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Review Article

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Hallucinations: A Narrative Review

Tiffany Field, PhD

University of Miami/Miller School of Medicine and Fielding Graduate University, USA

Corresponding author

Tiffany Field, University of Miami/Miller School of Medicine and Fielding Graduate University, USA.

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ABSTRACT

Hallucinations have been defined as sensory experiences - seeing, hearing, smelling, tasting or feeling things that occur without an actual external stimulus. While they feel real, they are generated by the brain. Hallucinations can affect any of the five senses including auditory, visual, tactile, olfactory and gustatory. They are not necessarily a sign of mental health disorder. A few negative effects of hallucinations have been studied including impaired self–other voice discrimination and suicidal mental imagery. Several comorbidities have been noted for hallucinations including migraine headaches, PTSD, borderline personality disorder, schizophrenia, Parkinson's disease and Alzheimer's disease. The risks/predictor variables that have been addressed for hallucinations include mental imagery, social stress, sexual trauma, auditory and otolaryngology problems and vitamin B12 deficiency.Potential underlying biological mechanisms have been the focus of current research on hallucinations including dysfunctional neurotransmitter activity, cholinergic dysfunction, decreased functional connectivity, decreased amygdala connectivity, dysfunctional circuitry, and reduced brain volume, gray matter volume and hippocampal volume. The intervention studies that have appeared in this current literature include mindfulness, virtual reality, trauma focused therapy, cognitive behavioral therapy, acceptance and commitment therapy, music, fMRI feedback, transcranial stimulation and theta burst stimulation.

Hallucinations have been defined by Google as sensory experiences - seeing, hearing, smelling, tasting or feeling things that occur without an external stimulus. Although they feel real, they are generated by the brain. Hallucinations can affect any of the five senses including auditory, visual, tactile, olfactory and gustatory. They are not always a sign of mental health disorder. They are sometimes temporary experiences that are associated with high fevers, severe dehydration, sleep deprivation or alcohol and drug use. They are often linked to psychiatric conditions including schizophrenia, bipolar disorder or severe depression, neurological disorders like Parkinson's disease and Alzheimer's disease and sensory impairment such as significant vision or hearing loss.

The research for this narrative review involved entering the terms hallucinations and the years 2024 to 2026 in PubMed and PsycINFO. Exclusion criteria included case studies and non-English language papers. This narrative review includes 36 papers on hallucinations. The papers can be categorized as different types of hallucinations (four papers), negative effects (three papers), comorbidities (seven papers), risks/predictor variables (five), potential underlying biological mechanisms (eight) and interventions (seven). These sections are followed by a discussion on methodological limitations of this current literature.

Different Types of Hallucinations

Different types of hallucinations appear in this literature including visual hallucinations, auditory verbal hallucinations and inner-speech based hallucinations (see table 1). Many of the samples are comprised of schizophrenics or adults with Parkinson's disease. The most frequently studied hallucinations are **auditory verbal hallucinations.** They are perhaps more frequent than visual hallucinations because untreatable auditory problems are more prevalent than visual problems, according to the World Health Organization. In a paper entitled "Auditory verbal hallucinations, the ins and outs of subtypes", two types were identified in a small sample of adults with hearing hallucinations (N=40) [1]. The two types included auditory verbal and inner speech-based voices.

Table 1: Different Types of Hallucinations (and first authors)

Types	First authors
Auditory Verbal	Cioroboiu
Complex Visual	Shenyan
Visual	Aynsworth

In a systematic review of 18 articles, **verbal hallucinations** were related to emotional recognition [2]. The authors concluded that less emotional recognition accuracy consistently occurred. The auditory verbal type may be more prevalent than the inner speech-based type as that type is more commonly studied or maybe it's a simpler type to research because it is more common.

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Complex visual hallucinations have also appeared in this literature. In a paper entitled "Reduced susceptibility to experimentally induced complex visual hallucinations with age", decreased proneness to hallucinations was a feature of old age in this study (N=22, mean age=19 for the young sample and N = 22, mean age= 68 for the old sample) [3]. When hallucinations of this type appear in old age, it has been a sign of underlying pathology. Although the authors may have intended their research to inform the diagnostic process, this research would seem to have human subjects ethical research concerns for inducing hallucinations. The older participants may have been less willing to experience induced hallucinations and actively mind-ignored them.

Visual hallucinations have frequently occurred in psychotic adults. In a study that addressed "what those people actually see", 12 adults were engaged in semi-structured interviews [4]. Not surprisingly, the authors concluded that people "actually see people who look and act real" just as they do in dreams. Visual hallucinations are typically less common than auditory hallucinations in psychotic individuals, but they are strongly linked to higher overall symptom severity and functional impairment. In contrast, frequent visual hallucinations are characteristic of neurological conditions like Parkinson's dementia or epilepsy rather than psychiatric diagnoses. Semi-structured interviews were an ideal methodology for exploring the content of hallucinations which has been missing from most of the studies in this current literature. Diary recordings would be another method for recording content, although less compliance might be expected from the majority of the participants of these studies who have schizophrenia or Parkinson's disease, as already mentioned.

Negative Effects of Hallucinations

A few negative effects of hallucinations have been studied including impaired self – other voice discrimination and suicidal mental imagery (see table 2). In a study entitled "Impaired self – other voice discrimination in patients with auditory verbal hallucinations and non-clinical hallucination proneness", a sample of schizophrenic patients and a sample of healthy controls were seen (N=41) [5]. The results are in the title, suggesting that those with auditory verbal hallucinations had **impaired self – other voice discrimination.** These findings were not surprising as auditory verbal hallucinations would limit the interaction experience with self-other voice discrimination for schizophrenic patients.

Table 2: Negative Effects of Hallucinations (and first authors)

Negative Effects	First Authors
Impaired self-other voice discrimination	Vukojevic
Suicidal mental imagery	Thompson
Suicidal ideation, attempts at non suicidal self-injury	Lu

In research entitled "An exploration of the co-occurrence of hallucinations and suicidal mental imagery among psychiatrically hospitalized adolescents at high risk for suicide" (N=219), the results are again in the title [6]. In this sample, hallucinations during the past month predicted **suicidal verbal thoughts and suicidal mental imagery** during the past week. Regression analysis or structural equation modeling would need to be conducted to determine the degree to which hallucinations contributed to the suicidal verbal thoughts and the suicidal mental imagery among these psychiatrically hospitalized adolescents.

In a systematic review of 29 studies on auditory verbal hallucinations and suicide, a significant association was noted between auditory verbal hallucinations and **suicidal ideation, suicide attempts and non-suicidal self-injury** [7]. The link between ideation and attempts was unknown, and appraisal of voices was reported as a predictor variable rather than hearing the voices themselves. Surprisingly, other variables did not emerge as significant predictors of suicidal ideation in as many as the 29 studies in this systematic review.

Comorbidities for Hallucinations

Several comorbidities have been noted for hallucinations (see table 3). These surprisingly diverse conditions include migraine headaches, PTSD, borderline personality disorder, schizophrenia, Parkinson's disease and Alzheimer's disease. In a systematic review of 48 studies on multisensory hallucinations and **migraine headaches,** hallucinations were experienced in addition to auras [8]. The relationship between headaches and hallucinations is likely bi-directional, as are the relationships between hallucinations and other comorbidities.

Table 3: Comorbidities of Hallucinations (and first authors)

Comorbidities	First Authors
PTSD	Dudley
Borderline Personality Disorder	Van Veen
Parkinson's	Panigutti
Alzheimer's	Panigutti
Schizophrenia	Panigutti
Psychiatric Disorders	Kerklaan
Hearing Loss	Kerklaan
Neurological Problems	Kerklaan

Hallucinations have been reported across sensory domains in people with post-traumatic stress disorder **(PTSD)** (N= 67 adults with PTSD) [9]. Of these adults with PTSD, 90% were noted to have auditory hallucinations, 58% visual hallucinations, 46% tactile hallucinations, and as many as 72% experienced hallucinations in two or more modalities. These data were surprising given that hallucinations are not frequently given as symptoms of PTSD like flashbacks and nightmares.

Adults with **borderline personality disorder** have been noted to have sexual hallucinations and delusions [10]. Sexual hallucinations have been reported in .4% of the general population, in 44% of adults with schizophrenia and 59% in adults with borderline personality disorder. In this sample (N=81), somatic, visual, tactile and auditory hallucinations were more frequent than olfactory and gustatory hallucinations. This result was not surprising given that adults typically experience at least visual and auditory stimulation more frequently than olfactory and gustatory stimulation. Although research on the relationships between stimulation that is experienced and hallucinations has not appeared in this literature, those relationships are likely. In

this sample, child trauma was reported by all participants which is not surprising given that sexual trauma in childhood would likely contribute to sexual hallucinations in adulthood.

Multiple comorbidities have been noted in a study entitled "Seeing without eyes: relations between visual mental imagery and visual hallucinations" [11]. **Parkinson's disease, Alzheimer's disease and schizophrenia** were implicated in the visual hallucinations. Reality monitoring deficits were also noted in those with Parkinson's disease and schizophrenia in this sample. Reality monitoring was likely more prevalent in Parkinson's and schizophrenia than Alzheimer's because of the relatively greater cognitive function in Parkinson's and schizophrenia. Based on fMRIs, hyper- functioning was noted in visual association areas which would be the expected regions for visual mental imagery and visual hallucinations.

Comorbidities were also noted in a sample of 81 patients with musical hallucinations [12]. Although musical hallucinations are reputedly relatively rare, affecting roughly .16 of general hospital populations, this sample included **psychiatric disorders** in 50% of the sample, **hearing loss** in 50%, **neurological problems** in 28% and a combination of these conditions in 28%. These high prevalence rates are not surprising based on the literature just reviewed on these conditions.

A high prevalence was also noted for **tinnitus** (perception of ringing, buzzing, clicking or hissing sounds in the ears without an external sound that is triggered by hearing loss, loud noise exposure, ear blockages, medications and/or medical conditions). Those with tinnitus were often observed to have multimodal hallucinations involving up to six sensory categories.

Risk Factors/Predictor Variables

Several risk factors/predictor variables have been addressed in this literature on hallucinations (see table 4). They include mental imagery, social stress, sexual trauma, auditory and otolaryngology problems and vitamin B12 deficiency.

Table 4: Risk Factors/Predictors (and first authors)

Risk Factors/Predictors	First Authors
Mental Imagery	Janssen
Social Stress	Farina
Sexual Trauma	Bere
Auditory and Otolaryngology Problems	Jin
Vitamin B12 Deficiency	Blom

In a systematic review entitled "Emotional and non-– emotional mental imagery and auditory verbal hallucinations (hearing voices): a systematic review of imagery assessment tools", 17 papers were included [13]. The papers consistently showed that **emotional mental imagery** was related to auditory verbal hallucinations. The hallucinations may have reflected the emotional mental images.

In a study on the relationship between social stress and the severity of auditory hallucinations, participants with a history of hearing voices from the Yale Control Over Perceptual Experiences Project were seen (N= 278) [14]. In a regression model, **social stress** uniquely predicted the distress of hearing voices. Finding social stress as a unique predictor variable was surprising given that regression analyses typically include several variables that contribute to different amounts of variance in the outcome variable.

Sexual trauma was also a risk factor for hallucinations in a study entitled "Trauma and hallucinations across the sensory modalities: the importance of considering experiences in childhood and adulthood" [15]. In this sample of adults with psychotic disorders (N= 66), visual hallucinations were associated with sexual trauma in childhood and adulthood. These visual hallucinations likely involved sexual hallucinations that were related to the sexual trauma that these adults with psychotic disorders had experienced.

Auditory and otolaryngology problems were also risk factors for hallucinations in a study from Korea [16]. In this sample, these problems were noted in patients with musical hallucinations. **Tinnitus** (hearing phantom noise) often results from hearing loss which may sound like musical hallucinations that would be more pleasant than the more typical ringing and buzzing sounds of tinnitus.

Vitamin B12 deficiency has been associated with hallucinations in a systematic review [17]. Visual and auditory hallucinations were the most prevalent, but 20% were complex hallucinations (seeing distinct people, animals or complex scenes). Vitamin B12 deficiency was noted in anemia, dementia, epilepsy, bipolar, depression, and obsessive-compulsive disorder. Some of these conditions, for example, dementia, depression and obsessive-compulsive disorder, themselves have been associated with hallucinations. They may have mediated the relationship between vitamin B12 deficiency and hallucinations.

Potential Underlying Biological Mechanisms for Hallucinations

Several potential underlying biological mechanisms have been the focus of research on hallucinations (see table 5). They include neurotransmitter dysfunction, cholinergic dysfunction, decreased functional connectivity, decreased amygdala connectivity, dysfunctional circuitry, reduced brain volume, reduced gray matter volume and reduced hippocampal volume.

Table 5: Potential Underlying Biological Mechanisms (and first authors)

Mechanisms	First Authors
Neurotransmitters	Xie
Central Cholinergic Dysfunction	Ignatavicis
Decreased Functional Connectivity	Montagnese
Dysfunctional Amygdala	Ignatavicis
Dysfunctional Circuitry	Zhou
Decrease Gray Matter Volume	Xie
Decreased Volume Hippocampus	Perez-Rando

Relationships between **neurotransmitter dysfunction** and auditory verbal hallucinations in adults with schizophrenia were explored in a systematic review and meta-analysis [18]. Across studies, excessive dopaminergic and noradrenergic neurotransmitter activity were noted. An excess of dopamine

and its derivative norepinephrine have been noted to drive hallucinations. Also, not surprisingly, increased activation in auditory and language networks, reward and motivation circuits and executive control regions were observed on fMRIs during auditory verbal hallucinations.

Central cholinergic dysfunction was reported for adults with Parkinson's disease who had visual hallucinations [19]. Degeneration within the central cholinergic system (which regulates attention, memory, sleep and muscle control) played a significant role in the genesis and progression of visual hallucinations in these patients.

Decreased functional connectivity in the default mode network, somatomotor and attention networks was another potential underlying mechanism for hallucinations in Parkinson's disease [20]. In this sample of hallucinators (N=25) and non-hallucinators (N=55), functional connectivity was associated with baseline and future motor, cognition, and attention functions.

In still another study on visual hallucinations in adults with Parkinson's disease, **dysfunction of the amygdala and nucleus basalis** was observed on fMRIs of those with visual hallucinations (N=30) and those without hallucinations (N=40) [19]. **Decreased amygdala connectivity** with networks involved in visual and attention processing was also noted on the fMRIs. The decreased connectivity in visual and attention processing networks was, not surprisingly, associated with visual hallucinations.

In a study entitled "Deciphering the neural signature of auditory hallucinations in early onset schizophrenia", fMRIs were again conducted, These implicated dysfunctional circuitry between the left superior temporal gyrus and the left cingulate gyrus [21].

A few studies appeared in this literature on fMRIs on **brain volume.** In a unique study on a healthy sample (N=68 university students), the relationship between hallucination proneness and brain morphology was explored [22]. The students completed a scale for hallucination proneness for auditory and visual experiences. Structural MRI scans were used to measure brain volume. Paradoxically, those with high hallucination proneness had high volumes in language – related areas (superior temporal gyrus and Broca's area). In contrast, those with clinical hallucinations had low volumes in those areas, as might be expected.

Gray matter volume was specifically decreased in the left and right insula and the left anterior cingulate cortex according to a recent meta-analysis on alterations in schizophrenics with auditory verbal hallucinations [23]. Not surprisingly, this volume decrease was associated with specific genes and neurotransmitter systems.

In still another sample, patients with schizophrenia and auditory hallucinations (N=35) as compared to healthy controls (N=55) had **decreased volumes in the hippocampus** (involved in memory functions) **and amygdala** (involved in emotions and emotional memory) [24].

Interventions for Hallucinations

Several intervention studies have appeared in this literature on hallucinations (see table 6). They include mindfulness, virtual reality, trauma-focused therapy, cognitive behavioral therapy, acceptance and commitment therapy, music, fMRI feedback, transcranial stimulation and theta burst stimulation.

Table 6: Interventions (and first authors)

Interventions	First Authors
Mindfulness	Yang
Virtual Reality	Kyle
CBT, ACT and Music	Sivaji
FMRI Neurofeedback	Dhanis
Transcranial Magnetic Stimulation	Hua
Theta Burst Stimulation	Kassar

In a study entitled "Mindfulness – based group therapy for auditory hallucination management in schizophrenia: a randomized controlled trial", the authors highlighted the importance of therapy for schizophrenics with auditory hallucinations given that 50% to 70% of schizophrenic patients have auditory hallucinations [25]. In this study, 80 patients with schizophrenia were randomly assigned to the **mindfulness group therapy.** After eight weeks of two hours of therapy twice a week, hallucinations were reduced as well as anxiety and depression. This study highlighted the relationships between hallucinations, anxiety and depression which are rarely discussed in the hallucinations literature as compared to the associations between hallucinations and schizophrenia and hallucinations and Parkinson's.

Auditory hallucinations in adults with schizophrenia have also been treated with **virtual reality.** In a systematic review and meta-analysis entitled "Virtual reality for the treatment of auditory hallucinations in schizophrenia spectrum disorders: a systematic review and meta-analysis", eight studies were included (N=1004) [26]. In these studies, auditory hallucinations were reduced by **avatar therapy** (a digital simulation of the entity the patient believes is behind the hallucinated voices). The avatar therapy is seemingly a form of re-exposure therapy.

Trauma–focused therapy, that focuses on trauma symptoms like flashbacks and panic episodes, has also been effective in reducing auditory hallucinations. In a study entitled "The effect of trauma–focused therapy on voice–hearing: an experience sampling study", trauma-focused therapy reduced voice-hearing [27]. This would be considered another form of re-exposure therapy which understandably would be effective.

In a review of several psychological interventions for adults with auditory hallucinations, surprisingly, only a few were notably effective [28]. These included **cognitive behavioral therapy for psychosis, acceptance and commitment therapy and music.** These findings are not surprising as these therapies have been effective for many conditions.

Transcranial magnetic stimulation (that uses magnetic pulses to stimulate nerve cells in the brain) has, not surprisingly, reduced auditory verbal hallucinations in schizophrenia. In a randomized clinical trial (N= 66 patients with auditory verbal hallucinations and schizophrenia) the Auditory Hallucination Rating Scale was used [29]. After two weeks of this treatment, the transcranial magnetic stimulation group versus the sham

group showed lower scores on that scale, and the lower scores were sustained at six weeks following the end of therapy.

Another form of transcranial magnetic stimulation called **theta burst stimulation** has also been effective for reducing auditory hallucinations in schizophrenia. In a paper that reviewed five randomized sham – controlled trials, theta burst stimulation reduced auditory hallucinations in adults with schizophrenia (N = 326) [30]. These data were not surprising given that theta burst stimulation Is a highly efficient form of transcranial magnetic stimulation that delivers magnetic pulses in rapid, patterned bursts to mimic the brain's natural theta rhythms.

In a study entitled "Real time **fMRI neuro feedback** modulates induced hallucinations and underlying brain mechanisms", healthy individuals received three days of training for the study [31]. Healthy individuals were trained to upregulate a fronto-parietal brain network that would reduce the hallucinations. It's unclear how the induction of hallucinations in healthy individuals could be approved by an "Institutional review board for human subjects".

Methodological Limitations of this Literature

Several Methodological limitations can be noted for this literature on hallucinations. They include diverse sampling, multiple comorbidities, a range of risk variables, several potential underlying biological mechanisms and several interventions that have not been compared for efficacy and cost.

Only a few research groups have sampled healthy individuals. This is perhaps not surprising given that the prevalence of hallucinations is only .4% in the general population. Most of the studies in this literature, not surprisingly, are on patients with Parkinson's or schizophrenia who have frequent hallucinations. Estimates suggest that 50% have psychological disorders and 50% have a hearing loss. These estimates suggest that they are convenience samples. In addition, most of the participants have single or multiple comorbidities which confound the effects of hallucinations, limiting any definitive conclusion.

Most of the studies are focused on auditory verbal hallucinations, which are more common than visual hallucinations, which is not surprising given that hearing problems are more prevalent than visual problems. None of the studies have compared the negative effects of auditory verbal versus visual hallucinations. And the content of the hallucinations is rarely described, likely because most of the data are self-report questionnaire data rather than interview or diary data.

Risk factors and predictors range widely from sexual trauma to social stress to vitamin B12 deficiency. As there are no multiple risk variable studies, no comparisons have been made between these risk factors.

Several potential underlying biological mechanisms have been proposed which all involve the brain. However, each study involves a different part of the brain and different problems ranging from reduced amygdala connectivity to decreased hippocampal volume. Again, multiple variable studies and regression analyses are needed to inform intervention research.

Multiple different interventions have been studied, ranging from music and cognitive behavior therapy to trauma-focused therapy to transcranial magnetic stimulation. No comparisons have been made on the efficacy and cost of these interventions.

Despite these methodological limitations, the current research has highlighted comorbidities and risk factors as well as effective interventions for hallucinations. These will hopefully inform future research for intervening and preventing hallucinations.

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