

Pareidolia in Schizophrenia and Bipolar Disorder

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Abstract

While there are many studies on pareidolia in healthy individuals and patients with schizophrenia, to our knowledge, there are no prior studies on pareidolia in patients with bipolar disorder. Accordingly, in this study, we, for the first time, measured pareidolia in patients with bipolar disorder (N = 50), and compared that to patients with schizophrenia (N = 50) and healthy controls (N = 50). We have used (a) the scene test, which consists of 10 blurred images of natural scenes that was previously found to produce illusory face responses and (b) the noise test which had 32 black and white images consisting of visual noise and 8 images depicting human faces; participants indicated whether a face was present on these images and to point to the location where they saw the face. Illusory responses were defined as answers when observers falsely identified objects that were not on the images in the scene task (maximum illusory score: 10), and the number of noise images in which they reported the presence of a face (maximum illusory score: 32). Further, we also calculated the total pareidolia score for each task (the sum number of images with illusory responses in the scene and noise tests). The responses were scored by two independent raters with an excellent congruence ($\kappa > 0.9$). Our results show that schizophrenia patients scored higher on pareidolia measures than both healthy controls and patients with bipolar disorder. Our findings are agreement with prior findings on more impaired cognitive processes in schizophrenia than in bipolar patients.

Introduction

Schizophrenia (SCZ) is a psychiatric disorder characterized by positive and negative symptoms (APA, 2013). Positive symptoms involve delusions and hallucinations, while negative symptoms include avolition and diminished emotional expression. Bipolar disorder (BPD) is a mood disorder characterized by alternating states of depression and mania or hypomania (APA, 2013). As we discuss below, both disorders show similar kinds of perceptual, cognitive, and neural patterns.

Perception, Visual Illusion, and Pareidolia

Our perception of the world is not solely determined by the input to our senses, but is strongly influenced by our prior experience with the world. A visual percept is inferred from often fragmentary and incomplete visual signals from the eyes through a process of unconscious inference (Gregory, 2006). For example, a face emerging from the shadows, which is barely visible, can be recognised despite only a small patch of light being received by the retina. The rest of the face is inferred based on prior knowledge, expectations, and our beliefs about faces. Illusory face detection is common in the human population (e.g., detection rates as high as 41%) (Rieth, Lee, Lui, Tian, & Huber, 2011); however, research suggests substantial individual variation (Gosselin & Schyns, 2003).

Several studies suggest that illusion can result from deficits in top-down processing, that is, existing cognitive and perceptual biases (Aleman, Bocker, Hijman, de Haan, & Kahn, 2003; de Boer et al., 2019; Hall et al., 2019; Hall et al., 2016; Hugdahl, 2009) or an imbalance between top-down internal factors (e.g.,

perceptual expectations, prior knowledge, and mental imagery) and bottom-up external sensory input (Aleman et al., 2003; O'Callaghan et al., 2017). Moreover, sensory isolation can induce the same effect as a perceptual bias towards prior expectations that leads to visual illusion (Corlett, Frith, & Fletcher, 2009; Daniel, Lovatt, & Mason, 2014).

Auditory illusion is quite common in schizophrenia and has been reported using several experimental paradigms (Catalan et al., 2014; Galdos et al., 2011; Vercammen, de Haan, & Aleman, 2008). Thus, a better understanding of the underlying cause will help treat such symptoms and prevent such outcomes. Typically, illusion in schizophrenia patients include people, faces, animals, objects with frightening content (Waters et al., 2014; Zeljic et al., 2021; Zopf, Boulton, Langdon, & Rich, 2021). Like schizophrenia, patients with bipolar disorder also show visual illusion (Baethge et al., 2005; Tam, Sewell, & Deng, 1998). However, compared to schizophrenia, there are fewer studies on visual hallucinations and illusions in bipolar disorder (Baethge et al., 2005; Chakrabarty & Reddy, 2011).

Pareidolia is the perception of faces in ambiguous visual stimuli, such as clouds, rock formations, or flocks of birds, and is thus a type of visual illusion (Smailes, Burdis, Gregoriou, Fenton, & Dudley, 2020). Pareidolia occurs when an indistinct and often randomly formed stimulus is interpreted as being definite and meaningful. This is something that many individuals have experienced, whether exercising their imagination as a cloud-gazing child, or seeing images in a textured ceiling during the last few waking moments of the day.

Several studies show that healthy “normal” people report pareidolic experiences. Uchiyama et al. (2012) found that pareidolia is related to impaired visual and perceptual processes. There have been several studies investigated personality traits and individual differences in relation to pareidolia (Zhou L. F. & M., 2020). It was reported that pareidolia is high in religious individuals (Rieki, Lindeman, Aleneff, Halme, & Nuortimo, 2013) and individuals high in schizotypy (Partos, Cropper, & Rawlings, 2016). Other studies found that mood states and feeling lonely may increase the occurrence of pareidolia (Epley, Akalis, Waytz, & Cacioppo, 2008). Pareidolic experiences are commonly reported during the use of hallucinogens such as Lysergic Acid Diethylamide (LSD) in healthy individuals (for discussion see, Iaria et al., 2010). One recent ERP study has investigated the occurrence of pareidolia in healthy individuals, showing that some EEG components can differentiate faces from face pareidolia (Akdeniz, 2020). In this study, N170 was larger for faces than face pareidolia, but VPP was larger for face pareidolia than for faces. Using fMRI, Wardle, Seymour, and Taubert (2017) found that face pareidolia is associated with the activation of fusiform area.

In addition, there have been few studies investigating pareidolia in patient populations including autism (Guillon et al., 2016), patients with migraine (Akdeniz, Gumusyayla, Vural, Bektas, & Deniz, 2020), schizophrenia (Mavrogiorgou, Peitzmeier, Enzi, Flasbeck, & Juckel, 2021), Lewy Bodies Dementia (Uchiyama et al., 2012), and Parkinson's disease (Ffytche & Aarsland, 2017). To our knowledge, there are only two study investigating pareidolia in schizophrenia (Mavrogiorgou et al., 2021; Rolf, Sokolov, Rattay, Fallgatter, & Pavlova, 2020), and no study has investigated pareidolia in bipolar disorder.

The current Study

The current study has, for the first time, investigated and compared pareidolia measures in both schizophrenia and bipolar disorder patients. Accordingly, we have used novel tasks to measure illusory face perception in these patient populations. In addition, we have also used several other clinical measures including the Structured Interview for Assessing Perceptual Anomalies (SIAPA) to measure both auditory and visual misperceptions.

Methods

Below, we describe the characteristics of our participants, pareidolia tests, and statistical analyses. The study was approved by the Hungarian Scientific and Research Committee of the Medical Research Council ethics board (Budapest, Hungary).

Participants

We enrolled 50 patients with schizophrenia, 50 patients with type I bipolar disorder with a history of psychotic symptoms, and 50 control volunteers without any history of psychiatric disorders. Participants were matched for age, sex, education, Intelligence Quotient (IQ), and general psychosocial functions (Table 1). The study was coordinated in the Nyírő Gyula National Institute of Psychiatry and Addictions and was approved by the Hungarian Scientific and Research Committee of the Medical Research Council ethics board (Budapest, Hungary). All participants gave written informed consents. The inclusion criteria are as follows: Diagnostic and Statistical Manual of Mental Disorders (DSM-5) diagnosis of bipolar disorder or schizophrenia, ability and willingness to participate, age between 18-65 years, and lack of acute psychosis. All of our participants were outpatients. All patients lived in the community and were in clinical remission according to the Andreasen-criteria for schizophrenia (Andreasen et al., 2005) and to the Systematic Treatment Enhancement Program for Bipolar Disorder criteria for bipolar disorder (Perlis et al., 2006).

The exclusion criteria were as follows: neurological disorders and other general medical conditions affecting the central nervous system, evidence of head injury, electroconvulsive therapy, and psychoactive substance misuse confirmed by clinical history or by a urine test. In total, we have excluded only 5 patients with comorbid substance and alcohol misuse. Forty-seven patients with schizophrenia and 40 patients with bipolar disorder received either second-generation antipsychotic medications (amisulpride, olanzapine, quetiapine, and risperidone) or third-generation medication (e.g., aripiprazole) at the time of testing. In total, 32 schizophrenia patients, 34 bipolar disorder patients, and 30 controls regularly smoked tobacco. The chlorpromazine-equivalent doses, calculated by a standard method (Leucht et al., 2015), are shown in Table 1. Twelve patients with schizophrenia and 45 patients with bipolar disorder also received mood stabilizers (lithium, valproate, or lamotrigine).

Pareidolia Tests and Clinical Measures

The pareidolia tests were based on the exact adoption of a previously published protocol (Kaji, Kitamura, & Kitagawa, 2015; Mamiya et al., 2016; Uchiyama et al., 2012; Yokoi et al., 2014). The *scene test* consisted of 10 blurred images of natural scenes that frequently produced illusory face responses in a previous study (Mamiya et al., 2016; Uchiyama et al., 2012). The task goal was to point to and describe the objects on each image in as much detail as possible. The *noise pareidolia test* included 32 black and white images consisting of visual noise (spatial frequency: $1/f^3$) and 8 images depicting human faces. Participants were asked to respond whether a face was present on these images and to point to the location where they saw the face. The maximum exposure time was 60 sec in the scene task and 30 sec in the face task. Participants did not receive feedback on the appropriateness of their responses, and they were not informed that in the face task only noise was presented. Illusory responses were defined as answers when observers falsely identified objects that were not on the images in the scene task (maximum illusory score: 10), and the number of noise images in which they reported the presence of a face (maximum illusory score: 32). We also calculated the total pareidolia score for each task (the sum number of images with illusory responses in the scene and noise tests). The responses were scored by two independent raters with an excellent congruence ($\kappa > 0.9$).

We used the following instruments for clinical evaluation: Structured Clinical Interview for DSM-5 Disorders—Clinician Version (SCID-5-CV) (First, Williams, Karg, & Spitzer, 2016), Positive and Negative Syndrome Scale (PANSS) (Kay, Fiszbein, & Opler, 1987), Hamilton Rating Scale for Depression (HAM-D) (Hamilton, 1960), Young Mania Rating Scale (YMRS) (Young, Biggs, Ziegler, & Meyer, 1978), and the World Health Organization Disability Assessment Schedule (WHODAS 2.0) of the DSM-5 (APA, 2013).

General intellectual and cognitive functions were measured with the Wechsler Adult Intelligence Scale - IV (WAIS-IV) (Wechsler, 2008). The DSM-5 structured clinical interview and the rating scales were administered by trained and supervised clinical psychologists or psychiatrists. Below, we provide a brief description of WHODAS 2.0, HAM-D, and PANSS scales

WHODAS 2.0.

This instrument enables assessment of health and disability in 6 domains (cognition, mobility, self-care, interacting with other people, life activities, participation in communities). The administration time is short (5 to 20 minutes), and WHODAS 2.0. is valid in clinical and general populations across cultures. The concept of WHODAS 2.0. is based on ICF (International Classification of Functioning, Disability and Health) principles.

HAM-D

We used the structured version of the 17-item HAM-D to assess the severity of depressive symptoms (e.g., depressed mood, feelings of guilt, suicide, and insomnia). Each item was rated on a 3-point (items 4-6,

12-14, 17) or 5-point Likert-scale (0 – absent or no difficulty). A score in the range of 0–7 is normal. Patients scoring 20 or higher regularly require clinical attention.

PANSS

The patient is scored from 1 to 7 on 30 items classified according to positive, negative, and general symptoms. The positive symptom scale contains 7 items (minimum score = 7, maximum score = 49), such as delusions, conceptual disorganization, hallucinations, excitement, and grandiosity. The negative scale also consists of 7 items (e.g., blunted affect, emotional withdrawal, and poor rapport). Finally, the general psychopathology scale consists of 16 items (minimum score = 16, maximum score = 112) (e.g., somatic concerns, anxiety, guilt, and tension).

YMRS

The scale includes 11 items. Four items are graded on a 0 to 8 scale (irritability, speech, thought content, and disruptive or aggressive behavior), whereas seven items are graded on a 0 to 4 scale (e.g. elevated mood, increased motor activity, and sexual interest). A score of 20 or higher indicate severe mania.

Interview for the assessment of anomalous visual and auditory experiences.

We used the Structured Interview for Assessing Perceptual Anomalies (SIAPA) (Bunney et al., 1999; Kiss, Fabian, Benedek, & Keri, 2010). The SIAPA focuses on three aspects of anomalous perceptual experiences: sensory intensity (hypersensitivity), inundation or flooding, and selective attention to external stimuli on a scale of 0 (absent) – 4 (pervasive). The interview begins with open-ended and then structured questions regarding subjective experiences in each sensory modality. For example, to assess hypersensitivity in the auditory modality, the following questions are presented: "Have you ever had the feeling or sensation that sounds were particularly loud? Or louder than usual? Or that your sense of hearing was particularly keen or sensitive? Or that your ears were picking up the slightest detail of sounds?" To evaluate inundation and flooding, participants are asked: "Have you ever had the experience or felt like you were being flooded or inundated by sounds? Or that you couldn't block out sounds? Or that it seemed as if your ears were picking up everything going on around you?" Finally, questions for selective attention are as follows: "Have you ever had the experience or felt like you couldn't pay attention to one sound, or a conversation, because of interference from other sounds, like background noise? Do you find that your attention is captured by irrelevant sounds, like traffic noises, even though they are of no interest to you?" (Bunney et al., 1999). Similarly, in the visual modality, participants are asked whether lights seemed much brighter, colors were unusually vivid, the environment was bothersome, and whether they were overwhelmed by multiple objects in the scene and could not attend to one of many simultaneous visual inputs. We observed a good congruence between two independent raters ($\kappa > 0.7$), and the internal consistency was good (Cronbach alpha > 0.8). The SIAPA scores correlated with objective psychophysical measures of sensory perception (Kiss et al., 2010).

Statistical Analysis

The STATISTICA 13.1 (Tibco, Palo Alto) software package was used for data analysis. First, we tested data distribution and homogeneity of variance with Lilliefors and Levene's tests, respectively. Measures with normal distributions were entered into analyses of variance (ANOVAs) and two-tailed Student's t tests. Dichotomous variables were analysed with chi-square tests. The SIAPA and the pareidolia scores were not normally distributed ($p < 0.01$), and therefore we used Kruskal-Wallis analyses of variance (ANOVA) followed by multiple comparisons for mean ranks tests. Spearman's rank correlation coefficients were calculated between the pareidolia scores and the clinical measures. We used a receiver operating characteristic (ROC) analysis to test the sensitivity and specificity of the pareidolia test to differentiate schizophrenia from bipolar disorder or controls. The schizophrenia-control and schizophrenia- bipolar disorder differentiation was also investigated with discriminant function analyses. The level of statistical significance was set at $\alpha < 0.05$, corrected for multiple comparisons with the Bonferroni method.

Results

The Pareidolia Test

Kruskal-Wallis ANOVAs conducted on the number of illusory responses indicated a significant difference among patients with schizophrenia, bipolar disorder, and controls in the scene test ($H(2) = 31.59, p < 0.001$), in the noise test ($H(2) = 29.68, p < 0.001$), and in the total pareidolia score ($H(2) = 33.30, p < 0.001$). Post-hoc tests indicated that patients with schizophrenia scored higher than controls and patients with bipolar disorder on all measures of pareidolia (p 's < 0.01) (Figure 1). In contrast, we observed no significant between-group differences in the number of correctly identified faces in the noise task ($p = 0.52$; median: 8 in each group with a lower-upper quartile of 7-8).

outsourcing controls and patients with bipolar disorder.

Pareidolia measures differentiated schizophrenia from controls with a sensitivity of 74% (scene test) and a specificity of 94% (total pareidolia score). In the schizophrenia- bipolar disorder differentiation, the highest sensitivity was 62% (total pareidolia score) and the highest specificity was 92% (noise test). The results from the ROC analysis are summarized in Table 2 and Figure 2.

Discriminant function analysis also indicated a significant difference between schizophrenia and controls in all tests (Table 3). Altogether, 76% of the cases were correctly classified by using the total pareidolia scores. In the schizophrenia- bipolar disorder discrimination, the most successful classification was also observed in the case of the total pareidolia scores (73% of correctly classified cases). In contrast, we observed no significant effects in the schizophrenia- bipolar disorder discrimination with a maximum of 57% of correctly classified cases (Table 3).

Anomalous perceptual experiences (SIAPA) and pareidolia

Kruskal-Wallis ANOVAs indicated a significant difference among patients with schizophrenia, bipolar disorder, and controls in the SIAPA visual modality ($H(2) = 25.75, p < 0.001$) and in the SIAPA auditory modality ($H(2) = 22.25, p < 0.001$). As shown in Figure 3, patients with schizophrenia scored higher relative to the bipolar disorder and the control group in both visual and auditory modalities (p 's < 0.01).

Table 4 depicts correlations between the pareidolia scores and clinical measures (including SIAPA, PANSS, and YMRS). In schizophrenia, there were significant positive relationships between the scene, noise, and total pareidolia scores and the SIAPA visual scores, which survived Bonferroni correction (r s $> 0.6, p$'s < 0.001) (Figure 4). There were no significant correlations when the auditory SIAPA scores were included in the analysis, and the remaining correlations including PANSS and YMRS values did not reach the level of statistical significance (Table 4).

Discussion

In the current study, we have measured pareidolia in patients with schizophrenia, patients with bipolar disorder, and healthy controls. To our knowledge, this is the first study to concurrently compare pareidolia measures in these populations. Our results show that schizophrenia patients show more illusory perception than patients with bipolar disorder and healthy controls. Similarly, our results also show that patients with schizophrenia scored higher than patients with bipolar disorder and healthy controls in both visual and auditory modalities of the Structured Interview for Assessing Perceptual Anomalies (SIAPA). Furthermore, we found a positive correlation between scene, noise, and pareidolia tests and visual scores of the SIAPA measures, but not with PANSS and YMRS. In addition, our study has also some novel findings that are not reported in prior studies. For example, we found that pareidolia measures successfully differentiated schizophrenia from health controls and also differentiated schizophrenia from bipolar disorder. However, pareidolia measures were not strong predictors of classifying healthy controls from bipolar disorder. In addition, patients with BPD and SCZ scored similarly and mildly on depression scales because they were in clinically stable conditions. The depression scores were low in both groups (mild-subthreshold level according to the NIHCE 2019 criteria) indicating no clinically significant major depressive episode in bipolar and schizophrenia patient. It is a major strength of the study because co-morbid depression is a serious confounding factor that may interfere with test results.

Our findings are in agreement with prior studies. A recent study has also reported face pareidolia in patients with schizophrenia using the Giuseppe Arcimboldo food-plate stimuli, which are stimuli made out of food but the whole stimulus is usually perceived as a face (Rolf et al., 2020). However, our results are different from those of Mavrogiorgou et al. (2021). Mavrogiorgou et al. (2021) found that schizophrenia patients show less pareidolia symptoms than healthy individuals. The discrepancy in findings between these studies can be related to demographical variables of healthy controls and schizophrenia patients. For example, it may be predicted that a high score in positive symptoms may be correlated with pareidolia measures.

There is also some evolutionary explanation of pareidolia. The ability to make sense of a stimulus based on noisy or ambiguous sensory data is suggested to be an adaptive function of the brain. The tendency to infer agency from sensory noise is thought to have evolved to serve an important function in predatory threat detection (Barrett & Lanman, 2008), but in daily life, can yield perceptual errors, such as mistaking an object as a face. However, another interpretation is that pareidolia is related to our increased cognitive fluidity and prosocial behaviour (Leopold & Rhodes, 2010). To test the plausibility of both views, future work should use and correlate surveys that measure predatory threat detection and prosocial behaviour, along with measures of pareidolia.

There are debates in the field on whether schizophrenia and bipolar disorder fall on the same continuum or are vastly different disorders (Ancin, Cabranes, Santos, Sanchez-Morla, & Barabash, 2013; Keshavan et al., 2011). Existing data on this topic is conflicting. Some studies found that schizophrenia patients are more impaired than bipolar disorder patients on several cognitive measures (Barch et al., 2017; Lynham et al., 2018), which is in agreement with our results. However, other studies argue that such disorders fall on a continuum, and are not thus markedly different (Crespi & Badcock, 2008). In line with this view, some studies found that patients with schizophrenia and bipolar disorder patients with psychosis symptoms are similarly impaired on several cognitive measures, in comparison to healthy controls (Baker et al., 2014; Lindenmayer, Bossie, Kujawa, Zhu, & Canuso, 2008; Saccuzzo & Braff, 1986; Serper, 1993; Thakkar, Schall, Logan, & Park, 2015).

Limitations and future studies

Our study suffers from some limitations. For example, unlike prior studies, we did not include patients with bipolar disorder I and II (Angst, Ajdacic-Gross, & Rossler, 2020; Green et al., 2020). Future work on pareidolia should include bipolar disorder patients with mania and hypomania. It is predicted that patients with bipolar disorder II may show reduced pareidolia than patients with bipolar disorder I. However, subgroups of schizophrenia with varying degrees of negative symptoms (i.e., deficit vs. non-deficit schizophrenia, Lopez-Diaz, Menendez-Sampil, Perez-Romero, Palermo-Zeballos, & Valdes-Florido, 2020; Tan, Chew, & Sim, 2020) may not show any differences in measures of pareidolia. Further, future studies should also investigate pareidolia in individuals with schizotypal personality disorder as well as other patient groups with schizophrenia-related disorders, such as schizoaffective disorder. It is predicted that like schizophrenia, these patient groups may also show pareidolia. Other limitation of the study is we do not have enough information from participants regarding their racial/ethnic identification, and culture/geographic background, a measure of income, and socioeconomic status. In addition, another limitation is a larger number of bipolar disorders are on mood stabilizers than patients with schizophrenia. However, this is the case in almost all studies on schizophrenia and bipolar disorder, and it is often possible to match patient groups on their medication use.

Future studies should measure neural activations underlying the occurrence of pareidolia in patients with schizophrenia and bipolar disorder. Based on prior findings (; Akdeniz, Toker, & Atli, 2018), we predict that schizophrenia patients may show more fusiform area activation than patients with bipolar disorder

during the performance of the scene test used in the task. Future work should investigate whether pareidolia is more common in psychotic bipolar disorder patients than in nonpsychotic bipolar disorder patients. In addition, one study found that negative mood increases pareidolia in patients with Lewy body dementia (Abohamza, Weickert, Ali, & Moustafa, 2020). Future work should also investigate whether negative mood increase pareidolia in patients with schizophrenia and bipolar disorder. Future research should also investigate the impact of antipsychotics as well as other medications for the treatments of schizophrenia and bipolar disorder, such as lithium, on the occurrence of pareidolia.

Abbreviations

Not applicable

Declarations

- **Ethics approval and consent to participate.**

The study was coordinated in the Nyírő Gyula National Institute of Psychiatry and Addictions and was approved by the Hungarian Scientific and Research Committee of the Medical Research Council ethics board (Budapest, Hungary) The approval number is 18814-2017/EKU. All participants gave written informed consents.

- **Consent for publication**

All authors confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

- **Availability of data and material**

The dataset supporting the conclusions of this article is available upon request with the co-author (S.K.).

- **Competing interests**

The authors have no conflicts of interest to declare.

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There is no funding for this project.

- **Authors' contributions**

All the authors acknowledged that they contributed equally to the current paper. E.A developed the study concept. S.K. contributed to the study design. Testing and data collection were performed by S.K. and K.C. performed the data analysis and interpretation under the supervision of A.M. drafted the paper, and

E. A. and D. B. provided critical revisions. All authors approved the final version of the paper for submission.

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Tables

Due to technical limitations, table 1-4 is only available as a download in the Supplemental Files section.

Figures

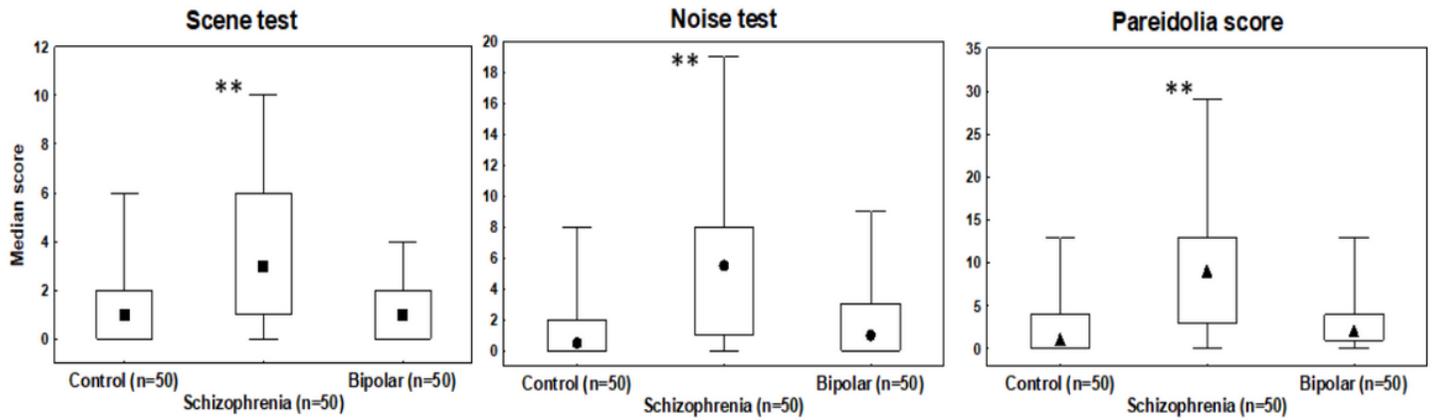


Figure 1

Median scores in the scene and noise test, and in the total pareidolia measures. Error bars indicate range; boxes indicate 25%-75% percentiles. ** $p < 0.001$, schizophrenia patients outscoring controls and patients with bipolar disorder.

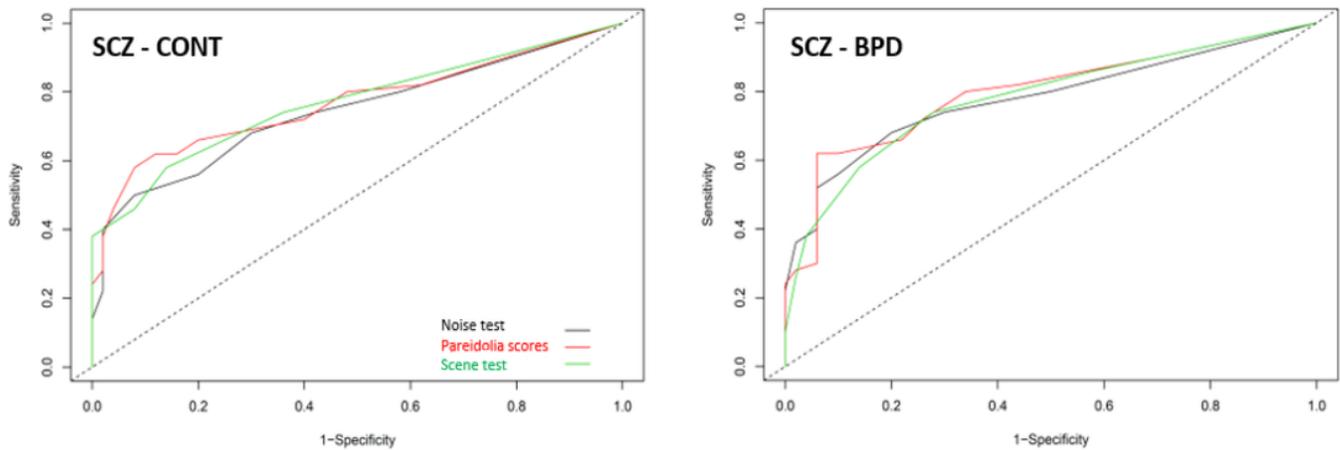


Figure 2

Receiver operating characteristic analysis for the pareidolia test to differentiate schizophrenia (SCZ) from controls (CONT) and schizophrenia from bipolar disorder (BPD).

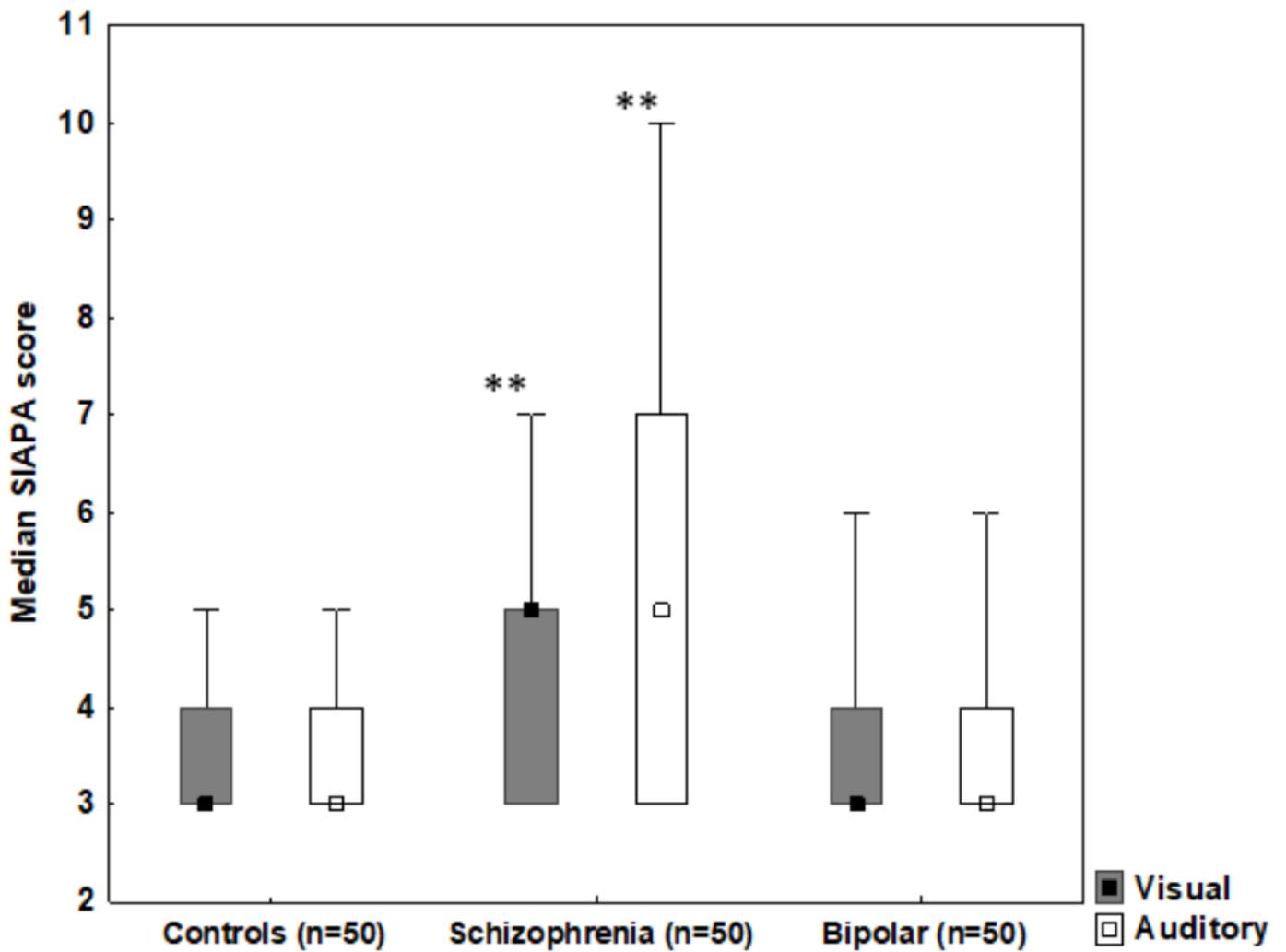


Figure 3

Median SIAPA (Structured Interview for Assessing Perceptual Anomalies) scores from the visual and auditory modalities. Error bars indicate range, boxes indicate 25%-75% percentiles. ** $p < 0.001$, schizophrenia patients outscoring controls and patients with bipolar disorder in both visual and auditory modalities.

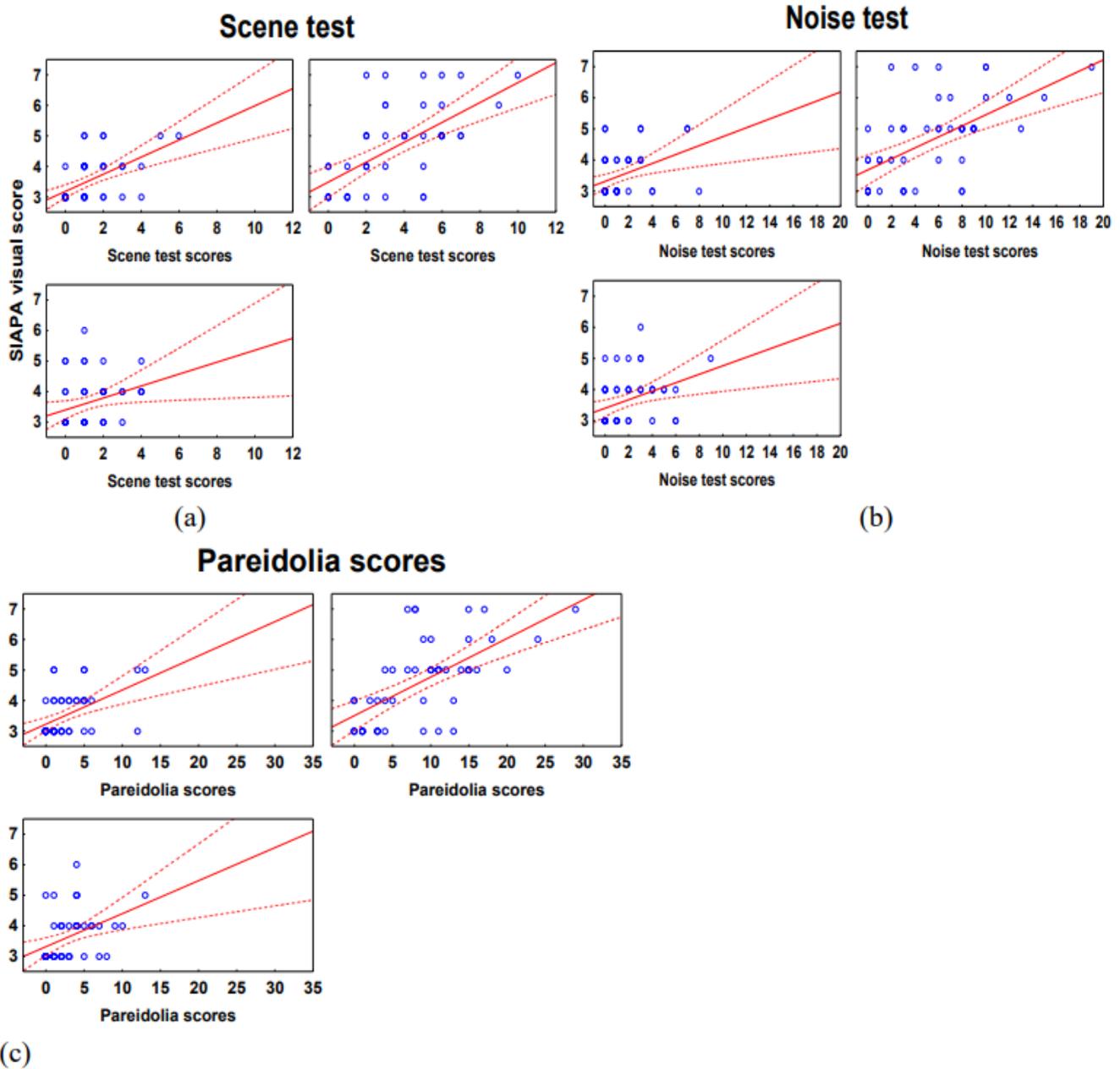


Figure 4

Correlations between SIAPA (Structured Interview for Assessing Perceptual Anomalies) visual scores and (a) Scene, (b) test, and (c) pareidolia test results. The correlation coefficients are shown in Table 4

Supplementary Files

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