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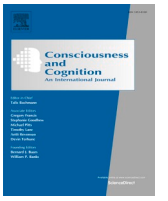

Review article

The Hitchhiker's guide to hallucination research

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ABSTRACT

Hallucination research is a fast-growing, inherently interdisciplinary field bridging psychology, neuroscience, psychiatry, and philosophy. This article maps out key conceptual and methodological issues underlying the study of hallucinations. We begin by unpacking core theoretical issues – how hallucinations differ from other perceptual alterations, whether they form a single construct or several, and how these distinctions influence study design and interpretation. Next, we review the most commonly used experimental paradigms. A clear distinction is drawn between tasks that measure enduring hallucinatory tendencies and those that capture hallucinations in real time. We also review the most widely used rating instruments – including confidence scales – and discuss the phenomenological approach, which foregrounds participants' first-person experience. The final section offers a concise, though not exhaustive, checklist of variables researchers must account for – ranging from sensory modality and context to cognitive style, affective state, and cultural background. Taken together, the article serves as an entry-level guide, posing critical questions that every researcher should answer before designing a study on hallucinations.

1. Introduction

Hallucination research is a growing field that brings together researchers from different disciplines. Due to the distress typically associated with hallucinations in psychiatric and neurological disorders (Kjelby et al., 2015; McCarthy-Jones et al., 2013), research has traditionally focused on patient populations (Honig et al., 1998), particularly those with psychosis disorders (Waters & Fernyhough, 2017). During the last decade, however, the importance of studying hallucinations in nonclinical samples has been highlighted (Aleman & Larøi, 2008; Johns et al., 2014). It is estimated that approximately 10–15 % of individuals from the general population experience hallucinations that do not interfere severely or negatively with their daily lives, and therefore are not considered 'pathological' (Beavan et al., 2011; Sommer et al., 2010). Conducting studies in non–clinical samples offers methodological advantages, since these samples fall on a continuum with clinical populations – yet avoid confounding factors like comorbid anxiety, depression, and pharmacological treatment that are typical in clinical groups (Johns & van Os, 2001).

The existing studies range from investigating spontaneously occurring hallucinations (e.g., Kimhy et al., 2006) to artificially inducing them in experimental settings (Rogers et al., 2021). The methods employed are also diverse: some are focused on the subjective experience of hallucinations (e.g., Linszen et al., 2022; Pienkos et al., 2019), others examine their neural correlates (e.g., Jones

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& Fernyhough, 2007; Marques et al., 2021; Pagonabarraga et al., 2014; Romeo & Spironelli, 2022), some probe altered cognitive processes in affected individuals (e.g., Aleksandrowicz et al., 2023; A. Bell et al., 2024), and others analyse the social and cultural factors associated with hallucinations (Dupuis, 2022; Ghanem et al., 2023; Khaled et al., 2023), among other aspects. The great variety in approaches and methodologies is largely due to the multifaceted nature of hallucinations that attracts multiple scientific disciplines, including psychology, psychiatry, anthropology, cognitive neuroscience or philosophy. Indeed, the *International Consortium on Hallucination Research* (ICHR) agrees on the importance of "mixed approaches and multiple perspectives to secure the best possible outcomes" in the field as, they argue, "challenges and opportunities cannot be achieved without strong collaborative relationships between experts with different areas of expertise" (Jardri et al., 2019, pp. S1, S3). While the convergence of different disciplines is undoubtedly enriching, it also adds another layer of complexity to an already challenging research field. Beyond the difficulties of communication across diverse backgrounds, multidisciplinarity means that researchers bring distinct perspectives to the design of experiments probing the mechanisms underlying hallucinations. Consequently, their specific areas of expertise may lead them to prioritize certain aspects while overlooking others, at least initially.

This is particularly important because hallucination research is a highly complex field in which it is crucial to consider different conceptual and methodological issues before starting a new study. For instance, several unresolved conceptual debates are still ongoing, including the definition of "hallucination" (Telles-Correia et al., 2015). The selected definition will, for example, determine what type of perceptual experiences are classified as hallucinations. Additionally, there are ongoing discussions regarding the boundaries of the hallucinatory phenomenon and whether it represents a single, unified construct or, rather, a collection of distinct phenomena grouped under the same linguistic label (Telles-Correia et al., 2015).

Methodological considerations are equally important and include discussions about the most suitable experimental designs for studying hallucinations, as well as the limitations inherent to each approach. Given the wide range of experimental paradigms in the field, a recurring debate concerns the balance between experimental control and ecological validity – that is, the extent to which a laboratory-induced phenomenon resembles hallucinations occurring in natural settings. While experimental methods like conditioning-induced hallucinations – where individuals are conditioned to perceive a stimulus that is sometimes absent, leading to hallucination-like experiences through learned associations (Ellson, 1941; Rogers et al., 2021) – offer high methodological control, their ecological validity remains questionable. Therefore, it is essential to critically assess the degree to which laboratory-induced phenomena reflect real-world experiences, avoiding a purely dichotomous perspective. Rather than simply asking whether artificially induced hallucinations are equivalent to those occurring spontaneously, the discussion should focus on identifying the specific variables in which they align and those in which they differ. This requires a conceptual reflection on the key characteristics of hallucinations and, more broadly, a clearer understanding of what a hallucination truly is.

The primary aim of this paper is to identify key conceptual and methodological issues that should be carefully considered before designing a study on hallucinations. To this end, it will first examine conceptual aspects related to the term "hallucinations" (Section 1). Next, it will discuss methodological considerations relevant to study design in this field (Section 2). Finally, it will review different factors that shape hallucinatory experiences, providing a framework for comparing distinct experimental settings (Section 3). To date, most reviews in this discipline have focused either on synthesizing findings according to specific factors (e.g., Badcock et al., 2017; Iudici et al., 2019; Maijer et al., 2018; Upthegrove et al., 2016; Waters & Fernyhough, 2017) or on specific methodologies (e.g., Aynsworth et al., 2017; Rogers et al., 2021). By contrast, this work aims to provide a broader framework by outlining key conceptual and methodological questions that should be considered at the outset of research in this area. Importantly, the focus is on the hallucinatory phenomenon itself, independent of whether a medical diagnosis – neurological or psychiatric – is present. Although both clinical and nonclinical studies are included, the literature in this field is predominantly based on clinical samples, and this imbalance is reflected in the review. This does not signal a conceptual preference for clinical over nonclinical approaches but rather mirrors the current distribution of available studies.

We expect that the approach adopted here will be particularly useful for researchers entering the field. As noted above, one's prior area of specialization may lead to overlooking essential aspects of hallucination research. None of the issues raised have straightforward or definitive answers, further underscoring the need to invest time, resources, and reflection in addressing them. Accordingly, the primary goal of this paper is to highlight some of the main critical questions that must be addressed in hallucination research, rather than to propose definitive answers.

2. Conceptual considerations: What is a hallucination?

Understanding what constitutes a hallucination remains a central challenge in the field. Although there is general agreement on their core features, debate continues regarding their precise boundaries. As a result, different perspectives have been proposed on how these experiences should be classified (Aleman & Larøi, 2008; Anthony, 2004; Berrios 2014; Collerton & Mosimann, 2010). Despite these ongoing discussions, hallucinations are commonly defined as "involuntary false perceptions in the absence of appropriate external stimulation of the corresponding sensory organ" (Rogers et al., 2021, p. 1). This definition distinguishes them from other perceptual phenomena such as illusions (i.e., distortions or misperceptions) or veridical perception (i.e., accurate perception of the external world; Rogers et al., 2021). Nonetheless, conceptual challenges persist, as the boundaries between these categories remain

blurred, making it difficult to establish a clear and universally accepted delineation of hallucinatory phenomena.

For example, the highlighted definition allows quite different phenomena to be grouped under the same label, ranging from hearing voices with a clear message, to seeing a person who is not present after substance use, to perceiving a background tone as in tinnitus. This raises the question of whether hallucinations constitute a "unitary concept"[1] (Larøi et al., 2012). Given the marked heterogeneity of hallucinatory phenomena, most researchers agree that they are non-unitary (Aleman & Larøi, 2008; S. Jones, 2010; Larøi, 2006), even though they have typically been studied as if they are a single phenomenon (Larøi et al., 2012). This heterogeneity extends across sensory modalities, including auditory, visual, olfactory, or tactile hallucinations (Li et al., 2024; Lim et al., 2016). Whether the same conceptual framework and definitions apply equally to all modalities remains debated, highlighting the need to consider this diversity when formulating hypotheses or identifying explanatory mechanisms. It is important to bear this aspect in mind, especially when trying to hypothesise or search for explanatory mechanisms (whether at the neurobiological, phenomenological, or cognitive levels), as distinct causes may underlie different types of hallucinations.

This pictures becomes even more complex when considering artificially induced perceptual phenomena. To what extent is it appropriate to label laboratory-induced experiences as "hallucinations"? For instance, in conditioned hallucination tasks, participants report hearing a tone when presented with a visual cue (Davies et al., 1982; Ellson, 1941). In such cases, no stimulus is present in the auditory modality, but a stimulus in another modality elicits the perceptual experience. Evidence suggests that the underlying neural mechanisms may partly overlap with those involved in hallucinations reported by individuals with schizophrenia (e.g., Kafadar et al., 2022; Powers et al., 2017). However, important differences remain – most notably in their real-world impact, which is negligible in experimental settings but often profound in clinical populations (Waters & Fernyhough, 2017).

These questions underscore, above all, the blurred boundaries between hallucinations and other perceptual phenomena. Some authors propose a "continuum of experience" (Larøi, 2012), in which hallucinations lie along a spectrum with everyday phenomena such as mental imagery, vivid or intrusive thoughts, daydreams, inner speech, or earworms. This perspective suggests that the differences between these experiences are more quantitative than qualitative (Johns & van Os, 2001).

Several theoretical frameworks have been proposed to account for hallucinatory phenomena. Early psychodynamic and phenomenological accounts emphasized the symbolic meaning of hallucinations and their relation to disturbances of consciousness (Berrios & Marková, 2012; Telles-Correia et al., 2015; Wilking & Paoli, 1966). Cognitive models, such as source monitoring theory, posit that hallucinations arise from difficulties in distinguishing internally generated from externally derived experiences (Ditman & Kuperberg, 2005; Garrett & Silva, 2003; Morrison & Haddock, 1997; Woodward et al., 2007). Other cognitive processes – including memory, attention, and metacognition – also shape hallucinatory experiences (Barkus et al., 2007; Behrendt, 2012; Ditman & Kuperberg, 2005; Morrison & Haddock, 1997; Obleser, 2025). Predictive processing frameworks highlight disruptions in the balance between sensory evidence and prior expectations (Corlett et al., 2019; McCleery et al., 2018; Wilkinson, 2014; Wilkinson & Fernyhough, 2017). Neurobiological models, in turn, focus on the contributions of neurotransmitter systems and neural circuits, such as dopaminergic, glutamatergic, and serotonergic pathways (Geyer & Vollenweider, 2008; Jardri et al., 2016; Matamales, 2021; Weber et al., 2021). Together, these frameworks offer complementary epistemological perspectives, each illuminating different aspects of the complex and multifaceted nature of hallucinations.

These conceptual considerations underscore the challenges inherent in hallucination research. Importantly, these debates are not merely theoretical: how researchers define hallucinations and whether they regard them as a unitary phenomenon directly shapes the explanatory models developed and the mechanisms identified – or overlooked – in empirical studies (Wilkinson et al., 2021).

3. Methodological considerations: How to study hallucinations?

The study of hallucinations poses several methodological challenges, largely because experimental tasks must quantify an inherently subjective phenomenon. A central challenge is the heavy reliance on self-report measures: a hallucination is only recorded if an individual reports experiencing one (Dorsch, 2013). While certain external clues – such as observing someone conversing while alone – may suggest that a person is hallucinating, self-report remains the primary criterion and takes precedence in ambiguous cases (Dorsch, 2013; Paulhus & Vazire, 2007). For example, in the scenario mentioned above, if the person clarifies that they were merely rehearsing lines for a play, the behaviour would not be classified as a hallucinatory episode.

This reliance on self-report inevitably exposes hallucination research to the longstanding challenges of introspection, a topic that has been central to psychology since its early days (Brock, 2018; Byrne, 2005). While introspection has been criticized and often rejected in scientific research, some scholars argue that it provides unique insights unavailable through other means (Bakan, 1954; Danziger, 1980; Radford, 1974). Regardless of one's stance on introspection, hallucination research inevitably raises questions closely tied to this discussion: To what extent is it valid to assess a hallucinatory experience solely through self-report? Is there an *objective* measure of hallucinations independent of the individual's account? Can the perceptual process itself be separated from the reported experience? Even if it was possible to assess perception by the presence of a specific EEG signal, for instance, would that alone suffice to confirm or disconfirm the individual's report? Conversely, if someone reports a hallucination without a measurable biomarker, could we consider their experience mistaken?

The goal of this section is not to provide definitive answers to these questions but rather to highlight the inherent challenges of

[1] A concept is considered to be unitary when it represents a single, coherent phenomenon, despite potential variations in its manifestations. In the context of hallucinations, this raises the question of whether diverse experiences – such as auditory or visual hallucinations, substance-induced phenomena, or sensory experiences like tinnitus –can be meaningfully treated as a single category.

studying hallucinations. Despite these complexities, the field has developed a wide range of experimental tasks and scales to investigate them. The following review presents some of the most commonly used methodological tools, along with their advantages and limitations.

3.1. Tasks

A wide range of tasks have been developed to investigate hallucinations. One key distinction in the field is between studies that examine *hallucinatory traits* and those that assess *hallucinatory states* (Ford et al., 2012). Hallucinatory trait studies rely on data collected when individuals – whether diagnosed with a clinical condition or not – are not necessarily experiencing hallucinations at the time of testing. In contrast, hallucinatory state studies record data at the precise moment a hallucination occurs. As a result, these two types of studies have slightly different foci. The former aim to identify traits associated with hallucinatory tendencies. For example, do individuals who frequently experience hallucinations exhibit distinct neural patterns compared to those who do not? On the other hand, the latter investigate brain activity specifically associated with hallucinations as they happen. For example, what neural mechanisms are engaged during an active hallucinatory episode?

Each approach employs different tasks and experimental paradigms. In the following sections, we provide a brief review of the most commonly used tasks within this framework.

3.1.1. As a trait

Hallucinations have been associated with distinct neurophysiological alterations, particularly in sensory and cognitive processing networks. Electroencephalography (EEG) studies have reported a reduction in the N1 component – a negative-going event-related potential (ERP) peaking around 100 ms after stimulus onset – during hallucinatory episodes (Hubl et al., 2007; Näätänen & Picton, 1987). This reduction suggests competition between external auditory stimuli and internally generated hallucinatory activity for neural resources in the primary auditory cortex (Hubl et al., 2007). Functional imaging studies have also demonstrated hyperactivity in sensory cortices, notably the auditory cortex, in individuals experiencing auditory hallucinations (Horga et al., 2014). Additionally, dysregulated connectivity between frontal and temporal regions has been observed, indicating disrupted network activity that may impair the ability to distinguish internally generated from external stimuli (Benetti et al., 2013). Alterations in predictive coding mechanisms have also been implicated, with evidence suggesting that deficits in sensory prediction errors contribute to the manifestation of hallucinations in schizophrenia (Horga et al., 2014).

Table1 summarizes some of the most commonly used tasks in the field.

3.1.2. As a state

Within hallucinatory state studies, a further distinction can be made between those studies in which the hallucinatory experience arises spontaneously (i.e., occurring naturally without experimental manipulation) and those in which it is artificially induced (e.g., either by an experimental paradigm or pharmacological means). While spontaneous experiences offer greater ecological validity, artificially induced experiences provide stronger experimental control and allow for better management of confounding variables (Rogers et al., 2021).

Some of the most commonly used tasks for measuring hallucinations as a state are summarized in Tables 2 and 3. While both tables present tasks assessing state hallucinations, the first focuses on methods measuring spontaneous hallucinations and the second highlights those that are artificially induced. For more detailed information, the interested readers should consult the work of Rogers and collaborators (2021), which provides an in-depth review of various tasks that measure induced hallucinations.

3.2. Scales

Scales are another commonly used methodological tool for assessing specific aspects related to hallucinations such as frequency, duration, occurrence, and sensory modality, as well as other related perceptual phenomena, including mental imagery, vivid and intrusive thoughts, vivid daydreams, or inner speech. A major advantage of these scales is that they are generally quick to administer and can complement other experimental designs, such as conditioning-induced hallucinations. For instance, correlational analyses between scale scores and the number of conditioning-induced hallucinations can strengthen both the experimental design and the interpretation of results (e.g., Abalo-Rodríguez et al., 2023).

Table 4 summarizes some of the most commonly used scales in the field. For more detailed information, the interested readers may consult Ratcliff et al. (2011), which reviews scales for assessing auditory hallucinations, and Montagnese et al. (2021), which provides an in-depth review of scales for assessing multimodal hallucinations.

3.2.1. Confidence scales

Confidence scales are also widely used in hallucination research.[2] They are particularly valuable as they allow researchers to assess

[2] Confidence scales are addressed in a separate section because they differ methodologically and conceptually from the instruments described above. While the latter focus on aspects directly related to hallucinations, confidence scales measure the degree of certainty participants have in their responses. This separate treatment does not imply that issues such as response variability or interpretive ambiguity are unique to confidence scales; similar concerns may also arise with other self-report measures.

Table 1
Tasks employed to measure hallucinations as a trait in clinical groups and in the general population.

Tasks Focused on Perceptual Processes		
These tasks examine how individuals process sensory input, particularly how the brain differentiates self-generated stimuli from externally occurring ones – a key impairment in hallucination-prone individuals.		
Auditory Mismatch Negativity (MMN) Task	This paradigm presents a sequence of repetitive standard auditory stimuli interspersed with infrequent "oddball" stimuli that deviate in pitch or duration. Reduced MMN responses in hallucination-prone individuals suggest deficits in predictive coding and sensory gating.	(e.g., Erickson et al., 2016; Umbricht & Krljes, 2005)
Talk-Listen EEG Task	This task compares neural response (e.g., N1, P2) when participants hear self-initiated vs. externally generated sounds. For instance, reduced N1 suppression in hallucinating individuals has been reported to indicate impaired sensory attenuation, contributing to difficulties distinguishing self-generated from external stimuli.	(e.g., Ford et al., 2007, 2013, 2014)
Two-Tone Task	In this task, participants are presented with ambiguous or degraded auditory or visual stimuli (e.g., a faint tone embedded in noise or a blurred image) and are asked to identify the target. Prior exposure to a clear version of the stimulus or to contextual cues facilitates more accurate recognition. Such tasks probe how prior knowledge shapes perception and are particularly relevant for studying hallucinations, as an increased reliance on prior knowledge in hallucination-prone individuals supports predictive-coding accounts.	(e.g., Teufel et al., 2015; Zarkali et al., 2019)
Sensory Attenuation Behavioural Task	Participants compare the perceived intensity of self-generated vs. externally generated sounds or tactile stimuli. Weaker attenuation of self-generated stimuli in individuals prone to hallucinations suggests altered efference copy mechanisms, a neural process responsible for distinguishing self- from externally generated perceptions.	(e.g., Shergill et al., 2003)
Tasks Focused on Cognitive Processes		
These tasks assess alterations in cognitive functions that contribute to hallucinations, such as impaired inhibition of intrusive thoughts, memory distortions, and difficulties distinguishing imagined from real experiences.		
Go/No-Go Task	A widely used inhibitory control task in which participants respond to "Go" stimuli but withhold responses to "No-Go" stimuli. Poor response inhibition in hallucination-prone individuals suggests difficulties suppressing intrusive mental representations, which may contribute to spontaneous hallucinatory experiences.	(e.g., Fryer et al., 2019; Gillespie et al., 2022)
Verbal Fluency Task	Participants are asked to generate as many words as possible for a given category or starting letter within a time limit. Reduced verbal fluency in individuals with hallucinations is linked to impairments in cognitive control and thought organization.	(e.g., Elvevåg et al., 2001; Gourovitch et al., 1996; van Beilen et al., 2004)
Source Monitoring Task	Participants are asked to remember whether a piece of information was self-generated, produced by another person, or presented in written form. Individuals prone to hallucinations often exhibit source monitoring deficits, struggling to distinguish internally generated thoughts from external stimuli, which is thought to underlie hallucinatory misattributions.	(e.g., Ditman & Kuperberg, 2005; Garrison et al., 2017; Morrison & Haddock, 1997; Woodward et al., 2007)
Auditory Verbal Working Memory Task	In this task, participants must retain and manipulate spoken information over short delays. Reduced working memory capacity in hallucination-prone individuals may contribute to the persistence of internally generated verbal thoughts, increasing the likelihood of hallucinations.	(e.g., Barch & Smith, 2008)
Tasks Focused on Emotional Processes		
Hallucinations, particularly in psychiatric disorders, are often associated with altered emotional processing. These tasks assess difficulties in recognizing and interpreting emotions, which may contribute to the emotional salience of hallucinations.		
Facial Emotion Recognition Task	Participants view images of faces displaying different emotions (e.g., happy, sad, angry, fearful) and must categorize the underlying emotion. Individuals with hallucinations often show impairments in recognizing negative emotions, particularly fear and anger, which may contribute to the distressing nature of hallucinatory content in clinical samples.	(e.g., Kohler et al., 2010)
Affective Prosody Recognition Task	This task assesses the ability to recognize emotions conveyed through speech prosody or nonverbal vocalizations. Altered decoding of vocal emotions in individuals prone to hallucinations suggest impairments in social communication and emotional processing.	(e.g., Edwards et al., 2001; you can also refer to some of my studies)
Emotional Stroop Task	Participants must name the colour of emotionally charged words (e.g., "death" in red ink) while ignoring the word's meaning. Slower response times for negative words in hallucination-prone individuals suggest heightened emotional reactivity and cognitive interference, which may exacerbate the impact of hallucinations.	(e.g., Bentall & Kaney, 1989; Phillips et al., 2005)

Table 2
Tasks employed to measure spontaneous hallucinations in clinical and general population samples.

Spontaneous hallucinations *Hallucinatory experiences arise spontaneously: they are not triggered or controlled for a given experimental setting.*		
Experience Sampling Method (ESM)	Participants are prompted to report their current thoughts, feelings, and perceptions at random intervals, capturing real-time data on spontaneous hallucinations in daily life. This method minimizes recall bias and offers ecological validity.	(e.g., Delespaul, 1995; Hahamy et al., 2021)
Resting-State Functional MRI (rs-fMRI)	Participants rest without engaging in specific tasks while their brain activity is recorded. Spontaneous neural activity is analysed to identify patterns associated with hallucinations.	(e.g., Whitfield-Gabrieli & Ford, 2012)
Ecological Momentary Assessment (EMA)	EMA utilizes mobile devices to collect real-time data on participants' experiences in their natural environments. Participants report hallucinations as they occur, allowing for the examination of contextual factors influencing these experiences.	(e.g., Kimhy et al., 2006)

Table 3
Tasks employed to measure artificially induced hallucinations in clinical and general population samples.

Artificially induced hallucinations *The hallucinatory-like experienced is artificially induced through a specific experimental setting.*		
Conditioned hallucinations	This method relies on classical conditioning, in which individuals learn to associate a neutral stimulus with a hallucinatory experience. For instance, a person may repeatedly hear an auditory stimulus paired with a specific visual cue (e.g., a flashing light). Over time, the visual cue alone can elicit the perception of sound, effectively inducing hallucinations though associative learning. This approach provides a valuable tool for studying how prior experiences and learned associations contribute to hallucinations in clinical and nonclinical populations.	(e.g., Davies et al., 1982; Ellson, 1941; Powers et al., 2017)
Flicker-induced hallucinations	In this method, hallucinations are induced using rapid visual flicker stimulation, often at frequencies of ~ 10–30 Hz. Participants view a flickering light or screen (e.g., stroboscopic stimulation), which can elicit vivid visual hallucinations, including geometric patterns, colours, and even complex imagery. These effects arise from disrupted neural activity in the visual cortex, making this technique useful for investigating how the brain generates hallucinatory percepts in the absence of external stimuli. It is particularly informative for studying internally generated percepts under conditions of reduced external sensory input.	(e.g., Allefeld et al., 2011; Pearson et al., 2016)
Ganzfeld procedure hallucinations	This method involves exposing participants to a homogeneous sensory environment, such as featureless diffuse light and, in some cases, uniform auditory stimulation. By reducing external sensory input, internally generated percepts are more likely to emerge, occasionally producing hallucinatory experiences. This approach provides a valuable tool for investigating how the brain generates perceptual experiences in the absence of dynamic external stimuli.	(Schmidt et al., 2020; Shenyan et al., 2024)

metacognitive abilities, that is, the capacity to monitor and evaluate one's own cognitive state (Obleser, 2025). Their value is particularly evident in experimental tasks involving ambiguous stimuli – for instance, in conditioned hallucination paradigms, where tones used as unconditioned stimuli are often played at intensities near the participant's perceptual threshold. By integrating confidence scales into experimental designs, researchers can systematically examine the degree of confidence participants report in their own perceptual experiences.

Typically, participants indicate whether they have perceived a stimulus and then rate their confidence in that decision, often using a Likert scale (Jebb et al., 2021). Key considerations in designing such scales include the optimal number of response options and whether the scale should have an odd or even number of points (Allen, & Seaman. 2007; Joshi et al., 2015; Nemoto & Beglar, 2014). To ensure consistency in interpretation, researchers often provide detailed descriptions of what each confidence level represents. Some studies use continuous confidence scales, which allow greater response flexibility but require additional processing to quantify responses for analysis (e.g., Powers et al., 2017).

Even when clear descriptions are provided, individual differences in the interpretation of confidence ratings must be considered. Two participants may assign the same numerical confidence rating, yet their actual levels of certainty may differ substantially. Moreover, overall confidence can vary across participants throughout an experiment. This raises the question of whether a high confidence score from a generally low-confidence participant should be treated the same as a high confidence score from someone consistently confident. One approach to addressing this issue is normalizing confidence scores relative to each participant's average confidence level, thereby adjusting for baseline differences and reducing bias from individual tendencies (e.g., Fleming et al., 2010; García-Pérez, M. A. 1998; Rouault et al., 2018). However, this method may obscure meaningful response variability, making its use a

Table 4
Scales that assess hallucinatory experiences in clinical samples and in the general population.

Scale	Brief description
Launay-Slade Hallucination Scale (LSHS)	One of the most commonly used scales in the field, this self-report questionnaire is designed to assess hallucinatory-like experiences in the general population. It measures the predisposition to hallucinations across multiple sensory modalities, including auditory and visual experiences. Originally developed by Launay and Slade in 1981, the scale has since been revised to improve its psychometric properties.
Psychotic Symptom Rating Scales-Auditory Hallucinations subscale (PSYRATS-AH)	The PSYRATS-AH is an 11-item clinician-administered scale targeting individuals with psychosis. It evaluates multiple dimensions of auditory hallucinations, such as frequency, duration, loudness, distress, and controllability. This comprehensive assessment provides insight into the subjective experience and impact of auditory hallucinations in patients.
Auditory Vocal Hallucination Rating Scale (AVHRS)	The AVHRS is a clinician-administered tool specifically designed for individuals experiencing auditory verbal hallucinations. It assesses features such as frequency, duration, loudness, and the emotional impact of the hallucinations, providing a detailed evaluation of their phenomenology.
Positive and Useful Voices Inquiry (PUVI)	The PUVI is a self-report measure designed for individuals experiencing auditory hallucinations with a clinical diagnosis. It focuses on the positive aspects and perceived usefulness of these voices, exploring how individuals may find them beneficial or supportive. This scale provides insights into the subjective value and functional role of auditory hallucinations in daily life.
Positive and Negative Syndrome Scale (PANSS)	The PANSS is a clinician-administered instrument widely used to assess individuals diagnosed with schizophrenia and related disorders. It evaluates positive symptoms (e.g., hallucinations, delusions), negative symptoms (e.g., blunted affect, social withdrawal), and general psychopathology (e.g., anxiety, depression). This comprehensive assessment provides a valuable measure of symptom severity and treatment response.
Scales for the Assessment of Positive/Negative Symptoms (SAPS/SANS).	The SAPS and SANS are clinician-administered scales designed for individuals with schizophrenia. The SAPS assesses positive symptoms, including hallucinations and delusions, while the SANS evaluates negative symptoms, such as affective flattening and alogia. Together, these scales provide a detailed assessment of the symptomatology associated with schizophrenia.
Cardiff Anomalous Perceptions Scale (CAPS)	The CAPS is a validated 32-item self-report measure assessing perceptual anomalies, including distress, intrusiveness, and frequency. Tested in both general and clinical (psychotic) populations, factor analyses have identified multiple components – clinical psychosis, temporal lobe disturbance, and chemosensation – supporting a psychosis continuum.

nuanced decision.

Two additional methodological considerations arise when using confidence scales. First, should separate scales be provided for "yes" and "no" responses (e.g., two independent scales where 1 = no confidence and 6 = high confidence), or should a single bipolar scale be used (e.g., one scale where 1 = high confidence in "no" and 6 = high confidence in "yes")? While a single scale may seem appropriate because the responses are mutually exclusive, two separate scales allow for more precise comparisons across response types (Haladyna & Rodriguez, 2013). The choice between these approaches depends on the specific objectives and design of the study.

Second, confidence levels may change over the course of an experiment due to task dynamics. This is particularly relevant in conditioned hallucination paradigms, where multiple trials are required to establish associations between conditioned and unconditioned stimuli before an artificially induced hallucination occurs. As participants gain experience with the task, confidence ratings may fluctuate. Therefore, analyses should account for temporal variability in confidence and its potential impact on the reported hallucinatory experiences.

3.3. Phenomenological approach

Among the various methodological approaches to studying hallucinations, phenomenology places the subjective experience of hallucination at its core. This approach has gained increasing attention in recent years, particularly in the study of auditory verbal hallucinations (McCarthy-Jones et al., 2013). Here, the central question shifts to 'what is the hallucinatory experience *like*'? Rather than focusing on isolated aspects, phenomenology emphasizes the intricate and dynamic changes that unfold simultaneously across multiple dimensions of experience (Pienkos et al., 2019).

Within this framework, a distinction can be made between phenomenology as a philosophical movement and "small-p" phenomenology, which refers to the qualitative description of experience across fields such as psychiatry (Wilkinson et al., 2021). The

tradition seeks detailed first-person accounts of experience, differing from mere rich descriptions of subjectivity in its focus, also known as "structures of experience". These include elements such as "embodiment", "intentionality", "selfhood" or "temporality" (Broome, 2012). Moreover, this approach aims to be atheoretical, aiming to describe experiences as they typically occur without committing to a specific theory of human experience (Broome, 2012). By contrast, small-p phenomenology within clinical disciplines focuses on qualitative signs of illness and does not analyze these experiential structures (Bürgy, 2008).

Wilkinson et al. (2021) provide a brief historical overview of phenomenology in hallucination research, tracing its roots to the Early Heidelberg School of Psychiatry, which conceptualized schizophrenia – including hallucinations – as subjective disturbances in selfhood (Kaminski et al., 2019; Sterzer et al., 2016). More recently, Louis Sass described schizophrenia as a "two-faceted disturbance of self-experience," offering a framework directly relevant to understanding hallucinations (Sass, 2003). Contemporary research has applied phenomenology to classify hallucinations based on their experiential features (McCarthy-Jones et al., 2014), explore their internal structure (Stephane et al., 2003), and incorporate phenomenological measures in clinical trials to provide a more comprehensive account of hallucinatory experiences (Linszen et al., 2022; Nayani & David, 2009). Other studies have used phenomenology to distinguish clinical from nonclinical voice-hearers (Moseley et al., 2022).

Despite its value, the phenomenological approach presents significant methodological challenges, particularly due to the complexities of qualitative research. Scholars emphasize the importance of interdisciplinary approaches within phenomenology (Woods et al., 2014). Nevertheless, a comprehensive understanding of hallucinations ultimately requires attention to the subjective experience itself (McCarthy-Jones et al., 2013; Wilkinson et al., 2021).

4. What variables need to be considered in hallucination research?

Examining the factors underlying hallucinations is essential for making detailed comparisons between different perceptual experiences. For example, the question of whether two hallucinatory experiences are equivalent – such as a conditioned hallucination vs. hearing a voice in a natural context – can be reframed in terms of the specific variables in which they coincide (e.g., auditory sensory modality) and those in which they differ (e.g., absence vs. presence of emotional content).

This section reviews factors that play a relevant role in shaping hallucinatory experiences. Previous authors have made similar proposals but focused primarily on the descriptive features of auditory verbal hallucinations in schizophrenia (Larøi et al., 2012). Building on this approach, this section extends the analysis to hallucinatory experiences across all sensory modalities. A summary of these variables is provided in Table 5, facilitating quick reference and comparison of the key factors discussed.

4.1. Sensory modality of the hallucination

Hallucinations have been reported across multiple sensory modalities, including visual, auditory, olfactory, gustatory, tactile, and kinaesthetic (Chesterman & Boast, 1994). Some studies have also included "sensed presence" and "hypnagogic/hypnopompic"

Table 5
Variables to be considered in hallucination research.

Factor	Brief description
Sensory modality of the hallucination	Hallucinations can occur in different sensory domains (visual, auditory, olfactory, tactile, etc.), often multimodal, with prevalence varying across populations and contexts.
Content	The content of hallucinations (e.g., linguistic vs. non-linguistic, culturally influenced themes) shapes their meaning and interpretation.
Emotional factors	Emotions can trigger, maintain, and intensify hallucinations, with negative affect linked to more severe and distressing experiences.
Contextual factors	Situational, environmental, and cultural contexts (e.g., stress, sleep deprivation, social isolation, certain substances) influence the onset and course of hallucinations.
Pathology or other symptoms	Hallucinations often co-occur with psychiatric or neurological disorders and interact with other symptoms (e.g., delusions).
Awareness and control	The degree to which individuals recognize or regulate their hallucinations varies and has been linked to severity and distress.
Significance and impact on daily life	The meaning attributed to hallucinations and their disruption of daily functioning distinguish clinical from non-clinical experiences.

Note. This table summarizes major variables that shape the occurrence, phenomenology, and impact of hallucinations. The list is not exhaustive but highlights core dimensions that should be considered in both experimental and clinical research.

experiences as additional categories (Larøi, Bless, et al., 2019). Multimodal hallucinations – those combining different sensory modalities either simultaneously or at different times – are also common (Montagnese et al., 2021).

The prevalence of each modality varies by population. In schizophrenia, auditory hallucinations are typically the most common (approximately 75 %), followed by visual hallucinations (approximately 27 %) (Bauer et al., 2011; Waters et al., 2014; Waters & Fernyhough, 2017). However, more recent evidence suggests that multimodal hallucinations may be the most prevalent in this population (Lim et al., 2016). In the general population, olfactory, tactile, and sensed-presence experiences are reported most frequently, with prevalence decreasing with age (hallucinations decrease with age; Larøi et al., 2019). In experimental settings, the visual and auditory modalities are the most commonly studied (see Fry et al., 2022, for modalities employed in conditioning paradigms). Given these differences, sensory modality represents a central factor to consider when studying hallucinations.

4.2. Content of the hallucination

Another crucial aspect to consider is the content of hallucinations. This is especially relevant for auditory hallucinations, where it is important to distinguish between linguistic and non-linguistic content (Larøi et al., 2012) or, in other words, whether the individual perceives a tone or a voice conveying a specific message. For verbal hallucinations, cultural context may be another important aspect to consider (Larøi et al., 2014). For example, individuals from religious backgrounds may experience hallucinations with religious themes (e.g., Abalo-Rodríguez, & de Pascual, R. 2020). Visual hallucinations also vary in complexity, ranging from simple, unstructured percepts such as lights or shapes to complex, fully formed images with recognizable semantic meaning (Hishaw et al., 2017).

4.3. Emotional factors in hallucinations

Emotions are closely interconnected with hallucinatory experiences in multiple ways (Badcock et al., 2011; Freeman & Garety, 2003; Serper & Berenbaum, 2008; Smith et al., 2006; Amorim et al., 2025). For instance, emotions can trigger hallucinations and contribute to their maintenance through mechanisms that remain to be fully understood (Freeman & Garety, 2003). Hallucinations with negative content – those that evoke distressing emotions – are associated with increased frequency, intensity, and severity (e.g., de Boer et al., 2022; Laloyaux et al., 2019; Larøi et al., 2019; Smith et al., 2006). Hallucination-like experiences have also been shown to increase negative affect and reduce positive affect (Brown, 2008), while lower levels of emotional clarity correlate with more severe hallucination ratings (Serper & Berenbaum, 2008). These findings indicate that hallucinatory experiences cannot be fully understood without considering emotional factors. This is particularly relevant in experimental settings, such as conditioning-induced hallucinations, where perceptual experiences often lack an emotional component (Rogers et al., 2021).

4.4. Contextual factors associated to hallucinations

Because hallucinations occur within specific contexts, it is essential to understand which contextual factors are associated with their occurrence, either as triggers or modulators of their course (Bell et al., 2010). In experimental settings, identifying such triggers is often more straightforward than in natural contexts. For example, in conditioning tasks, the conditioned stimulus serves directly as a trigger for hallucinatory experiences. Consistently, a recent review highlighted several experimental factors that moderate the strength of conditioned hallucinations in humans, such as participants' motivation to complete the task and the attention paid to contingencies (Fry et al., 2022).

In natural settings, a range of situational factors can also be identified. Negative emotions, for instance, can trigger hallucinatory experiences, implying that situations eliciting these emotions (e.g., arguments, stressful events) may increase hallucination occurrence (Luhrmann et al., 2019; Ratcliffe & Wilkinson, 2016). Other factors reported to elicit hallucinations include sleep deprivation (e.g., Juffer, 2021; Pallesen et al., 2018; Reeve et al., 2015; Waters et al., 2018), social isolation (e.g., Butter et al., 2017; Lincoln et al., 2021) or the ingestion of substances such as LSD or cannabis (e.g., Fiorentini et al., 2021; Mauri et al., 2018; West & Sharif, 2023).

Contextual factors can also modify the intensity of hallucinations over the course of an episode (Delespaul et al., 2002). For example, "social withdrawal", "doing nothing" and "work activities" were associated with decreases in intensity over time, whereas "social engagement" and "passive leisure activities" (e.g., watching TV) were linked to increases (Delespaul et al., 2002; original category labels). Cultural factors additionally shape hallucinatory experiences, influencing their identification, frequency, phenomenological patterns, and clinical outcomes, among others (Larøi et al., 2014).

4.5. Presence of pathology or other relevant symptoms

Although hallucinations can occur in nonclinical populations, they are frequently observed in the context of psychiatric (e.g., Bauer et al., 2011; Lyndon & Corlett, 2020; Silverstein & Lai, 2021) or neurological (e.g., Marques et al., 2021; Powell et al., 2022) disorders. Hence, it is essential to consider the individual's diagnosis and other co-occurring symptoms alongside hallucinations. Some authors emphasize the complex interplay between hallucinations and related phenomena, such as delusions (Jardri et al., 2019). Focusing exclusively on hallucinations within a pathological context risks overlooking their interactions with other clinical features. To categorize hallucinations relative to other clinical characteristics, some studies distinguish four groups: nonclinical populations, drug- and alcohol-related hallucinations, medical and neurological conditions, and psychiatric disorders (Waters & Fernyhough, 2017). Approaches to studying clinical vs. nonclinical populations often differ considerably: research in clinical groups typically emphasizes diagnostic relevance, symptom severity, and treatment implications, whereas studies in nonclinical populations focus on

phenomenological diversity and the presence of subclinical or transient experiences (Waters & Fernyhough, 2017). These differences highlight the need for caution when generalizing findings across populations and underscore the importance of considering population-specific factors in hallucination research.

4.6. Level of awareness and control over the hallucination

Other factors explored in relation to hallucinations include the level of awareness of the experience and the degree of control over it. Awareness refers to whether the individual recognizes that they are not grounded in an external stimulus – as in tinnitus – or remains unaware of the nature of the experience (Taylor & Vaidya, 2008). Control refers to the extent to which the individual can influence or regulate the experience (Taylor & Vaidya, 2008). Both factors have traditionally been considered key mediators of hallucinatory experiences and markers of clinical severity (Oyebode, 2008; Taylor & Vaidya, 2008). However, more recent evidence suggests a more nuanced role, indicating that awareness and control may contribute less than previously thought to the distress associated with hallucinated voices (Pappa et al., 2021). Nevertheless, these factors remain important variables to consider in hallucination research.

4.7. Attributed significance attributed and impact on daily life

Last but not least, the significance attributed to hallucinatory experiences and the extent to which they interfere with daily life are important variables to consider. Significance can be understood along a continuum: while some individuals attach highly negative meanings to their hallucinations – associating them with concepts such as "being crazy" or social stigma –, others adopt a more neutral or even positive perspective, perceiving the experiences as temporary rather than permanent (Larøi etal., 2014). The impact of hallucinations encompasses both their frequency (e.g., how often do they occur?) and the degree to which they disrupt everyday activities (e.g., whether they force the person to stop what they are doing or can be managed without significant interference). This factor is particularly relevant since, beyond early onset in nonclinical populations, the primary distinction between hallucinations in clinical and nonclinical groups lies in the emotional content and its consequences (Larøi, 2012). Specifically, clinical populations tend to experience hallucinations with highly distressing emotional content, which significantly disrupts their lives (Larøi, 2012). Consequently, this aspect has received considerable attention in recent clinical research, particularly within third-wave therapeutic approaches (Bach & Hayes, 2002; Cramer et al., 2016; Gaudiano et al., 2010) that aim to modify an individual's relationship with their symptoms, thereby reducing the significance and impact of hallucinations (García-Montes et al., 2006; García-Montes & Pérez-Álvarez, 2016).

The variables discussed here, while not exhaustive, highlight key factors that shape hallucinatory experiences. Emphasizing their importance ensures that they are systematically considered when designing studies in this field. For example, recognizing the role of emotions allows researchers to incorporate relevant experimental conditions (e.g., Castiajo & Pinheiro, 2021; Pinheiro et al., 2013, Pinheiro et al., 2016, Pinheiro et al., 2017, Pinheiro et al., 2019). Furthermore, taking these factors into account facilitates more precise comparisons between hallucinatory phenomena.

5. Conclusions

The study of hallucinations is a dynamic and increasingly prominent field that continues to attract researchers worldwide. Its inherent complexity demands a highly interdisciplinary approach, drawing on insights from psychology, neuroscience, philosophy, psychiatry, and related disciplines. While this diversity is intellectually enriching, it also poses significant challenges – particularly for newcomers – given the breadth of theoretical and methodological considerations involved.

In this context, the present paper outlined a set of key questions that frequently arise in hallucination research and that merit careful consideration before study design. These questions span a wide spectrum, from conceptual debates to methodological concerns, and none has straightforward answers. Conceptually, the discussion highlights the ambiguous boundaries between hallucinations and related perceptual experiences, as well as the ongoing debate over whether hallucinations constitute a unified phenomenon. These conceptual considerations are foundational, as they directly shape the design, interpretation, and implications of empirical research.

Methodologically, studying hallucinations involves complex and multifaceted challenges. This paper highlighted the critical decisions researchers may have to face, acknowledging that no single approach can fully capture such a complex phenomenon. While it does not attempt to resolve all methodological questions, it underscores the value of careful study design and the importance of interdisciplinary collaboration across laboratories and research traditions to advance understanding in this field.

By mapping the key conceptual and methodological landmarks, this paper aims to serve as a navigational tool for researchers embarking on the complex journey of hallucination research – a true Hitchhiker's Guide to the field.

CRediT authorship contribution statement

Inés Abalo-Rodríguez: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Ana P. Pinheiro:** Writing – review & editing, Supervision, Conceptualization.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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No data was used for the research described in the article.

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