Analysis of the differences between hallucinations caused by natural hallucinogens and schizophrenia

Kristofer L. Korth
Department of Biology
Lake Forest College
Lake Forest, Illinois 60045

Abstract
Hallucinations have piqued the interest of mankind for generations. A large body of knowledge exists on the various causes of hallucinations but there is a lack of focus on the comparison between hallucinations induced by different conditions. Natural hallucinogens have been used for centuries by different cultures as a way to communicate with the spirit world and ancestors. Shamans and priests have also used them for medicinal purposes (Schultes 1976). Natural hallucinogens commonly induce positive hallucinations that include feelings of euphoria and enlightenment. Schizophrenia is a mental disorder that causes the manifestation of hallucinations. These hallucinations are often negative and can lead patients into depression. This analysis examines differences in the visual, auditory, olfactory, and tactile hallucinations experienced by both groups. Although some similarities exist, experiences are quite different.

Introduction
Hallucinations can arise from a variety of conditions ranging from drug use to neurological complications. These hallucinations can be visual, auditory, tactile, and olfactory in nature and occur without the stimulation of the respective organs. Despite the research that has been done on hallucinations, a precise definition has not yet been decided due to the difficulty in separating hallucinations from misperceptions and illusions. Hallucinations can be defined as perceptions in the absence of external stimuli (Abad et al. 2014:184). Misperceptions and illusions both occur when there is a real stimulus, however, this stimulus is misinterpreted as something different (Sacks 2012:x). Hallucinations have played a role in human life for centuries, allowing shamans and priests to communicate with spiritual beings and gods.

Cultures across the world have been known to use hallucinogens for religious, recreational, and medicinal purposes. In the Americas, specifically the Amazon, hallucinogen use has become an integral part of native cultures due to the wide range of hallucinogenic compounds that can be found in the flora and fauna of the region. Chief among these hallucinogenic compounds are the ayahuasca brew (active ingredient: dimethyltryptamine or DMT), peyote and related hallucinogenic cacti (active ingredient: mescaline), and a variety of hallucinogenic fungi (active ingredient: psilocybin) (Bell 2014:667). The natural hallucinogens found in these regions have shaped cultures within the Americas, such as the Aztecs and Native Americans, who used them primarily for religious purposes.

Schizophrenia is a chronic and severe mental disorder which affects how a person thinks, feels, and behaves. People with schizophrenia often seem as though they have lost touch with reality (National Institute of Mental Health 2016). One of the more prominent symptoms of schizophrenia is the onset of hallucinations. The hallucinations caused by schizophrenia are involuntary and can disrupt everyday life for patients. Treatments for the hallucinations and other symptoms have the potential to be ineffective (National Institute of Mental Health 2016). The variety of symptoms experienced by individuals with schizophrenia can be extremely debilitating.

Natural hallucinogens and schizophrenia both cause hallucinations by affecting various regions of the brain. Natural hallucinogens commonly cause temporary hallucinations which dissipate after the active ingredient is metabolized and excreted from the body. Schizophrenia induced hallucinations can be alleviated through the use of medication. However, the medication is no always effective and the symptoms can linger. Natural hallucinogens produce primarily visual hallucinations, whereas schizophrenia produces auditory hallucinations. Both natural hallucinogen and schizophrenia induced hallucinations me be auditory, visual, olfactory, and tactile in nature. Often, hallucinations are a combination of these four senses. Hallucinations have the potential to disrupt normal life and cause distress in an individual’s life.

Natural Hallucinogens

Background
Narcotics that induce hallucinations are variously called hallucinogens, psychomimetics, psychotomimetics, and psychedelics. The fantastic effects that they produce make them sacred to primitive humans and have been an important part of the development of many cultures and religions (Schultes 1976: 12). Primitive societies often used hallucinogens as a way to cure sickness. They believed that sickness and health were affected by spiritual forces and that hallucinogens could give them access to the spirit world where a cure could be found. The Native American Church utilizes peyote to help cure members of sickness of the spirit, such as drug addiction (Schaeffer 2006: 154). Other cultures have used hallucinogens as a way to initiate adolescents into adulthood. The Algonquin Indians conduct a ceremony using wusoccan, a medicine containing the hallucinogen Datura. This medicine forces the adolescents into a state of delirium, causing them to forget aspects of their childhood. The ceremony allows them to enter into adulthood with few memories of ever being a child (Schultes 1976: 15). Many other cultures use natural hallucinogens for a variety of reasons such as: to establish contact with spirits or the souls of ancestors, to ponder religious and philosophical subjects, to establish a connection with the gds, to obtain magical and supernatural abilities, to heal psychologically diseased patients, to reach a form of enlightenment, to become a master shaman, and to use as an aphrodisiac during rituals (Savin 2012: 177). Hallucinogenic compounds cause an altered sense of perception in which the individual experiences many different types of hallucinations. The “trip” caused by each hallucinogen differs between people and experiences. The perceptual transformations and hallucinations induced by natural hallucinogens such as mescaline, psilocybin, and LSD are predominantly, but not exclusively, visual. The experience of color is often heightened and there may be sudden changes in orientation and alterations of apparent size (Sacks 2012: 103). Some hallucinations cause the appearance of imps, elves, dwarves, and fairies. Time, in many instances, appears to be altered.

LSD
Lysergic acid di-ethyl amide, commonly known as LSD was first discovered in 1935 by the Swiss chemist Albert Hoffman (Schultes 2012: 92). Although LSD is not a natural hallucinogen, its precursor, lysergic acid, is. Lysergic acid can be found in the fungus Claviceps purpurea, commonly known as ergot, which grows on rye grains in Europe. It has been known to poison entire towns when it is accidentally ground up and baked into bread (Schultes 1976: 134). Lysergic acid is a natural hallucinogen that is used to synthesise LSD.

There are many effects of LSD. About an hour after consumption of 80-150 μg of LSD colors become more vivid and previously unknown colors are perceived. The mind goes through a "journey" which last 7-8 hours. During this time, colors continue to be vivid and, in some cases, can be heard, a phenomenon called synesthesia. When the patient’s eyes are closed, geometric images and colored fractals appear. Occasionally, figures appear and talk about philosophical subjects. Sounds are often amplified, as are the emotions that go with them. Music may become deep and philosophical. Some patients have discussed an amplified sense of touch during their journeys. Tactile perception becomes extremely vivid, enhancing the perception of sexual stimuli (Savin 2012: 318). LSD causes a variety of hallucinations which can have positive effects on individuals. One student offered to share his experience of LSD use in December 2015. He was asked to describe the event and stated that: “I do not know how much I took, but the effects began to occur about an hour after ingestion. I was on the beach with my friends, listening to music and watching the sunset, when I started to notice that the colors seemed brighter and more defined. As I watched the sunset, I saw the clouds dancing through the sky. They appeared to shrink and expand. We went back to my friend’s house which was a five minute walk away, but seemed to take hours. As soon as we got back, I noticed a painting of a flower on the wall. As I stared at the painting, the flower began to move. I watched the flower sway in the wind and eventually lose its petals and die, only to rise again and repeat the process. I felt emotionally connected to the flower and every time it died, I felt sad while every time it regrew, I felt happy. I noticed that the process slowed down and sped up with the tempo of the music. It was unlike any other experience I had before and am afraid that any other trip will not be as profound for me" (Korth 2016).

LSD induced mood states may occur again, long after the ingestion of LSD. These events are known as flashbacks. They may be triggered by similar experiences that were had during a trip, such as a particular
type of music, sound, visual stimuli, taste, or smell (Sayin 2012: 321). The abuse of a hallucinogen may also cause flashbacks to occur more frequently. Whenever one patient would see a tree, a flashback would be triggered, causing him to hallucinate faces. The appearance of the hallucinations arose during a period of time when the patient was using LSD on a weekly basis (Iagro et al. 2010: 107). Researchers determined that he had what is known as Hallucinogen Persisting Perceptual Disorder, a disorder that is characterized by the persistence of visual phenomena after heavy hallucinogen use. LSD alters an individual’s state of perception, causing them to hallucinate. Typically, individuals on LSD trips see colors as being brighter and more vivid and experience feelings of euphoria.

Psilocybin

Psilocybin is the active ingredient in “magic mushrooms.” Cultures such as the Aztecs used psilocybin-containing mushrooms during rituals, banquets, and festivals. When Spain began to conqueror Mexico and other areas of Central America, the use of “magic mushrooms” was prohibited. Despite the efforts of the Spanish, mushroom ceremonies persisted in remote areas. In more populated areas, the mushroom cult remained present but in hiding. Due to the secrecy of the cult, little was known about the actual mushroom until the 1930’s (Schultes 1976: 64).

Hallucinations caused by the ingestion of psilocybin-containing mushrooms begin to manifest within the first 2 hours. Effects last an additional 3-4 hours and disappear within 8 hours (Tittarelli et al. 2015: 30). Similar to LSD, psilocybin creates feelings of euphoria. Visual hallucinations of colorful images, dancing geometric shapes, and feelings of being in contact with a “Great Spirit” are most commonly reported in users. It is believed that psilocybin journeys induce sharp changes in the philosophical and ideology of the individual. Alterations in perception of both time and size have been observed as well. Tactile and olfactory hallucinations are not common in individuals ingesting psilocybin-containing mushrooms (Sayin 2012: 327). Psilocybin has been used by priests and shamans as a way to communicate with spirits and ancestors.

Magic mushrooms have been used for spiritual purposes since humans first discovered them. Many reports speak of a “Great Spirit” that is felt during a psilocybin trip. This presence has caused people to believe that psilocybin-containing mushrooms can be used for moral and spiritual cleansing. One individual describes his experience as an inner cleansing. After consuming 6 grams of mushroom powder, the individual was able to reflect on his life and the obstacles currently facing him. During his trip, he had a vision of himself as a baby being cradled by his mother. An alien voice spoke to him, telling him to care for her and to do no harm to the people close to him. After his trip, he called his mother to apologize to her for being so cruel to her. Shortly thereafter, he quit drinking as well because he felt it was immoral and did harm (Alyushin 2011: 579). Psilocybin experiences differ between users and uses. Each trip is different from any other that has been experience beforehand.

There have been several cases where individuals who have consumed psilocybin have had negative trips. A 12-year-old boy was admitted to a hospital after ingesting magic mushrooms. He was found in a confused state, running through traffic. Several other patients defined their experiences as frightening and life-threatening (Pedan et al. 1981: 544). It is difficult to discern whether or not a trip will be good or bad beforehand. It is possible that any trip caused by a hallucinogen depends on the environment and mood that the individual is in prior to ingestion.

Mescaline

Mescaline is the active ingredient in the peyote cactus, Lophophora williamsii. Peyote has been used in Native American and Mexican cultures by shamans as a way to develop their own spiritual powers and to answer philosophical questions. It is reported that the spiritual and philosophical mysticimmetic effects of mescaline are much more profound than other hallucinogens (Sayin 2012: 324). Peyote is a small, spineless cactus that is native to the Rio Grande valley of Texas and northern and central parts of the Mexican plateau. The crown of the cactus is cut off and dried, allowing it to be kept for long periods of time and shipped to distant locations. Similar to magic mushrooms, the Spanish attempted to eradicate the peyote religion during their conquest of Central and South America. At one point, they equated the eating of peyote to cannibalism (Schultes 1976: 117). Despite their attempts, the peyote religion continued on in secrecy.

The hallucinations caused by mescaline are primarily visual but many trips have an auditory aspect as well. The mescaline induced images are commonly geometric figures of spirals, funnels, cones, honeycomb, and other kaleidoscopic images. Auditory hallucinations manifest themselves as a voice which has been described as a leading Guru or teacher (Sayin 2012: 325). In cultures such as Huichol Indians of Mexico, the hallucinations contain many different animals. One shaman, Rafael Pisano, reported that after ingestion of peyote, “Some animals appeared, they were like dinosaurs, and a big snake; they were all huge, really big! I was surprised to see them...they asked me what I was thinking, what I was feeling. Well, at that time I lost myself [traveling with the peyote]... [The creatures told him] ‘We will clean you’. And they cleaned me with their tongues” (Schaefler 2006: 153).

Experiences such as Pisano’s provide insight into why cultures believe that peyote has medicinal effects. Religions, such as the Native American Church, utilize peyote in healing ceremonies. The ceremony takes place in a teepee over the course of an entire night. A “roadman” leads the participants through the ceremony in which dried peyote tops are ingested. This ritual is done to heal the spirit of each participant (Schultes 1976: 126). Mescaline causes individuals to be extremely introspective, allowing them to analyze who they are. In some cases, this self-analysis has made users feel free and clear of their past troubles (Sayin 2012: 325). Mescaline containing peyote is used by individuals as a way to spiritually heal themselves.

Pathway

Soon after the discovery of LSD by Hoffman in 1943 and the identification of serotonin as 5-hydroxytryptamine in 1949, it was recognized that LSD could act via serotonergic mechanisms. Furthermore, symptoms of mescaline and DMT ingestion were similar to LSD ingestion suggesting that they share a common mechanism, specifically the stimulation of the 5-HT2A receptor. In addition to the 5-HT2A receptor, the 5-HT1A and 5-HT2C receptors have been found to act as mediators in the LSD-induced stimulus (Winter 2009: 253). Serotonin receptors are able to be activated by tryptamines such as LSD, DMT, and psilocybin and phenethylamines such as mescaline.

Neuroimaging studies on the brains of patients who have taken LSD show the changes in brain function during an LSD experience. Three neuroimaging techniques were used to determine changes in brain activity: arterial spin labeling (ASL), blood oxygen level-dependent (BOLD) measures, and magnetoencephalography (MEG) (Carhart-Harris et al. 2016: 4854). Scans showed that there is an increase in visual cortex cerebral blood flow and resting state functional connectivity between many cortical and subcortical regions of the brain, predating the magnitude of visual hallucinations. Decreased default mode network integrity and bilateral parahippocampal- retrosplenial cortex resting state functional connectivity were correlated with changes in consciousness, typically ego-dissolution (Carhart-Harris et al. 2016: 4856). Despite these findings, it is unclear how psychedelic drugs cause an altered consciousness. Further research can be done on how altered perceptions can lead to an altered consciousness such as ego-dissolution. Neuroimaging can be used to show brain activity under a variety of drug induced conditions, providing insight into the changes made in the brain during these psychedelic experiences.

Schizophrenia

Background

Schizophrenia is a chronic mental disorder that disrupts normal, everyday life for patients. Hallucinations induced by schizophrenia are often associated with high levels of anxiety, discomfort, and interference with daily life. Due to their disruptive effects, most patients seek out ways to eliminate these experiences (Langer et al. 2015:23-24). Hallucinations associated with schizophrenia can be auditory, visual, olfactory, and tactile. Similar to natural hallucinogens, a combination of hallucinations can be experienced at one time.

Auditory and Visual

Auditory hallucinations are the most common type of hallucination experienced by schizophrenic patients (Delespaul et al. 2002: 97). Imaging studies have shown that connections between a patient’s amygdala and medial prefrontal regions of the brain are significantly weaker, while connections between the limbic and sensory auditory regions of the brain are significantly stronger. Due to the limbic system’s role in emotional responses, the auditory hallucinations heard are commonly emotionally distressing for patients (Horga et al. 2013: 6). Visual hallucinations are the next most commonly reported type of hallucination experienced by schizophrenic patients (Delespaul et al. 2002: 97). These types of hallucinations vary in intensity and form. Hallucinations can manifest themselves as loved ones, pets, or as overlapped body parts (Abad et al. 2011: 161; Hoffman et al. 2006: 291). Auditory and visual hallucinations occur together quite frequently.
Auditory verbal hallucinations that occur together can be quite disruptive for a patient. One patient experienced hallucinations of her family and dog whenever she was in a crowded area. When she was alone, it was easier for her to tell that they were hallucinations. Her initial treatment was unsuccessful and, as a result, the hallucinations became more debilitating. Eventually, she was unable to function within the community due to their increasing intensity. Her relationships with her family members and friends were deteriorating as she struggled with the hallucinations. Her second treatment involved the use of Rivastigmine, an acetylcholinesterase inhibitor, which caused the auditory hallucinations to go away. The visual hallucinations remained but were less intense (Abad et al. 2011: 162). Unlike the hallucinations caused by hallucinogens, these were daily occurrences and a cause of constant distress in her life.

Another patient was a male who heard male and female voices 7-10 times per hour throughout the day. In addition, mouth movements were superimposed on other people, making it seem as though the voices were coming from them. The auditory and visual hallucinations were most intense when he was with family members. A second patient reported similar hallucinations of a superimposed mouth on the faces of real people and voices coming from the mouth. However, these voices primarily said negative things to him, causing emotional distress. A third patient reported hearing the voices of people she had recently been in contact with. The voices came from human-like forms that exhibited mouth movements. Furthermore, they made hand gestures and finger movements conforming to American Sign Language, a language that the patient could speak fluently. Due to the reports of auditory and visual hallucinations occurring together, it is believed that the hallucinations are caused by similar dysfunctions in the brain (Howard et al. 2006: 290-291). The combination of auditory and visual hallucinations seems to be a common occurrence in individuals with schizophrenia. Many reports show that these experiences have a negative effect on the individual.

**Olfactory and Tactile**

Both olfactory and tactile hallucinations are experienced by a minority of individuals with schizophrenia. Little research has been done on both due to the rarity of both hallucinations. Investigations into olfactory hallucinations have shown that they are emotionally distressing for individuals and can lead to the development of depression. False perceptions of one’s own body odor have been linked to self-deprecation (Kimhy 2016: 117). Tactile hallucinations can cause physical pain in individuals (Pfeifer 1970: 57). Both types of hallucinations are disruptive to the everyday life of the individual.

A patient with olfactory hallucinations reported that he constantly smelled of feces. Initially, he thought only he could smell it but eventually became convinced that other people could smell it as well, causing him to remove himself from social situations. His friendships became strained as he increasingly avoided contact with others. He took several long showers each day and changed clothes frequently, but could still smell feces. As this behavior continued, he developed severe depression and suicidal thoughts (Howard 2016: 119). In this case, olfactory hallucinations caused a man severe emotional distress. Cases in which individual hallucinate bad smells on themselves can lead to depression and anxiety in daily life.

A patient with tactile hallucinations described them as unbearable and painful, but only when he was awake. Upon falling asleep, the patient would no longer feel as though his skin was being stretched away from his body. During the most intense part of the hallucination, he feels as though his skin is being stretched one foot above his head. In order to cope with these hallucinations, he would bang his head against various objects, tap his foot, rock back and forth, grimace, or go completely rigid (Pfeifer 1970: 60). These types of hallucinations are difficult to describe accurately, causing patients to say that they are in pain.

**Pathway**

Distinct patterns of connectivity in the brains of schizophrenic patients are associated with different types of hallucinations. Hippocampal complex connectivity plays are large role in the determination of hallucination type. Patients with auditory-only hallucinations exhibited a higher functional connectivity between the hippocampal complex and thalamus than patients with both auditory and visual hallucinations. The patients experiencing auditory and visual hallucinations had a higher functional connectivity between the hippocampal cortex and medial prefrontal cortex and caudate nuclei when compared to the auditory-only patients (Amad et al. 2014: 187). Between hallucination types there are differences in brain connectivity between different structures of the brain. This phenomenon can be seen in the increased fractional anisotropy between the hippocampal cortex and visual areas of the brain in auditory-only and auditory-visual patients. Furthermore, the volume and shape of the hippocampus is hypertrophic in both groups of patients (Amad et al. 2014: 188). Hallucinations are a common symptom of schizophrenia. They are caused by a dysfunction in the brain. Connectivity between different brain regions may be increased or decreased, leading to the onset of hallucinations in patients.

**Conclusion**

Natural hallucinogens and schizophrenia both cause hallucinations of various types including visual, auditory, tactile, and olfactory. However, the hallucinations caused by both are vastly different. Natural hallucinogens produce euphoric hallucinations that allow for introspection and deep thinking. Visual hallucinations are the most common type of hallucination caused by ingestion of natural hallucinogens. They often manifest as geometric shapes, however, other images such as animals, fairytale creatures, and aliens have been reported. Auditory hallucinations are often described as a great voice that leads the individual through a journey of introspection. The senses are heightened as well; colors become much more vivid, touch becomes much more pleasurable, and sounds appear to have deep meanings. In rare occurrences, natural hallucinogens cause bad “trips” that leave the individual anxious and fearful. These hallucinations last several hours before disappearing. Schizophrenia induced hallucinations are more negative. Auditory hallucinations, the most common type, often cause deep emotional distress in patients. Voices can be overly critical or negative. They are sometimes combined with visual hallucinations of people, body parts, or animals. This combination can cause confusion and distress. Although olfactory and tactile hallucinations are rare their effects are quite negative. These hallucinations can cause individuals to feel self-deprecating or physical pain, respectively. Regardless of the type of hallucination experienced, the possibility of anxiety or depression is ever present in schizophrenia patients.

Hallucinations induced by natural hallucinogens and schizophrenia cause changes in brain function. Imaging studies show that there is an increase in connectivity between many cortical and subcortical regions of the brain when hallucinogens are ingested. There is also an increase in blood flow to the visual cortex. These increases lead to hallucinations. Decreases in the functionality of the default mode network and connections between the parahippocampal region and retrosplenial cortex lead to ego-dissolution. Brain scans of schizophrenic patients show that there are differences in connectivity between the hippocampal and visual cortex and frontal cortex and nucleus. Furthermore, the hippocampal cortex has a different shape and volume compared to a normal brain. Natural hallucinogens and schizophrenia affect the brain differently. Hallucinations can be caused through a variety of conditions. Each experience varies from person to person regardless of the cause.

**References**


