

Preface

The rapid progress of knowledge in the field of hallucinations is intimately linked to active and exciting research areas, including phenomenology, cognitive psychology and affective science, neurobiology, genetic and computational modeling, neuroimaging and electrophysiology, psychotherapy, psychopharmacology, and neuromodulation. Each of these areas is sufficiently broad to fill a textbook. This striking increase in the salience of the subject of hallucinations is demonstrated by the exponential growth in the number of articles published on this topic over the past decades (see Fig. 1). The current volume focuses on the contributions of the most recent findings in neuroscientific research toward understanding this fascinating phenomenon. This book aims to provide an up-to-date synthesis of research on hallucinations and to provide the vast, multidisciplinary neuroscientific and medical community with the necessary elements to build a comprehensive evidence-based model of this intriguing subjective experience. The primary intended audience is neuroscientists who are interested in this growing field and who wish to gain an understanding of the major findings and problems in studying hallucinations. A secondary audience is psychiatrists, neurologists, and psychologists who are professionally involved in the diagnosis and treatment of hallucinations and who seek a contemporary view of the pathophysiology of hallucinations as well as a summary of the most commonly used neuroscientific methods. Finally this book is essential reading for all students in these fields.

This book is organized in five sections. The multidisciplinary nature of research in the field of hallucinations is clearly illustrated by the numerous cross-chapter and cross-sectional references. Part 1, *Basics of hallucinations*, comprises Chaps. 1, 2, 3, 4, and 5 and reviews the scientific background necessary to fully understand the richness of hallucinatory experiences. In Chap. 1, E. Peyroux and N. Franck provide an exhaustive historical overview of the term “hallucination” from its seminal antic conceptions to its contemporary definitions, distinguishing it from other disorders of perception. In Chap. 2, K. Hill and D.E. Linden examine hallucinations occurring in healthy individuals who do not require psychiatric care. They present recent data on the neural correlates of these experiences among non-clinical auditory hallucinators. Chapters 3 and 4 detail the various clinical and phenomenological aspects of

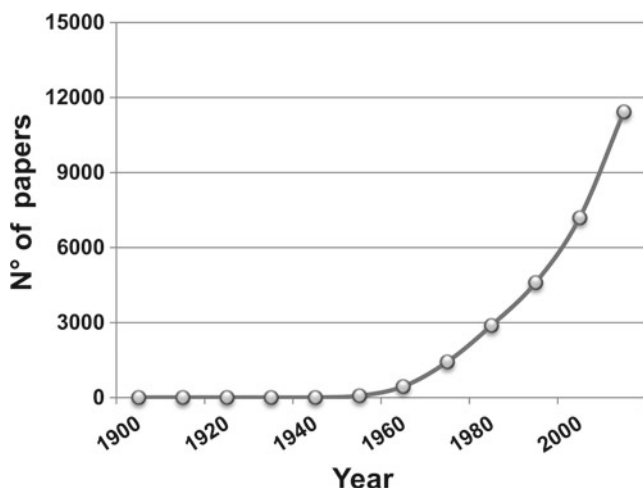


Fig. 1 The graph shows the exponential increase in the PubMed database counts for the search term “hallucinations” over the period 1900–2011. A more than fourfold increase in the cumulative number of scientific publications in this field can be observed in the last 30 years

hallucinatory experiences occurring in psychiatric (J.D. Blom) or neurological conditions and in sensory loss (G. Fénelon). In Chap. 5, M. Stéphane presents crucial issues in the assessment of hallucinatory experiences across an individual’s life-span and across disorder categories and sensory modalities. Specific hallucination instruments are detailed in this context.

Part 2 (Chaps. 6, 7, 8, 9, 10 and 11) explores the broad area of *Cognitive models for hallucinations*. In Chap. 6, A. Aleman and A. Vercammen provide an overview of bottom-up and top-down processes that have been suggested as mechanisms in the generation and/or perpetuation of hallucinations. Chapter 7, by S. Dollfus, A. Razafimandimby, and M. Alary, reviews studies exploring the pathophysiology of auditory verbal hallucinations (AVH) based on speech-processing paradigms, including the connections with brain imaging and therapeutic chapters. The role of emotional salience and unintentional memory retrieval in the occurrence of hallucinations is critically discussed by S.L. Rossell in Chap. 8. Chapters 9 and 10, which develop the “misattribution models” of hallucinations, present two sides of the same coin. In Chap. 9, F. Varese and F. Laroï exhaustively review empirical studies on the presumed association between hallucinations and meta-cognitive beliefs and show how these beliefs may constitute a crucial determinant of the distress related to hallucinations. In Chap. 10, T.S. Woodward and M. Menon complete this view by providing evidence for an association between hallucinations and externalization errors in source-monitoring situations. Finally, another original approach is described by F. Waters in Chap. 11 to examine timing abnormalities in people with schizophrenia and their connection to hallucinations.

In Part 3, *Neurobiological and computational models of hallucinations*, the chapters focus more fundamentally on the role of genetic, developmental, and

neurobiological factors and their interactions in the expression of hallucinations. In Chap. 12, C.N. David and J.L. Rapoport first review the neurodevelopmental aspects of hallucinations with a particular focus on pediatric populations, and they defend a dimensional dynamic model of hallucinatory experiences. In Chap. 13, J. San Juan, M. Moltó, and A. Tolosa review genetic studies of AVH in psychotic patients and develop the idea of AVH as an alternative phenotype for genetic research. Various aspects of drug-induced hallucinatory experiences are critically presented in the Chaps. 14 and 15. Chapter 14, by A. Kozlenkov and J. González-Maeso, summarizes recent advances in the understanding of the molecular mechanisms of hallucinogenic drugs (including mescaline, psilocybin, and lysergic acid diethylamide) using animal models, while Chap. 15, by P. Allen and T.T. Winton-Brown, focuses on the effect of cannabis on human perception. Because a considerable explanatory gap remains between neuronal processes and psychological functions, a tentative attempt to integrate the main findings on hallucinations into a common computational framework is proposed by R. Jardri and S. Denève in Chap. 16.

The rapid maturation of neuroimaging in the study of brain function over the past 20 years has led to impressive accomplishments in the study of hallucinations and has motivated us to devote an entire section to *Brain-imaging insights into hallucinations* (Part 4). In Chap. 17, C. van Swam, T. Dierks, and D. Hubl describe recent methods in electroencephalographic (EEG) and magnetoencephalographic (MEG) explorations of hallucinatory phenomena, particularly the disturbed interplay between speech production and speech listening brain areas during AVH. Chapter 18, by A. Cachia and M. Plaze, provides insight into the main structural variations of the “hallucinating” brain in schizophrenia, including cortical thickness and sulcal analyses. In Chap. 19, J.M. Ford and R.E. Hoffman focus on functional brain imaging explorations of the cognitive aspects of AVH (fMRI and PET studies), providing evidence for dysfunctions in the efference copy and corollary discharge mechanism. A complementary aspect is provided by state studies of the hallucinatory phenomenon (also called capture studies). The main findings of functional brain imaging capture studies of AVH are summarized in Chap. 20 by R. Jardri and I.E. Sommer. State studies also cover intrinsic brain activity at rest (i.e., when the voices are silent). Specific aspects of resting-state functional connectivity data in auditory hallucinators are reviewed by V. van de Ven in Chap. 21. In Chap. 22, S. Benetti, W. Pettersson-Yeo, and A. Mechelli provide an overview of the functional and effective connectivity impairments observed in AVH and discuss the main challenges of network analysis of the hallucinating brain.

Finally, Part 5, *Innovative therapeutic approaches of hallucinations*, addresses the crucial issue of developing new interventions for hallucinations. An integrative psychotherapeutic and psychosocial program is first detailed by J.A. Jenner, who extensively illustrates hallucination-focused integrative therapy (HIT) in Chap. 23. N.G. Lowe, M-P. Rapagnani, C. Mattei, and S.M. Stahl then examine the neurobiological mechanisms of both antipsychotic agents and neuromodulation therapy and hint at the development of a new generation of medication (Chap. 24). Following a general introduction to neuromodulation principles, current data on the use of repetitive Transcranial Magnetic Stimulation (rTMS) to

relieve AVH in schizophrenia are reviewed by P.B. Fitzgerald and K. Hoy in Chap. 25. Strategies to improve the efficacy of brain stimulation techniques for hallucinations are discussed by E. Poulet, F. Haesebaert, J. Brunelin, and M-F. Suaud-Chagny in Chap. 26. They notably review data about optimizations in stimulation protocols and critically discuss the development of other stimulation techniques, such as transcranial direct current stimulation, epidural cortical stimulation, and deep brain stimulation. Finally, brain-imaging-guided therapies of hallucinations are presented by J.R. Foucher in Chap. 27. A special emphasis is given to fMRI-guided neurofeedback and neuronavigated and robotized brain stimulation techniques. In the conclusion of the book, we propose key issues for future research in the neuroscience of hallucinations.

We are aware that many other interesting clinical and therapeutic aspects of the hallucinatory phenomenon could have been included in this volume. We hope that readers will share our excitement about this growing area of neuroscience research. We would also like to take this opportunity to express our deepest gratitude to the colleagues who accepted our invitation to contribute their scholarly and cutting-edge chapters to this book. We thank Fabien D'Hondt for assisting us with the editing of this book, Springer US for their confidence, and, especially, Janice Stern for her patience as our editor. As always, none of this would have been possible without the love, support, and encouragement of our respective families. Finally, our utmost gratitude goes to the patients who have been our teachers in our quest to improve understanding of hallucinations.

Lille, France
Paris, France
Lille, France
Lille, France

Renaud Jardri
Arnaud Cachia
Pierre Thomas
Delphine Pins

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Jardri, R.; Cacia, A.; Thomas, P.; Pins, D. (Eds.)

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