PERCEPTION

Book Review

Deutsch, D. *Musical Illusions and Phantom Words: How Music and Speech Unlock Mysteries of the Brain.* New York, NY: Oxford University Press, 2019; 272 pp.: $34.95 (hardcover), ISBN: 0190206837.

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In her recent book, *Musical Illusions and Phantom Words*, renowned cognitive psychologist and auditory scientist Diana Deutsch explores the fascinating world of auditory illusions and discusses their implications for understanding the human mind. She begins by proposing that musical and auditory illusions, rather than being mere perceptual oddities, can yield profound insights into the nature of human perception, the organization and function of the brain, and the roles of nature and nurture in shaping perceptual development. Over the course of the book, these broader conclusions are supported by evidence gathered from Deutsch's own research program on auditory illusions and related literature on the neurobiology of music and speech.

A central thesis of the book, and one of interest to readers of *Perception*, is that perception is an active process that synthesizes bottom-up (i.e., stimulus-driven) and top-down (i.e., higher level knowledge) operations. This constructive view of perception follows in the rich tradition of Helmholtz, whose theory of unconscious inference is espoused by Deutsch as a general model of sound perception. Deutsch uses examples from her work on musical and auditory illusions to illustrate how perceptual experiences of sound recruit both bottom-up and top-down processes to construct percepts: For instance, the tritone illusion—an auditory illusion involving two Shepard tones separated by half an octave (i.e., the interval of a tritone)—can be perceived as rising or falling in contour. Deutsch and her colleagues discovered that the tritone illusion varies according to listeners' exposure to spoken languages, implicating that language-related, top-down influences contribute to the percept. Furthermore, research regarding phantom words and auditory hallucinations also implicates a role of language-related, top-down influences on sound perception: Here, listeners are inclined to interpret ambiguous acoustic signals as semantically coherent, often reporting that intelligible lexical items and phrases emerge from sequences of white noise or repeating strings of single words.

Yet, how do experiences with spoken language and other auditory-based cognitive systems, such as music, come to shape our perception of sound? Furthermore, what roles do nature and nurture play in the development of our perceptual systems? To address these questions, Deutsch turns to absolute-pitch (AP) possessors—individuals who can correctly

name the pitch class of a note in the absence of a reference note. While the prevalence of AP is quite low (<5%) in the general population, Deutsch and colleagues discovered that populations with extensive early musical training and exposure to tonal languages are more likely to develop AP during ontogeny, even when controlling for potential confounds such as ethnicity and style of musical instruction. These findings highlight how specific developmental experiences related to spoken language and music (i.e., "nurture") can ultimately shape sound perception.

In addition to informing our understanding of human perception, studying auditory illusions can help illuminate the neural architecture of the brain. For instance, individuals who experience musical hallucinations do not typically experience speech hallucinations and vice versa, findings which support a modular framework for speech and music processing. Further, individuals who experience musical hallucinations often report that some musical features are experienced in vivid detail, while other musical features are distorted or unintelligible, implicating independent processing modules for separate musical features. And while music and speech are processed by separate processing streams, Deutsch's famous speech-to-song illusion demonstrates that our perception can flexibly shift between the two percepts. For instance, when a recording of Deutsch's spoken phrase "sometimes behaves so strangely" is repeated on loop, the spoken phrase undergoes a perceptual transformation into song. This illusion highlights that the same acoustic input can produce distinct percepts and suggests that the perception of speech or song may not depend on acoustic features that are specific to either domain.

Throughout the book, Deutsch uses these and other examples of music and auditory illusions to advance a number of conclusions about human perception. In doing so, she draws heavily from cognitive theory, explaining many of her findings in terms of schemas, mental representations, beliefs, knowledge, modularity, and evolutionary perspectives. While, at times, *Musical Illusions and Phantom Words* does regress to outmoded conceptual frameworks in cognitive science (e.g., genetic determinism, the nature-nurture dichotomy) to discuss Deutsch's illusory phenomena, *Musical Illusions and Phantom Words* is, nevertheless, the first book that systematically considers the implications of music and auditory illusions on theories of perception. Readers of *Perception* will find that Deutsch conveys her conclusions with an engaging, story-like quality, drawing on detailed, original anecdotes to illustrate concepts related to the psychology and neuroscience of perception. For example, in her discussion of tonal languages, Deutsch cites an eccentric poem by Yuen Ren Chao written in ancient Mandarin that repeats a single word "shi" approximately 100 times (p. 183). In addition, in her discussion of phantom words, Deutsch references the recent (2018) viral Laurel-Yanny illusion, in which a recording of the spoken word "Laurel" can be perceived as "Laurel" or "Yanny" (p. 108). Moreover, *Musical Illusions and Phantom Words* is accompanied by rich multimedia that allow readers to listen to the illusions themselves: Throughout each chapter of the book, Deutsch has included QR codes which direct the reader to audio demonstrations and detailed explanations of each illusion on her website.

To conclude, we find that *Musical Illusions and Phantom Words* offers a fascinating retrospective on the history and science of auditory and musical illusions, written from the unique perspective of one of the field's founding pioneers. Deutsch's volume on music and auditory illusions ranks among the classics in music cognition and perception, such as Bregman's perceptual streaming and auditory-scene analysis (Bregman, 1994), Krumhansl's cognitive constraints of musical pitch (Krumhansl, 1990), and Lerdahl and Jackendoff's generative theory of tonal music (Lerdahl & Jackendoff, 1983). We believe this seminal work will continue to enrich our understanding of music cognition and sound perception for decades to come.

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