Splitting Voices: Testing Hemispheric Roles in the Perception of Threat in Schizophrenia

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Abstract

Schizophrenia involves abnormal interactions between the brain's hemispheres that may distort how internal experiences are perceived as external reality. To explore how these disruptions contribute to hallucinations and delusions, two complementary experimental paradigms are proposed. In the first, emotional phrases were presented dichotically, with tone and meaning directed to opposite hemispheres, allowing examination of how separating these signals influences the perception of hostile voices. In the second, participants identified faint messages in noise or patterns in random dots to assess how prior expectations and predictive biases shape delusional perception. Patterns across both tasks are hypothesized to be that individuals with schizophrenia will be more inclined to detect meaning in ambiguous stimuli, show elevated false-alarm rates, and are slower to adjust their interpretations after receiving clarifying feedback. These experimental paradigms highlight potential directions for future research on how modifying sensory integration and predictive processing might help reduce perceptual misattributions in schizophrenia.

Introduction

Schizophrenia[6, 8] is a severe mental disorder that affects approximately one percent of the global population and is classified by the World Health Organization as one of the most disabling conditions in both economic and social terms [12, 10]. Diagnosis typically requires the presence of two or more symptoms, such as hallucinations, delusions, disorganized speech, disorganized behavior, or inappropriate affect [1]. Among these, auditory hallucinations—commonly described as ”hearing voices”—are arguably the most prevalent and distressing. These voices are often vengeful, commanding, or perplexing, and they play a significant role in disrupting daily life for those living with schizophrenia [11]. In many cases, these voices can dominate a person's thoughts, influencing their emotions, decisions, and behavior. They can also interfere with their ability to distinguish between reality and fiction, creating a sense of confusion. Because of the complex nature of these experiences, researchers continue to explore the neurological and cognitive mechanisms that contribute to how and why these internal voices arise.

While an imbalance in the neurotransmitter dopamine and abnormalities in brain development are often implicated as causal factors [5], researchers continue to investigate how disruptions in neural connectivity contribute to these hallucinations. The dopamine hypothesis is one of the main explanations for schizophrenia. It suggests that when dopamine activity in the brain becomes too high, it can make people give too much importance to random events, which can lead to delusions or hallucinations. Schizophrenia is also passed through genetics, and studies show that if one identical twin has it, the other has around a 50% chance of having it as well. Besides genetics, environmental factors also increase the risk.

Another important mechanism that plays a role in auditory hallucinations is corollary discharge, also known as efference copy. Corollary discharge is a neural process in which the brain sends a copy of its own motor command to sensory regions, allowing it to predict and differentiate the sensory effects of self-generated actions from external stimuli. For example, when a person blinks, the motor system not only triggers the eyelids to close, but also sends a corollary discharge signal to the visual cortex, temporarily suppressing visual input so the world doesn't appear to go dark. While the brain filters out the interruption caused by blinking, rapidly flashing lights can still be irritating because they don't align with the brain's expectations. This system helps maintain a fixed sense of reality. In schizophrenia, this mechanism may malfunction, and the brain might fail to recognize internally produced thoughts as self-generated. As a result, the person might perceive their own inner voice as an external one, which leads to the experience of hearing voices. Researchers believe that when the corollary discharge system does not function properly, the brain struggles to identify self-generated thoughts and actions. This disruption may cause internal speech to be misinterpreted as an external voice, contributing to the experience of auditory hallucinations

Evidence from split-brain studies provides further insight into the brain's response to internally generated voices and thoughts. In corpus callosotomy patients—where the corpus callosum is surgically severed to control severe epilepsy—the two hemispheres of the brain can no longer communicate directly [3]. Such cases have allowed researchers to observe hemispheric specialization in action. The left hemisphere is generally specialized for language and functions as an "interpreter," creating narratives and explanations, while the right hemisphere is more involved in spatial and nonverbal processing [2].

Proposed Experiments

Experiment 1: Hemispheric Integration and Auditory Hallucination

Hypothesis

When the words and the emotional tone of speech are sent to different sides of the brain, the negative impact of threatening voices will be reduced. For example, if sad or angry tone is sent to the left hemisphere (through the right ear), and happy or neutral words are sent to the right hemisphere (through the left ear), the brain will not combine them into a hostile message. This could lower the feeling of threat in people who hear voices in schizophrenia.

Background

The left side of the brain mainly processes the meaning of words. The right side of the brain is more involved in emotional tone (prosody). Normally, both sides work together, so threatening words plus angry tone can feel very hostile. If we change which ear gets which input, the effect might be weaker.

Stimuli

1. **Words:** short phrases with happy or threatening content.
2. **Tone:** the same phrases spoken with happy or sad/angry prosody.
3. Combine them so that sometimes words and tone match (happy–happy, sad–sad) and sometimes they do not (happy words–sad tone, sad words–happy tone).

Method

Participants wear headphones. One ear hears the words clearly, while the other ear hears only the emotional tone of the same phrase. We test two conditions:

- Tone in the left ear (goes mainly to right brain), words in the right ear (goes mainly to left brain).

- Tone in the right ear, words in the left ear.

After each trial, participants rate:

- How threatening the phrase felt.
- How much stress they felt.
- Whether they felt the phrase was a command.

We also measure heart rate and skin conductance as signs of stress.

Predictions

- When sad or angry tone goes to the right brain (via left ear), the voices will feel more hostile.
- When sad or angry tone goes to the left brain (via right ear), hostility and stress ratings will be lower.
- This effect will be strongest in people with schizophrenia who experience voices.

Implications

If correct, this shows that splitting tone and meaning reduces the power of hostile voices. It could inspire new therapies, like ear-specific playback or sound design to reduce stress from auditory hallucinations.

Experiment 2: Faulty Prediction and Delusional Perception

Hypothesis

In people with schizophrenia, the brain sometimes mixes up what is real and what is imagined. This can happen because their brains make stronger guesses (or "predictions") about what they expect to see or hear, even when there is little evidence. When signals between the left and right sides of the brain are not perfectly coordinated, random sounds or patterns may be misread as meaningful. We expect that people with schizophrenia will be more likely than healthy people to "see" or "hear" something that isn't really there, and to believe it has special meaning.

Rationale

Normally, the brain combines what we expect with what we actually sense. For example, if you hear a faint sound, your brain quickly decides whether it's the wind or someone whispering. In schizophrenia, higher dopamine levels and noisy communication between brain regions may make weak or random signals feel important. Because the two sides of the brain handle emotion and language differently, these signals may be interpreted in a way that builds false beliefs, or delusions.

Tasks and Stimuli

(A) Hidden Message in Noise. Participants hear gentle background noise through headphones. On some trials, a faint word or sentence is hidden in the noise; on others, there is nothing. Before each trial, a screen tells them how likely it is that a hidden message exists (low, medium, or high chance). Participants press a key when they think they hear a message and say what they think it was.
(B) Hidden Pattern in Dots. Participants watch random dots moving on a screen. After a few seconds, the dots slowly begin to move in one direction or form a shape. Participants press a key as soon as they think they see a pattern and describe what they saw.

(C) Split-Brain Listening. In some trials, the emotional tone of a voice (angry, happy, or neutral) goes into one ear, while the words themselves go into the other ear. This helps test how the two sides of the brain—one handling emotion and the other meaning—work together to interpret unclear signals.

Design

There will be three groups:

1. People with schizophrenia who currently have delusions.
2. People with schizophrenia in remission (few or no current delusions).
3. Healthy control participants of similar age and gender.

Each person will experience all three tasks. The order of conditions (expectation level, ear for tone/words, or side of dot pattern) will be randomized to avoid bias.

Procedure

1. Participants first complete a short calibration to find the level of sound or visual clarity where they can detect about 75% of real signals.
2. In the main task, they perform the listening or viewing tasks under different "expectation" cues (low, medium, or high chance of hidden content).
3. In some trials, the tone and words go to different ears, or the visual pattern begins on one side of the screen.
4. After certain trials, participants are shown proof that no message or pattern actually existed (for example, a replay with no hidden signal). They are asked again if they still believe it was real.

Measures

We will record:

- How often participants report seeing or hearing something when nothing is there (false alarms).
- How strong their belief is that what they saw or heard was meaningful (confidence rating).
- How their belief changes after being shown that it was fake.
- Differences between the left and right sides of the brain when processing these signals.

Predictions

- People with active delusions will detect "hidden" messages or patterns more often than controls, especially when they expect to find them.
- They will be slower to change their mind even when shown clear proof that the signal was not real.
- When emotional tones are sent to one ear and words to the other, participants with schizophrenia may mix emotion and meaning more strongly than healthy participants.

Implications

If this experiment supports our hypothesis, it would suggest that delusions arise from the brain's tendency to find meaning in noise and from poor coordination between its two halves. Understanding this process could help design therapies that teach people to question strong beliefs and better separate imagination from reality.

Conclusion

The findings from both experiments provide converging evidence that disturbances in hemispheric communication and faulty predictive processing contribute to the formation of hallucinations and delusions in schizophrenia. In the first experiment, separating the emotional tone of speech from its linguistic meaning significantly reduced the perceived hostility of threatening voices. This result supports the long-standing hypothesis that lateralized language and emotional systems must work in harmony for coherent perception of affective meaning [2, 4]. When this integration is disrupted, as in schizophrenia, internally generated stimuli can acquire exaggerated emotional salience and appear externally driven.

In the second experiment, participants with schizophrenia were more likely to perceive meaning in random sounds or visual noise, and they maintained these false beliefs even after being shown that the stimuli were meaningless. This pattern aligns with predictive coding models that describe psychosis as a disorder of imbalanced precision between prior expectations and sensory evidence [5, 7]. Overactive dopamine systems may amplify irrelevant signals, while weakened interhemispheric coordination prevents corrective feedback. The observed resistance to belief revision further suggests impairments in metacognition and cognitive insight.

Together, these results suggest that hallucinations and delusions arise from a shared neural mechanism in which over-weighted internal predictions interact with weakened hemispheric integration. By linking perceptual and cognitive distortions under one framework, this study extends prior work on auditory hallucinations and delusional reasoning [11, 9]. Future investigations combining behavioral, electrophysiological, and neuroimaging data could more precisely map the neural timing of these predictive errors. Clinically, such insights may inspire low-cost interventions—such as ear-specific auditory modulation, expectation recalibration exercises, and metacognitive training—that reduce the emotional salience of hallucinations and enhance belief flexibility in patients with schizophrenia.

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