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Review Article

# Hallucinations Induced by Psychoactive Drugs: Mechanisms, Consequences, and Therapeutic Interventions

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## Abstract

Millions of people worldwide experience hallucinations caused by psychoactive substances. These hallucinations are a serious problem for both health care and society. The main culprits are hallucinogens like psilocybin, phencyclidine (PCP), methamphetamine, and lysergic acid diethylamide (LSD). These substances lead to perceptual changes characterized by sensory experiences that happen without any external triggers. This study focuses on how these drugs interact with serotonin and dopamine systems and how they affect different areas of the brain. The immediate effects of drug-induced hallucinations can vary widely. They can cause slight visual distortions or lead to severe psychotic episodes. These effects can result in lasting psychological issues, including permanent changes in perception and a greater risk of mental health disorders. The impact goes beyond individual health, affecting social and economic aspects as well. Early diagnosis is essential. It relies on thorough clinical evaluations and toxicological tests to tell apart drug-induced hallucinations from primary psychiatric disorders. Treatment usually includes medications like antipsychotics and psychological support, such as cognitive behavioral therapy and counseling, to help manage symptoms and reduce the chance of relapse. Detox programs and rehab centers are also important for recovery. Recent research into new treatment methods and harm reduction strategies shows potential in reducing the negative effects of these substances. This review highlights the need for a combined approach that involves neuroscience, psychiatry, and public health. Such collaboration can enhance our understanding, prevention, and treatment of drug-induced hallucinations, ultimately benefiting patients and society as a whole.

**Keywords:** Drug-Induced Hallucinations; Psychoactive Substances; Neurobiological Mechanisms; Psychosis; Antipsychotic Treatment; Cognitive Behavioral Therapy

## Introduction

Hallucinations are experiences that happen without an external trigger. They can involve any of the senses, including sight, hearing, touch, or smell [1]. Unlike illusions, which are misunderstandings of real stimuli, hallucinations are completely created by the brain. They can have a major influence on a person's mental state and behavior. Many psychoactive substances can cause hallucinations by changing the brain's normal function. Classic hallucinogens like lysergic acid diethylamide (LSD) and psilocybin mainly target serotonin receptors, especially the 5-HT2A receptor. This leads to changes in sensory perception and thinking [2]. Dissociative anesthetics, such as ketamine, primarily work by blocking NMDA receptors. This results in hallucinations and a feeling of being detached from reality [3]. Stimulants like methamphetamines can also cause

hallucinations, which are often visual or tactile. This occurs due to their effects on dopamine transmission and the resulting neurotoxicity [4]. While these drugs differ in how they work and their effects, they all share the ability to bring about altered sensory experiences, from mild distortions to intense psychotic episodes. Hallucinations can affect any sense, but visual and auditory ones are the most frequent [1]. Though often linked with psychiatric disorders like schizophrenia, hallucinations can also come from many psychoactive substances. Some of these include classical psychedelics (like LSD and psilocybin), dissociative (like ketamine and phencyclidine [PCP]), and entactogens (like 3,4-methylenedioxymethamphetamine (MDMA) (Figure 1) [2].

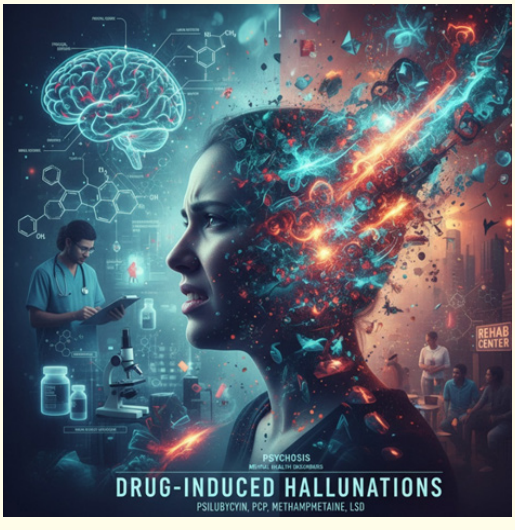


**Figure 1:** Image for encapsulates the complex and serious nature of drug-induced hallucinations, focusing on both the individual experience and societal impact, as well as the scientific and treatment aspects discussed (Image generated by AI).

Psychoactive drugs change perception, mood, awareness, and thinking by interacting with specific neurochemical systems in the brain. They often cause hallucinations as a main part of the drug experience [5]. In certain situations, such as spiritual ceremonies or clinical studies, hallucinations can be seen as helpful or transformative [6]. On the other hand, they can also result in intense psychological distress, risky actions, or long-lasting perceptual issues. This is particularly true when used outside of controlled settings or by at-risk individuals [7]. The renewed focus on psychedelic research has highlighted the mechanisms and effects of drug-induced hallucinations. Clinical trials involving psilocybin, LSD, and ketamine indicate that with proper guidance, these substances might offer therapeutic benefits for conditions like depression, anxiety, and post-traumatic stress disorder [8]. However, these substances remain controversial because of their potential for misuse and negative psychological effects. This paper looks into the neurobiological mechanisms behind how psychoactive drugs cause hallucinations, the short- and long-term effects of these experiences, and current and emerging strategies to manage or use hallucinogenic states in clinical practices (Table1).

Psychoactive substance-induced hallucinations provide a special perspective for analyzing the relationship between perception, cognition, and brain function. Although researchers have been thoroughly examined in pharmacological and clinical settings, more focus should be paid to their wider ramifications, especially in educational settings. By reviewing the fundamental mechanisms of drug-induced hallucinations, their possible long-term cognitive effects, and how this information can guide educational policy, drug literacy initiatives, and support services in colleges and universities, this paper seeks to close the gap.

## Mechanisms of hallucination induction

Hallucinations caused by psychoactive substances come from complex interactions between neurochemical systems and large brain networks. The specific processes differ based on the type of drug. Each one targets different receptors and neural pathways that affect perception, thinking, and awareness. Two main mechanisms are involved: the neurochemical effects of the substances and their impact on brain network dynamics (Figure 2).

## Neurochemical basis

### Serotonergic hallucinogens

Classical psychedelics like lysergic acid diethylamide (LSD), psilocybin, and dimethyltryptamine (DMT) mainly produce their hallucinogenic effects by activating the 5-hydroxytryptamine 2A (5-HT2A) receptors in the brain's cortex. This is especially true for layer V pyramidal neurons [2]. When these receptors are activated,

**Table 1**: Psychoactive Drugs and Drug-Induced Hallucinations - Mechanisms, Effects, and Interventions

| | Key Details | Notable Insights / Effects | References |
|---|---|---|---|
| Drug Classes | Hallucinogens: LSD, psilocybin, DMT<br>Dissociatives: Ketamine, PCP<br>Stimulants: Amphetamines, cocaine<br>Deliriants: Atropine, scopolamine | Hallucinogens act on serotonin; dissociatives on NMDA; stimulants on dopamine; deliriants on acetylcholine systems | [9] |
| Neurobiological Mechanisms | 5-HT2A receptor agonism (hallucinogens)<br>NMDA receptor antagonism (dissociatives)<br>Dopaminergic hyperactivity (stimulants)<br>Cholinergic antagonism (deliriants) | 5-HT2A stimulation causes visual/cognitive distortions; NMDA blockade causes dissociation and hallucinations | [9-11] |
| Types of Hallucinations | Visual: patterns, color enhancement<br>Auditory: voices, music<br>Tactile: crawling, tingling<br>Olfactory/Gustatory: rare | Visual are most common; tactile and auditory more often linked with deliriants or stimulants | [8] |
| Short-Term Effects | Panic, anxiety, paranoia<br>Risky behavior, accidents<br>Transient psychosis | Acute episodes can involve overwhelming fear or psychotic states | [12-13] |
| Long-Term Effects | HPPD (Hallucinogen Persisting Perception Disorder)<br>Drug-induced psychosis<br>Cognitive/emotional blunting | HPPD includes persistent visual distortions; linked to underlying psychiatric vulnerability | [14-15] |
| Therapeutic Interventions | Acute: Benzodiazepines, safe environment<br>Chronic: Antipsychotics (e.g., risperidone), lamotrigine, psychotherapy<br>Experimental: Psychedelic-assisted therapy under supervision | Benzodiazepines ease anxiety; Lamotrigine beneficial in HPPD; Psychotherapy central for long-term recovery | [11-16] |
| Risk Factors | Genetic predisposition<br>Psychiatric history (depression, anxiety, PTSD)<br>Frequent/high-dose use<br>Poly-drug combinations | Pre-existing mental illness increases susceptibility to persistent hallucinations | [15-17] |
| Preventive Strategies | Mental health screening prior to use<br>Controlled, supervised environments<br>Harm reduction education<br>Substance regulation | Informed, regulated use reduces risks and negative outcomes | [10-18] |


**Figure 2:** Image showing drug-induced hallucination, serubycyin and dopamine systems (Image generated by AI).

they increase glutamate release and change how the cortex reacts, which affects how we process and perceive sensory information [19]. One important result of 5-HT2A activation is the disruption of thalamocortical filtering. This process usually controls how sensory information moves from the thalamus to the cortex. When someone is under the influence of serotonergic hallucinogens, this filtering becomes less effective. This allows too much sensory input to enter consciousness, leading to intense visual and auditory hallucinations [9].

### Dissociative anesthetics

Dissociative drugs like ketamine and phencyclidine (PCP) mainly block the N-methyl-D-aspartate (NMDA) receptor. This receptor is a type of glutamate receptor that plays an important role in synaptic plasticity and cognitive function [20]. When NMDA receptors are blocked, it causes cortical disinhibition, especially in the prefrontal cortex. This can lead to fragmented sensory integration, out-of-body experiences, and changes in how people see themselves [21]. Unlike traditional psychedelics, dissociative often create a deeper sense of detachment from reality. This includes feelings of depersonalization and derealization rather than complex visual hallucinations.

### Entactogens

Entactogens such as MDMA (3,4-methylenedioxymethamphetamine) boost the release of serotonin, dopamine, and oxytocin. This improves mood, empathy, and sensory perception [22]. While MDMA is not usually labeled as a hallucinogen, it can cause hallucinatory experiences at high doses or in people sensitive to sensory changes [23]. These effects probably result from too much serotonin and disruption in how sensory information is processed.

### Brain network dysregulation

Beyond receptor-level interactions, psychoactive drugs have a strong impact on how large-scale brain networks operate. This is especially true for networks that are involved in self-referential thinking and sensory integration (Figure 3).

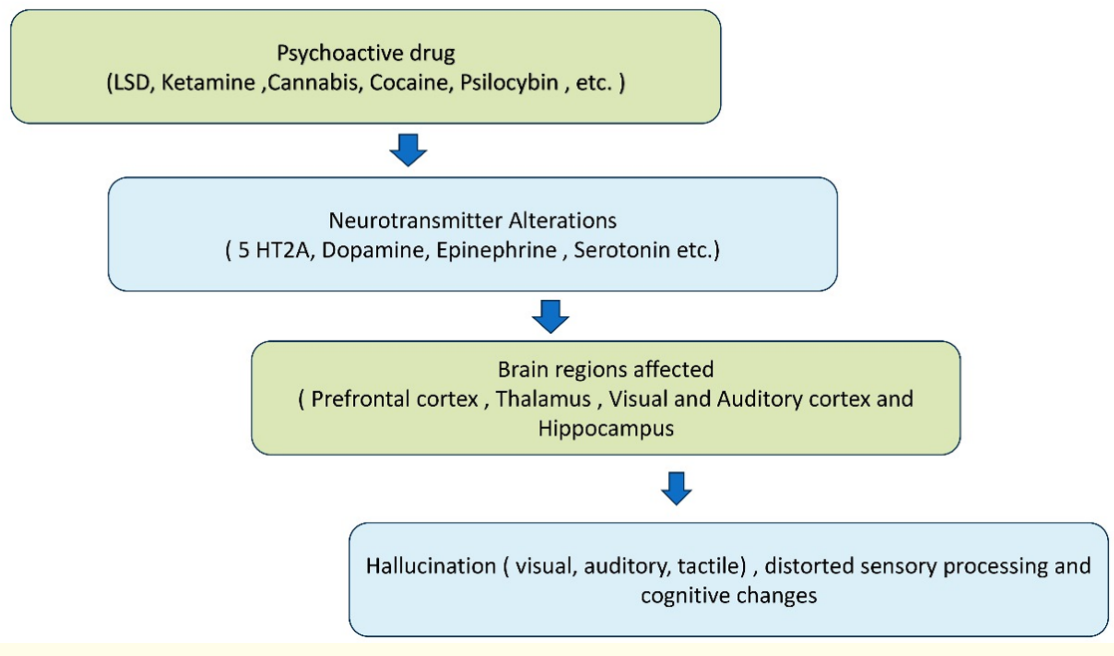


**Figure 3:** Effect of hallucinating drugs in brain.

### Default Mode Network (DMN) Suppression

The Default Mode Network (DMN), which includes the medial prefrontal cortex, posterior cingulate cortex, and precuneus, is linked to introspection, autobiographical memory, and the sense of self. Psychedelics like psilocybin and LSD have been shown to reduce DMN activity. This reduction relates to experiences of ego dissolution and loss of personal boundaries [24,25]. This breakdown of the DMN disrupts the brain's normal hierarchical organization. As a result, information can flow more freely and without restriction.

### Increased functional connectivity

These substances also increase global functional connectivity between normally separated brain regions. This promotes new associations and improves sensory integration [26]. Researchers believe this "hyperconnectivity" contributes to the vividness of hallucinations, synesthesia, and the blending of sensory modalities often seen during psychedelic experiences. Together, these changes in the brain create a unique state of consciousness. It features altered perception, impaired reality testing, and deeply personal experiences, which can range from visionary imagery to mystical insight.

### Consequences of drug-induced hallucinations

The effects of hallucinogenic substances go beyond temporary changes in perception. While many users share positive or even life-changing experiences, hallucinogenic effects can also come with serious risks. These outcomes differ depending on factors like the type of drug, the amount taken, individual brain chemistry, and the psychological context, often referred to as "set and setting," in which the substance is used [27]. This section looks at the immediate, psychological, and long-term effects linked to hallucinogenic drug use (Table 2).

**Table 2**: Hallucinogenic Plants and Their Properties.

| Plant Name | Active Compound(s) | Origin / Cultural Use | Hallucinogenic Effects | References |
|---|---|---|---|---|
| Peyote (*Lophophora williamsii*) | Mescaline (phenethylamine) | Native to Mexico and U.S. Southwest; used by Native American Church | Vivid visual hallucinations, synesthesia, time distortion | [28,29] |
| Ayahuasca (*Banisteriopsis caapi* + *Psychotria viridis*) | DMT + MAOIs (harmine, harmaline) | Amazonian tribes in Peru, Brazil; used in shamanic healing | Visual and auditory hallucinations; spiritual visions | [28-30] |
| Psilocybin Mushrooms (*Psilocybe* spp.) | Psilocybin, psilocin | Mesoamerican religious rituals, modern clinical trials | Patterned visuals, altered perception, ego dissolution | [29-31] |
| Salvia (*Salvia divinorum*) | Salvinorin A (kappa-opioid agonist) | Mazatec shamans in Oaxaca, Mexico | Intense spatial and identity distortion; short-lasting | [32] |
| Iboga (*Tabernanthe iboga*) | Ibogaine (tryptamine alkaloid) | Bwiti religion in Gabon and Congo | Long-lasting visions, relived memories, spiritual insight | [30-32] |
| Datura (*Datura stramonium*, etc.) | Scopolamine, atropine, hyoscyamine | Global; ritual use and poison in many cultures | True hallucinations, delirium, confusion | [28-32] |
| Henbane (*Hyoscyamus niger*) | Scopolamine, hyoscyamine | Ancient Greece, Rome; associated with witchcraft | Deliriant hallucinations; altered body perception | [32] |
| Mandrake (*Mandragora officinarum*) | Atropine, scopolamine | Europe/Mediterranean; witchcraft and folk medicine | Dream-like hallucinations, delirium | [28] |
| Morning Glory (*Ipomoea tricolor*) | LSA (lysergic acid amide) | Used by Aztecs as *ololiuqui* in spiritual rituals | Mild LSD-like visuals; introspection | [28,29] |
| Cannabis (*Cannabis sativa*, *indica*) | THC (tetrahydrocannabinol) | Global use; medicinal and recreational | Mild hallucinations in high doses; altered perception | [31,32] |

## Acute effects

Psychoactive substances often produce intense and complex effects. Users frequently report visual hallucinations. These can include geometric patterns, distortions of objects, and vivid imagery, with eyes either closed or open [33]. Auditory hallucinations are less common. They can involve hearing voices, music, or ambient sounds that aren't actually present in the surroundings [5]. Many users also experience synesthesia, which is a mix of senses (for example, "seeing sounds" or "hearing colors"), especially with serotonergic psychedelics [34]. Changes in how users perceive time, space, and their sense of self are often noticed during the peak effects of the drug. This feeling, known as ego dissolution, is frequently reported [25]. While users often describe these experiences as mystical or insightful, they can also be disorienting or overwhelming. This largely depends on the user's mental state and environment.

## Psychological and behavioral risks

Though many psychedelic experiences are harmless or even helpful, some users go through intense psychological distress, usually called a "bad trip." This can involve panic, paranoia, anxiety, confusion, and a deep fear of losing control or going insane [35]. These negative reactions are more likely with high doses or in unpredictable situations. Hallucinations can also affect judgment and motor skills, raising the risk of accidental injury, especially if users engage with their surroundings in dangerous ways, like walking into traffic or jumping from heights [2]. Additionally, while rare, certain individuals, particularly those with a history of mental health issues, may experience drug-induced psychosis or worsen existing conditions after using hallucinogens [36]. In the case of MDMA and other stimulants, excessive use can result in serotonin syndrome, a serious condition caused by too much serotonergic activity, especially when mixed with other substances [37].

## Long-term consequences

While many short-term effects of hallucinogens are temporary, some people experience ongoing perceptual and psychological issues after using the drugs. One of the most noted long-term effects is Hallucinogen Persisting Perception Disorder (HPPD). This condition leads to visual disturbances like halos, afterimages, and tracers that persist long after the drug has left the system [10]. Although it is rare, HPPD can cause distress and disrupt daily life. Frequent use of dissociative anesthetics like ketamine can result in cognitive problems, which may include issues with memory, executive function, and attention [38]. Long-term use of ketamine has also been connected to bladder issues and urinary tract problems. Conversely, positive long-term effects are reported, especially in controlled therapeutic environments. Many people who participate in psychedelic-assisted psychotherapy say they experience lasting improvements in well-being, openness, and life satisfaction, particularly with the guidance of trained professionals [39]. These results underscore the complex nature of drug-induced hallucinations, which can offer both therapeutic benefits and psychological risks, depending on how they are used.

## Therapeutic potential and clinical use

Although hallucinations from psychoactive substances have often been seen as harmful or risky, more research shows that these experiences can be beneficial when managed properly. Recent clinical studies have looked into using psychedelics like psilocybin, MDMA, and ketamine to treat various mental health issues, and the results are encouraging. This section discusses how these substances are used in therapy, how negative reactions are handled, and the ethical and legal issues tied to their clinical use.

## Psychedelic-assisted psychotherapy

Psychedelic-assisted psychotherapy is a new treatment approach that uses hallucinogenic drugs along with structured psychological support. Psilocybin, the active ingredient in "magic mushrooms," has been effective in reducing symptoms of treatment-resistant depression, anxiety, and existential distress in patients facing terminal illnesses [6-24]. Likewise, MDMA-assisted therapy has shown strong results in treating post-traumatic stress disorder (PTSD), with many participants experiencing significant and lasting symptom relief [40]. Ketamine, a dissociative anesthetic, is already approved in some countries as ketamine nasal spray for treatment-resistant depression. Unlike traditional psychedelics, ketamine works by blocking NMDA receptors but still creates altered states of consciousness that seem to help with emotional processing and brain flexibility [41]. A key part of psychedelic therapy is paying attention to "set and setting," which refers to the person's

mindset and the environment where the drug is used [42]. Trained therapists guide patients through the experience and help them integrate insights gained during the session into long-term healing.

### Managing adverse reactions

Despite their potential benefits, psychedelic experiences can be psychologically intense and sometimes distressing. Clinical protocols stress the importance of screening for risk factors like psychotic disorders. They also incorporate preparation sessions to build trust and set clear expectations, as well as integration sessions to help patients process their experiences after treatment [27]. During the acute phase of a session, if a patient feels anxious, panicked, or agitated, benzodiazepines like lorazepam may be given to calm them down. In rare situations involving severe psychosis or dangerous behavior, antipsychotic medications might be used, but these interventions are typically a last resort [43]. The presence of trained professionals and the use of supportive, non-coercive techniques are essential for managing challenging experiences and ensuring patient safety.

### Ethical and legal considerations

The use of hallucinogens in therapy raises complex ethical and legal questions. Many substances with therapeutic potential, such as LSD, psilocybin, and MDMA, remain Schedule I drugs under international and national drug control treaties. This classification means they are officially considered to have no accepted medical use and a high potential for abuse. However, this legal status is changing quickly due to recent research. Decriminalization efforts in cities like Denver, Oakland, and Seattle, along with legal therapeutic use in countries such as Canada and Australia, have shifted public and professional views on psychedelics [44]. Ethical guidelines stress informed consent, careful risk assessment, and a non-exploitative relationship between therapist and participant. This is particularly important given the vulnerability and suggestibility that often come with hallucinogenic experiences [45]. As psychedelic therapy gains mainstream acceptance, it is crucial to develop strong, evidence-based frameworks for clinical use to ensure safety and effectiveness.

### Future directions

As interest in using psychoactive substances in clinical settings grows, future research must address a complicated mix of scientific, regulatory, and ethical challenges. Recent findings show that hallucinogens can be helpful in treating mental health disorders. However, many questions still exist about their long-term safety, how they work, and the best ways to use them in medical practice.

### Expanding the evidence base

Despite promising early results, many psychedelic studies so far have small sample sizes, short follow-up periods, and similar participant demographics, such as healthy, educated volunteers. We need large-scale, multi-center randomized controlled trials to confirm findings in broader populations. This includes individuals with comorbidities and those from different cultural backgrounds [46]. Additionally, more research is necessary to differentiate the therapeutic mechanisms of various hallucinogens. For example, the ways that MDMA helps with emotional processing may be very different from those involved in psilocybin-induced ego dissolution. Understanding these differences will be important for customizing treatments to specific disorders and individual needs [47].

### Developing safer and more precise treatments

Pharmacological innovation is likely to be important for the future of psychedelic medicine. Researchers are looking into developing non-hallucinogenic versions of psychedelics. These would keep the therapeutic benefits without causing perceptual distortions. This could make them more acceptable to patients and regulators [48]. Another approach is micro dosing, which involves taking very small doses of psychedelics over time. Some people claim this method improves mood, cognition, and creativity. However, there is still no clear scientific evidence to confirm that micro dosing is effective or safe, and it needs more thorough research [49].

### Integration into mental health systems

The successful incorporation of psychedelic therapies into regular mental health care will need strong clinical data and infrastruc-

ture development. This involves training and certifying therapists for psychedelic-assisted therapy, creating regulatory frameworks, and developing clinical guidelines for patient selection, dosing protocols, and post-session integration [44]. There is also increasing interest in using digital tools and artificial intelligence to help monitor patient progress, predict treatment outcomes, and customize integration strategies. These innovations could improve access to care, especially in remote or underserved areas.

### Addressing societal and cultural implications

Finally, the renewed interest in psychedelics must address their complicated social history and the risk of commercial exploitation. As pharmaceutical companies become involved, there are worries that profit motives may overshadow values like equity, accessibility, and cultural sensitivity [50]. Partnerships with Indigenous communities, many of which have deep connections to ceremony involving plants like ayahuasca or peyote, should be handled with respect and fairness. Ethical guidelines should ensure that these communities are not pushed to the sidelines or taken advantage of in the global growth of psychedelic medicine.

## Conclusion

Hallucinations caused by psychoactive drugs have both positive insights and psychological risks. These substances change neurochemical pathways and disrupt how the brain works, especially by interacting with systems like serotonin, glutamate, and dopamine. The experiences can vary widely, including changes in perception, loss of ego, strong emotions, and spiritual insights. Many seek these experiences for their potential to transform lives, but they can also lead to heightened anxiety, confusion, or chronic perceptual issues in those who are at risk. Clinically, increasing evidence shows that substances like psilocybin, MDMA, and ketamine may be beneficial when used in controlled and supportive settings. They hold promise for conditions like treatment-resistant depression, PTSD, and anxiety related to terminal illness. However, using hallucinogens in therapy needs careful attention to safety measures, ethical guidelines, and the specific challenges posed by altered states of mind. In the future, the success of psychedelic medicine relies on thorough research, careful regulations, and awareness of cultural contexts. As researchers uncover more about how these powerful substances work and how they can be used, it is vital to keep a balanced view that recognizes both their healing powers and their potential dangers. With responsible development and compassionate care, therapies that include hallucinogens could lead to significant changes in mental health treatment. The impact on learning and behavior, the long-term cognitive effects on young people, and the limited incorporation of neuroscientific findings into educational practices are among the main research gaps. Future research should concentrate on the effects of these experiences on emotional control and academic performance. Implementing evidence-based drug education, preparing teachers to recognize and address hallucinatory behavior, and encouraging interdisciplinary research are some examples of practical suggestions. School-based support networks and early intervention are essential. Effective policies addressing drug use and cognitive development can be informed by bridging the fields of neuroscience and education.

## Conflict of Interest

Authors have no conflict of interest.

## Contribution of Authors

All authors have equal contributions.

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