnocellular system and/or dorsal stream (e.g., Kim et al., 2006). Furthermore, emotion processing dysfunction correlates with magnocellular but not parvocellular processing in schizophrenia (Butler et al., 2009).

Whether there are differences in the integrity of these visual systems that subserve emotional processing in individuals within the schizophrenia spectrum is still debated, though such research may provide valuable insights into the emotion dysregulation experienced in schizophrenia. Some have explored this relationship by filtering photographs of faces to retain only the low or high spatial frequencies (LSF, HSF) that are preferentially (though not exclusively) associated with magnocellular and parvocellular processing, respectively (Lee et al., 2016) (see Supplementary Fig. 1 for example faces). Indeed Lee et al. found that cortical volume in dorsolateral prefrontal cortex in schizophrenia patients correlated with an early occipital electrophysiological response to LSF fearful faces, but not to HSF faces.

A further approach to avoid potential confounds such as medication, and severity and heterogeneity of symptoms of schizophrenia is to investigate the broader schizophrenia spectrum, which assumes that neurotypical individuals with higher schizotypy personality traits are part of a spectrum with clinically diagnosed schizophrenia at the top end of the spectrum (Ettinger et al., 2014). To date whilst there is some evidence for emotion recognition anomalies in healthy adults with higher schizotypy traits, only a few reports have examined visual processing in such populations with some evidence for differences in magnocellular processing (Ettinger et al., 2014). To our knowledge there are no studies exploring the influence of spatial frequency channels in emotion processing in subclinical schizotypy populations.

Hence 61 neurotypical adults were split into high and low schizotypy personality (SzP) groups ($n = 20$ per group) following a tertile split from scores on an online version of the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991). Groups were well matched for age, nonverbal intelligence, as well as cognitive performance as assessed by forwards and backwards visual digit spans (see Supplementary Table 1).

Participants completed an emotion recognition task that presented 15 male and 15 female models from the Karolinska Directed Emotional Faces set with each model displaying three different emotions (disgust, neutral, happy) presented on an iMac computer (80 Hz; 1920 × 1080 resolution). Using Adobe Photoshop each photo was processed with a high pass filter (using a Gaussian blur with a radius of 7 pixels, which leaves behind low spatial frequency (LSF) information), and a low pass filter (set to 2 pixels, leaving behind high spatial frequency (HSF) information). The contrast of each image was manually adjusted to be comparable between LSF and HSF conditions, though these conditions were not directly compared and hence precisely matched luminance was not required (e.g., see Supplementary Fig. 1). After a fixation cross (random duration 500–750 ms), each of the 180 images (10° × 13.5°) were presented once for 200 ms, followed by a whitenoise mask which remained on screen until a response was made. Participants used a keyboard response to indicate which of the three emotions were presented, as quickly and accurately as possible.

Given that reaction time and accuracy were positively correlated, the impact of accuracy and reaction time together was explored by use of an inverse efficiency score (reaction time divided by the proportion correct). A 3-way mixed design ANOVA demonstrated a significant 3-way interaction between spatial frequency, emotion and group, $F(2, 37) = 3.82$, $p = .031$, $\eta^2 = 0.171$, driven by a significant group difference for LSF disgust faces ($p = .015$) (see Fig. 1 suggesting relatively superior performance in the high SzP group). Analysis of accuracy data showed the same pattern of results. Correlation analysis on the full sample established a significant correlation between the suspiciousness subscale and inverse efficiency scores for LSF disgust faces ($r = -0.34$, $p = .007$), such that *higher* suspiciousness traits predicted superior performance for the low spatial frequency disgust faces.

The results, rather than suggesting generalised emotion recognition differences in those with higher schizotypy traits, indicate that performance depended on both the emotion and the spatial frequency targeted by the stimuli. Specifically, although all participants found the LSF disgust faces harder to detect, this effect was significantly attenuated in the high SzP group.

Apparently in conflict with these results, schizotypy traits have previously been associated with impairments in emotion recognition (Ettinger et al., 2014). However, there is some evidence for an advantage, or bias, in negative expressions in the schizophrenia spectrum (Brown and Cohen, 2010). A negative valence, or threat-related attentional bias thus could potentially result in overall impaired emotion recognition, despite higher performance on negative affect faces. In fact, enhanced recognition of disgust facial emotions has been suggested in a range of clinical populations, such as in bipolar disorder (Harmer et al., 2002) though, faces were not spatial frequency filtered in such studies. Consistent with the current findings, patients with schizophrenia demonstrate a bias towards processing LSF faces when presented in hybrid combination with HSF faces (Laprevote et al., 2010).

Evidence for a fast, direct LSF signal to amygdala through the predominantly magnocellular-driven pulvinar-superior colliculus pathway, primarily driving threat-related signals (Mendez-Bertolo et al., 2016) suggests such a mechanism also warrants further consideration in the schizophrenia spectrum in light of the current results. Based on

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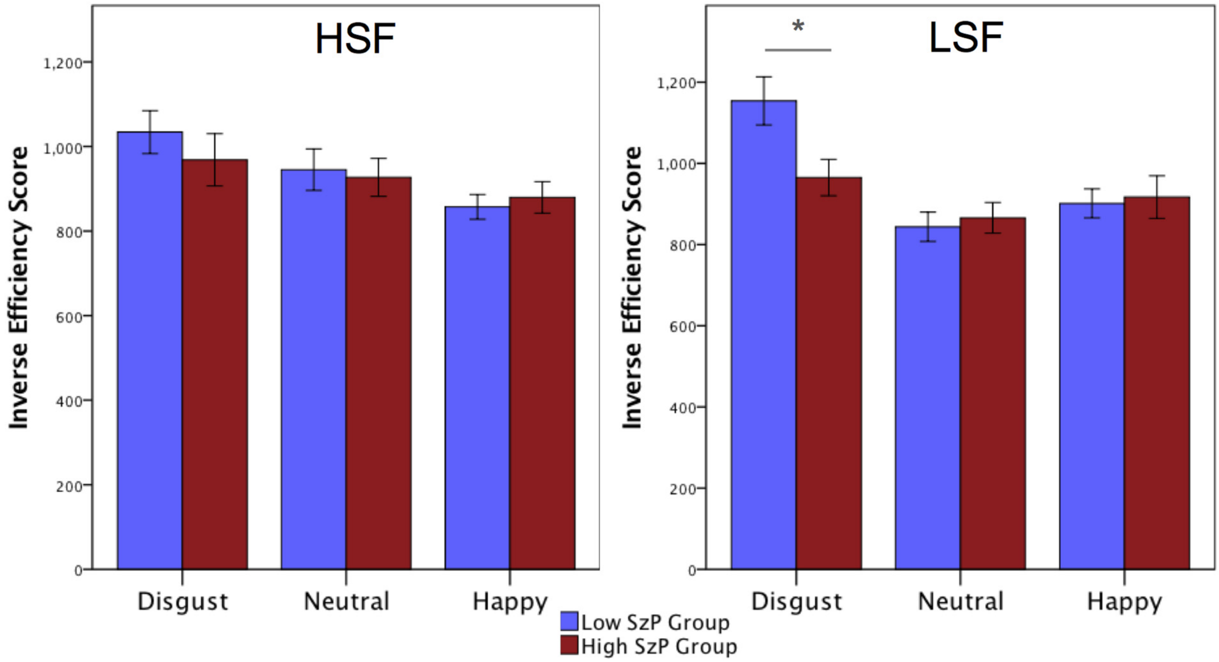

Fig. 1. Inverse efficiency scores (calculated as reaction time/proportion correct) for emotion recognition performance in both high (HSF) and low (LSF) spatial frequency conditions. Higher scores indicate worse performance. Error bars indicate ± SEM. * indicates $p = .015$.

the current data, it is unclear whether these results would generalise to LSF non-face objects, though the emotion specificity reported here suggests valence may be important. In conclusion, these findings demonstrate perceptual differences in sub-clinical schizotypy and hence the utility of investigating the broader schizophrenia spectrum to understand the interaction of perceptual and emotion difficulties in schizophrenia and the potentially important role of the faster conducting magnocellular pathway.

Conflict of interest

All other authors declare that they have no conflicts of interest.

Contributors

Robin Laycock conceived and designed the study, conducted the data analysis and interpretation of results, and article preparation. Elizabeth Cutajar assisted with the study design, data collection and analysis, and contributed to the interpretation of results and article preparation. Sheila Crewther conceived and designed the study, and contributed with the interpretation of results, and article preparation.

CRediT authorship contribution statement

Robin Laycock: Conceptualization, Formal analysis, Writing - original draft. **Elizabeth Cutajar:** Conceptualization, Data curation, Formal analysis, Writing - review & editing. **Sheila G. Crewther:** Conceptualization, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2018.12.035.

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