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Review of Aniruddh D. Patel. *Music, language, and the brain*. Oxford: Oxford University Press, 2008.

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"Music, both as a science and an art, has reached a stage of development so far advanced that further improvement in any department must necessarily seem slow and insignificant." So claimed the author of an 1888 *Science* article, who apparently had not anticipated Stravinsky, the Rolling Stones, or Aniruddh Patel's new book on the neurocognition of music and language. Patel surveys an astonishing body of research, synthesizing a coherent account of what is known, what has been claimed, and what we should try to find out about these two fundamental domains of human experience and their interrelations.

It is easy to point out similarities between language and music, and equally easy to find differences. The challenge is to distinguish the scientifically illuminating similarities and differences from the specious ones. This is Patel's particular talent. To benefit from his subtle thinking, the reader should be prepared to make a considerable investment of time and concentration. The writing is easy to read, but the information is dense and might be too technical for music enthusiasts and language fanciers outside of academia. But for students and researchers in the cognitive sciences, this book is an accessible and invaluable resource.

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Each chapter begins with a detailed outline of its contents, and includes introductory material that equips language researchers with basic concepts needed to understand an area of music research, or vice versa (e.g., the anatomy of a spectrogram, the circle of fifths). But don't let the organization of the book fool you: this is not a textbook, even though it provides excellent materials for teaching. The reason is that Patel asserts his own vision of the language-music interface, which is original and at times far from the modal view on topics such as the relationship between linguistic and musical syntax and the entwinement of language and music in our evolutionary history.

Patel focuses on instrumental music rather than song, to minimize distraction from superficial connections between language and music inherent in this hybrid form. This appears at first to be a risky decision, since it would seem to exclude much basic music making in non-Western cultures. But instrumental music isn't only symphonies and concertos played in concert halls. It also includes Indian ragas, Javanese gamelan, Melanesian panpipes, and Congolese talking drums. Data from rare languages and exotic musical traditions are not just included to increase variety, generality, or cultural sensitivity (although they do this, too). Rather, cross-cultural analyses are essential to Patel's arguments, and provide powerful leverage on questions about learning, universality, and innateness.

Any comparison between music and language begins with deciding what dimensions can be fruitfully compared. *Pitch* is a salient element of both domains, but for Patel the linguistic analogue of musical pitch is not spoken pitch, but rather spoken *timbre* (e.g., vowel quality). Despite superficial differences, pitch and timbre are alike because humans organize them into perceptually discretized sound systems, which Patel argues do not arise as a natural byproduct of auditory perception. Instead, they reflect statistical learning over culture-specific patterns of sounds. He proposes that a common mechanism may enable learners to acquire both the phonological categories in their native language and the pitch categories in their native musical tradition, an idea he calls the "Shared Sound Category Learning Mechanism Hypothesis" or SSCLMH (one recommendation for Patel's next book is that he develop some catchier acronyms). This proposal is quietly subversive of traditional post-Chomskyan assumptions, suggesting that the process of acquiring native sound categories – the cornerstone of language acquisition – is not unique to language, and that the categories themselves are given by the statistics of the input.

Inspired by Chomsky's theory of generative grammar, the composer Leonard Bernstein famously proposed a set of parallels between musical

and linguistic syntax. In response, musicologist Fred Lerdahl and linguist Ray Jackendoff developed their influential *generative theory of tonal music*. Lerdahl and Jackendoff, however, denied that there were useful analogies between syntax in music and language, pointing out several clear differences between the two syntactic systems (notably, there are no musical equivalents to linguistic parts of speech such as nouns and verbs). Patel reviews studies from patients with focal brain damage that support a distinction between syntactic representations in language and music.

Acknowledging these differences, Patel proposes deep commonalities between musical and linguistic syntax, and provides initial experimental evidence for his "Shared Syntactic Integration Resource Hypothesis" (SSIRH). Although syntactic *representations* in music and language may be distinct, there may be overlap in the neurocognitive *resources* that serve to activate and integrate these representations during syntactic processing. This 'middle path' between a domain-specific and a domain-general view of syntax could have far-reaching implications for our understanding of music, language, and of cognitive architecture more broadly. Linguistic syntax, the parade case of a modular system in Fodor's theory, may interact with other cognitive systems in ways that had not been considered previously.

Having explored parallels in the sound, structure, and meaning of language and music, Patel turns to the question of how these domains evolved. He starts by noting that both language and music are uniquely the province of humans, simpler communicative signals and 'sung' mating displays in other animals notwithstanding. He asserts that both music and language are human universals, and proceeds to argue a distinction that is often blurred: the fact that a cognitive capacity is manifested universally does not mean that it is a product of natural selection. After untangling a knot of seemingly contradictory evidence, Patel concludes that language is probably a biological adaptation, but music probably isn't.

Patel rejects Darwin's conjecture that human music evolved for the same reason that birdsong did: sexual selection. But he also eschews the traditional alternative to the idea that musical ability enhances fitness for survival and reproduction: the idea that music is an epiphenomenon with no teleological significance, espoused by other thinkers from William James to Steven Pinker. Again, Patel proposes a middle way. Music is neither an adaptation nor a frill, but rather a kind of technology that humans use to transform their minds and societies. Patel suggests that music belongs to a "category" of such technologies that humans have the unique ability to invent (p. 400).

This appealing compromise position faces a challenge, however, when we consider the other members of the category of invented technologies

that Patel discusses: writing systems, airplanes, and the internet. There's no doubt that, like music, these technologies are uniquely human and profoundly transformative. But unlike music, they are far from universal. Patel also mentions the ability to control fire as a possibly universal technology that transforms society. But as Patel notes, using fire is not instantiated in the brain the way music is, and does not interact with other cognitive systems the way that music does. As such, it appears that music may be the only member of the proposed category of *complex*, *universal, uniquely human, neurally-specified, non-adaptive, culture-transforming technologies*. If so, then I am inclined to agree most strongly with his final remarks on the evolution of music: that further research is needed. As with nearly every other question Patel raises throughout the book, he outlines some potentially valuable experiments to investigate the extent to which natural selection molded our minds and bodies into musical instruments.

When sitting down to read a book with 'music' and 'brain' in the title, I was prepared for the disconcerting experience of having art and emotion reduced to the spiking of nerve cells. But reduction is not on Patel's agenda. Patel was a student of the visionary biologist E. O. Wilson, and this book exemplifies his mentor's notion of *consilience*, demonstrating that principles devised to explain one natural system may be ready-made to elucidate another, and that music and language may be better understood in conjunction than in isolation. In an age of lip service to interdisciplinarity, Patel rolls up his sleeves and starts building bridges, not just among the subdisciplines of cognitive science, but also between the sciences and humanities. I recommend this book enthusiastically as a guide to language and music in the brain and mind, and as a model of integrative thinking.

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