Exploring Depth Perception and Vision-Action Dissociation through the Concave-Face Illusion

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Abstract

Optical illusions serve as a fascinating window into the workings of human perception. The "Concave-Face" illusion, where a concave mask of a face is perceived as convex, highlights the complex interplay between bottom-up sensory input and top-down cognitive processes. This study investigates the depth perception response to the Concave-Face illusion, particularly in relation to individuals with schizophrenia and other psychotic disorders. We hypothesize that individuals with schizophrenia may experience a significant dissociation in brain connectivity, resulting in altered perception of depth cues. We constructed a model of the Concave-Face illusion to assess depth perception across individuals with different visual impairments. Our findings suggest that schizophrenia patients show impaired depth perception when exposed to the illusion, which could serve as a diagnostic tool for detecting certain mental and neurodevelopmental disorders.

Index Terms Optical illusions, Concave-Face illusion, Depth perception, Schizophrenia, Vision-action dissociation, Visual perception, Mental health diagnostics

I. INTRODUCTION

Optical illusions are phenomena where the brain misinterprets visual stimuli, often due to complex cognitive processing. One such illusion, the Concave-Face illusion, occurs when a concave mask of a face appears to be convex. This visual misperception is an example of how bottom-up sensory data, such as the visual input from the eyes, is integrated with top-down processing, where prior knowledge and expectations influence perception. The Concave-Face illusion serves as a useful tool for understanding how the brain processes visual information and how disorders such as schizophrenia may affect these processes. In schizophrenia, altered connectivity between brain regions may lead to a disrupted perception of depth and spatial cues, making the Concave-Face illusion less effective in these individuals.

II. STATEMENT OF THE PROBLEM

Schizophrenia patients are often unaffected by the Concave-Face illusion, while healthy individuals perceive a concave face as convex. This dissociation suggests a phase lag between sensory and conceptual areas in the brain of schizophrenic patients. The implications for understanding visual processing and its breakdown in psychotic disorders are significant, offering potential diagnostic applications for mental health professionals. This study aims to explore how different populations perceive the Concave-Face illusion and its potential use in detecting cognitive and perceptual abnormalities associated with mental disorders.

III. HYPOTHESIS

We hypothesize that the Concave-Face illusion operates by creating a conflict between sensory input (bottom-up processing) and cognitive expectations (top-down processing). We also hypothesize that individuals with schizophrenia experience impaired depth perception due to poor connectivity between the left and right hemispheres of the brain. This dysfunction likely results in an altered perception of the concave mask, where the depth cues are less detectable, especially in individuals with severe forms of the disorder.

IV. OBJECTIVE

The primary objective of this study is to construct the Concave-Face illusion apparatus and measure depth perception across individuals with normal vision, visual impairments, and schizophrenia. We aim to investigate the dissociation between vision-for-perception (perception of size, shape, and color) and vision-for-action (perception related to movement and physical interaction with objects).

V. REVIEW OF LITERATURE

Schizophrenia is characterized by hallucinations, delusions, and disorganized thought, with approximately 1 in 100 individuals affected globally. Previous studies suggest that schizophrenia patients often show altered responses to visual illusions, particularly those that require integration of sensory data with cognitive expectations. The Concave-Face illusion has been widely used to study the relationship between perception and action, with findings indicating that healthy individuals experience a powerful

illusion, even when they are aware of the distortion. In contrast, patients with schizophrenia often fail to experience the illusion as strongly, which may be indicative of disrupted top-down processing.

VI. METHODOLOGY

6.1. Materials

- Concave face (hollow mask)
- Wooden box (75 cm x 45 cm x 45 cm)
- Glass shutter
- Thermocol sheet
- 15-Watt fluorescent bulb and holder

6.2. Construction Process

The wooden box is designed to house the concave mask illusion, with the concave face mounted on a thermocol sheet. The thermocol sheet is cut to fit the dimensions of the box, and the concave face is affixed at the center of the sheet. A fluorescent bulb is placed on the convex surface of the face to illuminate the mask. The box is designed to allow the concave face to face a glass shutter, positioned 45 cm from the face.

Optical illusion device

Mask from Front

Mask from Back

Mask with Lighting

***Figure 1*: Experimental Setup for the Concave-Face Illusion Study**

6.3. Setup and Procedure

The setup is aligned so that subjects view the concave mask through the glass shutter. Depth perception is measured for various subjects with different visual impairments. The experimental procedure involves asking participants to report the depth of the concave face at varying distances.

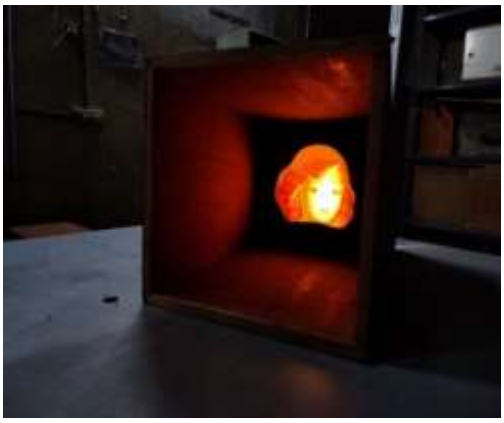
VII. RESULT

Front View

View from Above

View from below

***Figure 2*: Concave-Face Illusion - Mask Perception from the Front**



Right View

Left View

***Figure 3*: Concave-Face Illusion - Mask Perception from the Side**

Subjects with normal eyesight were able to perceive depth in the concave face at approximately 100 cm, while subjects with one eye (zero vision) detected depth at around 25 cm. The results suggest a relationship between visual acuity and depth perception, with those having normal eyesight able to perceive depth more accurately than those with impaired vision.

Category 1: Depth perception in subjects with normal eyesight – 120 cm.

Category 2: Depth perception in subjects with large differences in eyesight between the eyes – 100 cm.

Category 3: Depth perception in subjects with one eye (zero vision) – 60 cm.

Barely detectable: Depth perception at 20 cm with significant decline in visual cues due to phase lag or monocular vision.

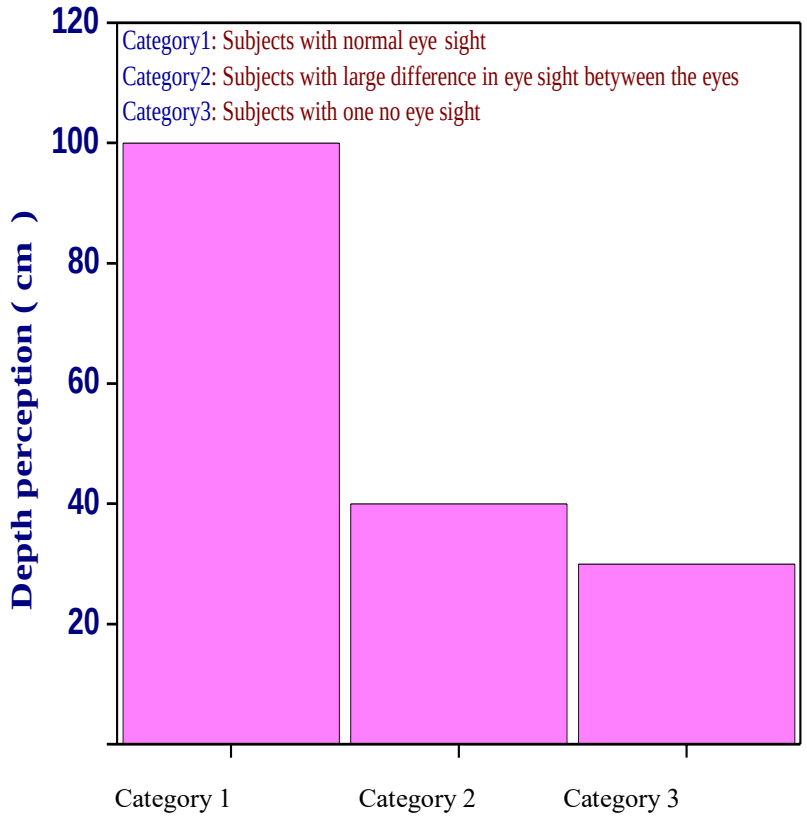


***Figure 4*: Chart Representing Depth Perception Across Categories**

These findings suggest that the degree of phase lag in brain connectivity impacts the ability to perceive depth. The Concave-Face illusion highlights the reliance of the brain on visual cues to infer depth and how disruptions, like reduced binocular input, impair depth perception.

VIII. ANALYSIS OF DATA

The data indicates that subjects with normal vision exhibit no significant phase lag between their right and left-brain connectivity, allowing for accurate depth perception. In contrast, subjects with significant visual impairments or one eye (zero vision) show a marked decline in depth perception, likely due to a phase lag in brain connectivity.

IX. CONCLUSIONS AND SUGGESTIONS

The Concave-Face illusion model can effectively predict mental disorders, particularly schizophrenia, by assessing depth perception. Schizophrenia patients often show impaired connectivity between the left and right hemispheres of the brain, contributing to their inability to perceive depth in the illusion. This model could be used in clinical settings to aid in the diagnosis of certain mental and neurodevelopmental disorders, with potential applications in areas such as driving license assessments.

Key Suggestions

1. Use in Clinical Settings: The model could assist in detecting schizophrenia and similar disorders by evaluating brain connectivity.

2. Integration in Driver's License Testing: Devices using this illusion can identify individuals with depth perception challenges critical for driving safety.

3. Further Research and Development: Future research could expand the model for other cognitive and neurodevelopmental conditions and explore its application in virtual and augmented reality environments.

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