A Shift in Reality: Schizophrenia and Visual processing

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Abstract

Schizophrenia is a severe mental illness in which false beliefs and reality are confused by an individual. The illness can affect more than a person's social difficulty; the disorder can cause an individual several hardships. On another note, processing visual information is key in allowing organisms to navigate their environment, as it creates conscious awareness for social interaction and personal activities. In patients with schizophrenia, it has been established that impairments in visual processing exist and contribute to symptoms of the disorder. These visual impairments are misperceptions of real, external stimuli in their environment. Individuals with schizophrenia experience visual processing issues (i.e., issues with transduction), such as blurred vision and hypersensitivity. They can additionally experience hallucinations, which can be caused by irregular neurotransmitter flow. This can distort an existing stimulus or cause the perception of an entity that is not even there. The significance of these findings is to highlight possible dysfunction in neural networking regarding the visual processing of schizophrenic patients and to encourage future correlational studies on the topic.

Keywords: *Schizophrenia; Visual Processing, Visual Impairments, Autonomic Nervous System, Hallucinations, Delusions, Transduction.*

Schizophrenia

Within the last 200 years, psychologists have devoted more effort to studying mental illnesses, yet speculation exists about how they arise and affect people. At the beginning of the 20th century, psychiatrist Eugen Bleuler strived to classify and understand the biology of mental illness and was the first to propose schizophrenia as a disorder in the psychiatric field. He regarded schizophrenia as arising from the "expressions of an inner psychodynamic life." In other words, the hallucinations and delusions characteristic of schizophrenia arises from unconscious conflicts in the individual. Since Bleuler's time, other researchers and scientists have developed other theories about schizophrenia, including the biological underpinnings of the disease, as well as environmental contributions (I.e., family, trauma).

Schizophrenia is a severe mental illness in which false beliefs and reality are confused by an individual. Two key symptoms of the disorder outlined by the *Diagnostic and Statistical Manual of Mental Disorders,* Fifth Edition (DSM-5) are hallucinations and delusions. Hallucinations are false perceptions of objects that do not exist and can involve auditory, visual, or olfactory sensations. Delusions are false beliefs that suggest an abnormality in one's judgment. Both symptoms are considered psychotic. Other symptoms include disorganized speech (i.e., "word salad," or poverty of speech), disorganized behavior, lack of emotion, suicidality, depression, motor-related issues, and also cognitive deficits (i.e., the decline in concentration and memory). Schizophrenia can be comorbid with other disorders, such as anxiety. The symptoms of schizophrenia are severe, causing the individual social and physical dysfunction. For instance, a person would have trouble and delayed responses towards performing instructed tasks.

Schizophrenia affects approximately 24 million people, or 1 in 300 (0.32%) worldwide (World Health Organization, 2022). This rate is 1 in 222 adults (0.45%) (World Health Organization, 2022). Schizophrenia is uncommon compared to other mental disorders like depression and anxiety. The prevalence of schizophrenia has been studied for several decades. For instance, with the collaboration of the Greater Southeast Community Hospital, and the Renard Hospital, doctors Michael Alan Taylor and Richard Abrams (1978) conducted a study on one psychiatric inpatient unit in a suburban-rural population in New York (U.S.A). Six hundred twenty admitted members of the unit were studied and diagnosed accordingly. The results of this study were related to the findings from more recent studies (World Health Organization, 2022) on the same topic in the following decades, which provide evidence that individual prevalence in the general population of schizophrenia is less than one percent (Alan Taylor & Abrams, 1978).

However, there is debate about how prevalent the disorder is in specific locations and populations. For instance, in 2005, the International Pilot Study of Schizophrenia (IPSS) looked into the global prevalence of the disorder among individuals. The study deduced that 10% of their sample had been diagnosed with the disease in developing countries, rather than less than one percent in particular developed countries (which was suggested in previous studies on schizophrenia prevalence, as cited above) (Bhugra, 2005). According to the article, "in developing countries, the proportion of cases with acute onset schizophrenia was twice as high as in developed countries" (Bhugra, 2005). Resources and methods to diagnose schizophrenia may be easier to access in more developed areas. However, paradoxically, prognosis and outcomes in developing countries are better than in developed countries. Culture seems to affect schizophrenia outcomes, and researchers continue to try to understand which cultural

factors are most impactful (Kulhara, 2009). A 2005 *Public Library of Science Medicine* volume included 200 additional studies that showed no correlation between sex/gender and schizophrenia and ethnicity and schizophrenia (PLSM, 2005). Additionally, the relation between whether an individual grew up in an urban or rural area did not affect their chances of having schizophrenia. There is still debate on how environmental factors (nurture) affect the chances of schizophrenia occurring.

Disorders, including schizophrenia, can affect more than a person's social difficulty; the disorder can cause an individual to have several hardships. As Jim Van Os, Gunter Kenis, and Bart P.F. Rutten wrote (2010), "the cognitive alterations in schizophrenia and related psychotic disorders include not only the neuropsychological domains of attention, memory, processing speed, and reasoning but also the correlated, although not entirely overlapping, higher order domain of social cognition" (European Graduate School for Neuroscience, Maastricht University Medical Centre, 2010). Particularly with social interactions, psychotic patients can fail to recognize their actions and read emotional cues from their environment. Treatments prescribed are used to heal or lessen the severity of the disorder, making life simpler for the patient. Antipsychotic medications are typically the first line of treatment for schizophrenia; they act as antagonists, which inhibit dopamine and serotonin receptors in the synapse between an axon terminal and the next neuron's dendrites in the brain. There are many types of antipsychotics, and different medications work better (or worse for different people). Two branches of antipsychotics are separated by the umbrella terms: first-generation and second-generation antipsychotics. First-generation antipsychotics proceed to inhibit dopamine receptors and reduce their activity in the brain, which, if left alone in schizophrenic patients, may overstimulate them (Khan, 2022). One example would be Haloperidol, which helps relieve positive symptoms of schizophrenia: delusions and auditory hallucinations. (Dold M, Samara MT, Li C, Tardy M, Leucht S. 2015) However, drugs intaken via tablets or orally-ingested capsules may cause minor side effects, like urinary retention and constipation, although major manifestations would be the rise of depression and weight gain. Haloperidol can cause irritation, strange posture, and shaking (Dold M, Samara MT, Li C, Tardy M, Leucht S. 2015). Second-generation antipsychotics seek to prevent the faults and side effects of the first-generation (Leucht, Corves, Arbter, Engel, Li, Davis, 2009). Psychiatrists may have patients try different medications under supervision, and if treatment with first-generation medication is unsuccessful, they may consider using second-generation antipsychotics. Examples of second-generation medications consist of Brexpiprazole and Cariprazine, which both also have the ability to control dopamine activity levels in addition to serotonin regulation. Use of these substances lessens the chance of a psychotic relapse significantly (making it almost three times less likely) (Last Name of Author, Date). Antipsychotics, while helpful for the most part, can be dangerous if multiple are taken simultaneously. Crossing multiple drugs can result in overload and in some severe cases, overdose and hospitalization.

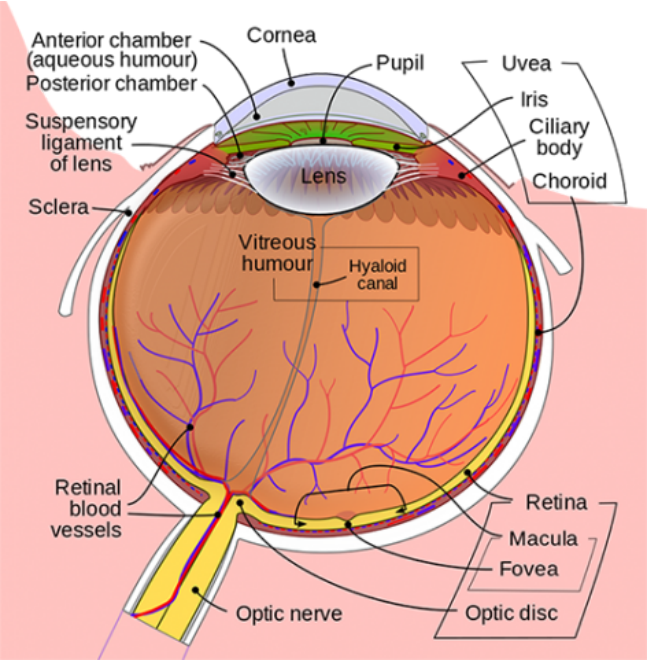
In addition to antipsychotic medication treatment, other methods are being developed by clinicians and researchers. For instance, recent research involving the use of lysergic acid diethylamide (LSD), a type of excitatory drug that boosts levels of serotonin flowing through the brain, helped biotechnologists to create an antagonistic compound that blocked both dopamine and serotonin receptors. This is pre-clinically tested for the therapeutic efficacy of the drug as an antipsychotic. (Gregorio, Comai, Posa, Gobbi, 2016) This led to preventing relapse and severe psychotic episodes in schizophrenia patients. However, many are still cautious about

administering this form of treatment because of how new the technology is (Csernansky, Schuchart, 2002).

Visual Processing: The Basics

Visual processing consists of the sequence of events in which light is perceived and interpreted to create an image by the brain. Light enters the cornea, the transparent film-like structure on the superficial part of the eye. From there, the light is reflected onto the iris (the colored part of the eye), which controls the dilation of the pupil and allows a specific amount of light to enter the lens. The light then reaches the retina, which activates receptors such as rods and cones at the back of the eye. From there, the sensory message reaches bipolar nerve cells, which transfer the signal to the optic nerve. This nerve then sends an action potential, or electrical impulse, across the neural network to the visual cortex of the brain (in the occipital lobe) at the back of the cerebrum. Therefore, transduction occurs, the process of converting sensory stimuli into information processed by the brain.

Processing visual information is key in allowing organisms to navigate their environment, as it creates conscious awareness for social interaction and personal activities. Additionally, the ability to read and write is only possible because of visual processing. Without one's visual prowess, the individual can lose some ability to analyze information in their environment and may require assistance to live life safely again. Visual impairment occurs when the eye or the brain mechanisms involved in visual processing do not function normally. Visual impairment can be separated into two categories: organic visual impairment (damage to the eye), and psychological visual impairment (damage to brain networks involved in visual processing). For instance, an example of organic visual impairment considers the clouding of the lens of the eye over time. This can cause some individuals to experience severe blurring, which causes them to become clinically blind. Surgeons which specialize in ophthalmology (who tend to diagnose and treat optic health) perform cataract surgeries to remove the clouded lens and replace them with an artificial replica to regain proper function of the eye. This operation subsequently allows transduction, and therefore visual processing to continue as usual.

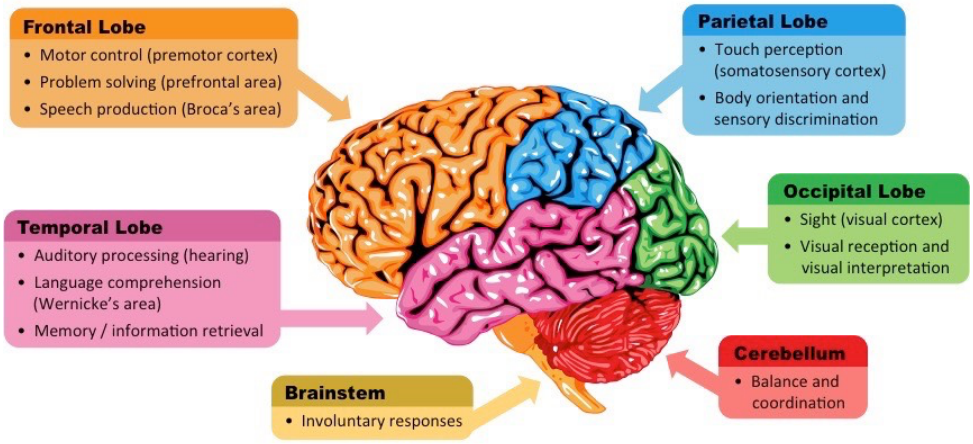


The psychological aspect of visual processing allows organisms to derive meaning from the light that makes its way to be interpreted in the brain. Based on monocular cues such as interposition (i.e., where the object is in regard to other objects in view) and relative size (i.e., the ability to judge how large an object is while taking into account the distance it is away from the viewer), humans can derive meaning from their environment. Monocular cues that are relayed to the brain get interpreted based on prior experiences and knowledge.

Schizophrenia & Visual Processing

In patients with schizophrenia, it has been established that impairments in visual processing exist and contribute to symptoms of the disorder. These visual impairments are misperceptions of real, external stimuli in their environment. In standard visual processing, humans perceive motion through correlational images. This is known as the phi phenomenon which provides an explanation of how lights flashing in a specific pattern can give the illusion of movement (which also explains how television works). While these illusions pose no drastic threat, and perhaps even help individuals in connecting visual variables, those with schizophrenia have displayed symptoms of visual disturbances in relation to existing stimuli. The Bonn Scale for the Assessment of Basic Symptoms (BSAB) is an interview for individuals with schizophrenia and asks questions that focus particularly on what they experience in terms of visual and cognitive interference. Symptoms allocated in this scale can vary in severity; blurred vision is a mild symptom that manifests itself in patients as "if you were seeing one picture one minute and another picture the next" (Chapman, 1966). However, some severe symptoms have been reported as well. For instance, one patient exhibited visual hypersensitivity, and stated that he "began to notice that the colors and shapes of everything around [him] were becoming very intense" (Saks, 2008).

It is fundamental to recognize the difference between visual impairments and visual hallucinations related to psychosis in schizophrenia. It's difficult to separate the exact differentiating line between an experience related to a visual impairment and an experience that is hallucinatory, but in schizophrenia there is documented evidence of both. Visual impairments are due to anatomical damage or physiological dysfunction during transduction, and impact perception of existing stimuli. Hallucinations are absent from an external stimulus, but can also lead to distortions in the perception of an existing stimulus. Hallucinations are often very realistic, and can be detailed and dynamic (changing); often there are distortions in size, shape, and color of hallucinated objects; hallucinations are often negative in content and have personal relevance to the individual. Often, as a result, the sympathetic nervous system can get aroused when there is no stimulus presented (i.e., heart rate and breathing rate increase); this can happen when hallucinations appear as something which instills fear in the individual.



Additionally, it is fundamental to refer to the physiological aspect of how schizophrenia affects the body functionally. In 2021, a study was conducted to research autonomic dysfunction in schizophrenia. The autonomic nervous system activates involuntarily when homeostasis (the body's natural internal state) is breached, and initiates the fight-or-flight response, to raise or lower the body's breathing/heart rate. The autonomic nervous system is divided into the sympathetic nervous system, which boosts body rates of arousal (increased breathing and heart rate, dilated pupils, decreased digestion), and

the parasympathetic nervous system, which calms the body (decreased breathing and heart rate, constricted pupils, decreased perspiration) (Bethesda, 2020). The researchers involved studied HRV (the variability in heart rate over an interval of time) and acetylcholine levels (an excitatory neurotransmitter involved in somatic activity) in the parasympathetic nervous system using Electrocardiogram (ECG), when individuals with schizophrenia were actively experiencing visual hallucinations. Findings revealed that while hallucinating, they experienced an increase in emotional response and reaction, therefore meaning an increase in the sympathetic nervous system's activity, and a decrease in the parasympathetic nervous system's activity (Stogios, N., Gdanski, A., Gerretsen, P., 2021).

Moreover, visual hallucinations experienced in psychosis, (specifically schizophrenia) have characteristics that set them apart from other organic disorders (visual impairments). Psychosis can manipulate personal significance and emotional response. In fact, 16% to 72% of hallucinations (Teeple, Caplan, & Stern, 2009) experienced during psychosis are visual, which stem from negative emotions and thinking (auditory hallucinations are more common). On the biological side, high amounts of dopamine, glutamate, and serotonin (neurotransmitters) present in the limbic system are linked with the manifestation of hallucinations and delusions in schizophrenia. Visual Hallucinations are linked to a more severe psychopathological profile and less favorable outcomes in psychosis.

Conclusion

The severe mental disorder, schizophrenia, often leads individuals to experience false delusions and hallucinations (whether they are auditory or visual). The DSM-5 criteria for diagnosing the disorder outline these and other symptoms. Individuals with schizophrenia experience visual processing issues (i.e., issues with transduction), such as blurred vision and hypersensitivity. They also can experience hallucinations, which can be caused by irregular neurotransmitter flow. This can distort an existing stimulus or cause the perception of an entity that is not even there. The significance of these findings highlights possible dysfunction in neural networking regarding the visual processing of schizophrenic patients. Finding treatment will aid in the reduction of the negative impact of schizophrenia on a person’s life and how they interpret the environment around them. There is still much to learn about schizophrenia; this field is still growing in discovery. There are still questions to be answered–such as the reason why more developed countries seem to have a higher prevalence of schizophrenia. New research in the last two decades probing the correlation of visual processing and psychosis provides foundations for further understanding the neural and biological bases of psychosis in schizophrenia and potentially new avenues of treatment.

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