

Visual processing in autism and sequence-color synesthesia – a twin study

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Abstract

Objective

Sensory hyper-sensitivity and enhanced attention to detail characterize both autism and synesthesia, which led to the hypothesis that the conditions are linked via similarly altered sensory processing. However, few studies investigated sensory processing simultaneously in both conditions, which is what we did in this study, using a battery of well-established tasks assessing sensory hyper-sensitivity and attention to detail. Applying co-twin design, we assessed these relationships also within pairs, allowing drawing conclusions regarding their dependency on genetic and shared environmental factors.

We expected to find similar sensory processing patterns (higher visual stress sensitivity, reduced illusion susceptibility and elevated motion coherence thresholds) compared to controls in the two conditions, and that these effects would be attenuated within twin pairs (when familial factors are implicitly controlled for).

Methods

Participants were tested for both grapheme-color synesthesia (GCS) and Other Sequence-color synesthesia (OSCS, for weekdays and/or months). The preliminary sample consisted of 53 adult twin pairs (N=106, 65% monozygotic, 13 with autism, 18 GCS, 25 OSCS; 75% female, mean age = 24 years). Autistic traits were assessed with Autism Spectrum Quotient, and divided into Attention to details and AQ-other sub-scales.

The battery included the Pattern Glare test (PGT)², a commonly used tool to assess visual stress sensitivity (n=106), two commonly researched visual illusions (Ebbinghaus and Mueller-Lyer illusions, n=98) and the random-dot kinematogram to assess coherent motion perception (n=101).

Visual stress sensitivity, illusion proneness and motion coherence threshold were used as outcome measures in a linear regression with autism diagnosis / autistic traits, and GCS / OSCS as predictors. Biological sex and test age were added as covariates in a second step. Conditional linear regression analysis assessed the within-pair associations between outcome variables and predictors.

Results:

Across the cohort, autism diagnosis ($p<.01$), GCS ($p<.01$) and Attention to detail ($p<.01$) predicted more visual experiences in the PGT, while AQ-Other predicted fewer visual experiences ($p<.05$). Visual discomfort was only negatively associated with Attention to detail ($p<.01$). Within twin pairs, the positive association between the number of visual experiences and Attention to detail (but not GCS) remained significant ($p<.05$), beyond familial confounding.

GCS (but not OSCS or autistic traits) predicted reduced susceptibility to both illusions across the cohort ($p<.05$) and this association strengthened for the Müller-Lyer illusion but disappeared for the Ebbinghaus illusion within pairs.

Higher AQ Attention to detail (but not synaesthesia) predicted higher motion coherence thresholds across the sample ($p<.05$), but not within pairs.

Discussion

Our findings suggest that both Attention to detail and GCS contribute individually to a higher visual stress, where the association with GCS appears to be driven by familial factors such as genetics. Reduced illusion susceptibility was only found for GCS, with illusion-specific familial influence. Finally, we found no evidence for reduced motion coherence in synesthesia and only a weak association with Attention to detail which could be explained by family factors.

Overall, despite similarities in their association with visual stress sensitivity, synesthesia and autism / autistic traits show different relationships with visual processing, suggesting at least partially separate mechanisms.