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"Music, Language, and the Brain" by Aniruddh D. Patel

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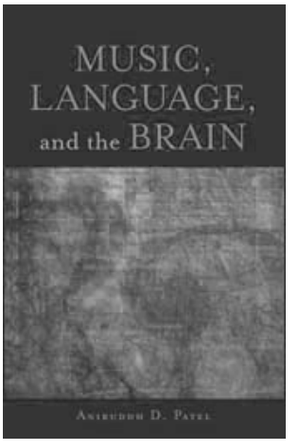
"Music, Language, and the Brain" by Aniruddh D. Patel. (New York: Oxford University Press, 2008). (ISBN13: 978-0-19-512375-3 ISBN10: 0-19-512375-1, Hard cover, 528 pages, $59.95).

The book starts by reminding us that the interest in music-language relations is over 2000 years old (going back to Plato) and has now led cognitive scientists to ask how the brain deals with these two domains: Are cognitive and neural correlates domain-specific or common to music and language processing? Patel's aim is to look systematically at various aspects of both domains and to present similarities and differences between the two systems. The emphasis, however, is on the search for commonalities: Even if the two systems have specific features and representations, he analyzes the extent to which these differences might reflect the same domain-general processes. In searching for commonalities rather than differences in processing mechanisms, Patel's comparative study of music and language investigates how the brain makes "sense out of sound" (p. 417) in a parsimonious way (e.g., by sharing structural processing and separating representations). While this represents Patel's favored approach, he also reviews research showing domain-specificity and attempts to integrate these data in a framework of shared processing. A metaphor illustrates this when he discusses dissociations in patients showing selective music and language deficits (see p. 73): If a factory manufacturing both cars and motorcycles catches fire that damages only one warehouse (e.g., the one for cars), this does not tell us anything about the overlap in tools used for the construction of both vehicles. Patel's book reviews research and approaches to investigate the possible overlap in cognitive and neural correlates of music and language processing.



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The book provides a thorough state-of-the-art review of recent studies and ongoing debates on music, language, and the brain. Patel presents emerging questions and new studies that provide at least partial answers or add new questions, stimulating future research. He communicates his curiosity and interest in studying music and language processing to understand how the brain deals with structured sound systems.

The book is organized to start with small units (i.e., sound categories, Chapter 2), goes on to discuss larger structural regularities (based on pitch and time respectively, Chapters 3 and 4), which leads to syntactic structures (Chapter 5) and then ends with questions related to meaning (Chapter 6) and evolution (Chapter 7). Avoiding the pitfall of superficial analogies between music and language, Patel is careful with definitions and restrictions of his discussions and interpretations: He does not attempt to be all-encompassing, aiming for precision rather than vague generalization. For example, the book focuses on instrumental music and ordinary spoken language, a choice justified for the investigation of common cognitive and neural mechanisms. At appropriate places, the book also includes "interludes" that focus on other art forms, such as sung music

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and poetry (Chapters 3 and 6), when this serves the purpose of understanding brain function.

Before starting an overview of the chapters, it is worth underlining the book's merit in balancing the Western-centric approach, which is dominating the research domains of music and language, with the presentation of numerous examples and cross-references to music and language of other cultures. This emphasizes that general hypotheses on music and language processing have to apply also to other cultural systems (see also Stevens & Byron, 2008).

Each chapter has a similar structure: After an introduction, two sections focus on music and speech, respectively, while making comparisons with the other system. A third section then discusses the specific aspects that might provide links between the two systems.

Chapter 2 presents the most important basic sound features of both systems: pitch for music and timbre for speech. For music, the chapter first introduces pitch, scales, and interval patterns and then discusses timbre, also tracing possible reasons why musical structures are based on pitch rather than on timbre. For the linguistic sound system, the chapter also considers first pitch (notably pitch contrasts in tone languages) and then timbre (forming vowels and consonants). Even if each system has its specificities, Patel underlines that despite these surface differences, listeners learn sound structures and categories relevant for a given sound system, and the acquired knowledge provides a mental framework that then influences the perception of these sounds. Patel proposes a "shared sound category learning mechanism hypothesis" or SSCLMH, and reviews comparative neurophysiological studies that support this hypothesis. The chapter also introduces spectrographic representations of sounds and gives basic information about neuroscientific methods used in the presented research.

Chapter 3 focuses on rhythm, first in music, then in speech, continues with an interlude on rhythm in poetry and song, and then highlights nonperiodic aspects of rhythm as a key link between music and speech. While beat as a stable mental periodicity is rather straightforward in music, rhythm in speech needs to be found in perception (i.e., systematic temporal, accent, and grouping patterns of sound) and not in the signal (i.e., isochrony of stresses or syllables). The chapter reviews debates in linguistics and empirical evidence concerning the claim that languages are either stress- or syllable-timed, goes on to discuss the influence of rhythmic structure on attention and perception (see Jones & Boltz, 1989), and then focuses on the importance of nonperiodic aspects of linguistic rhythm. At this point the chapter incorporates Patel's research in which he applies the normalized Pairwise Variability Index (nPVI) to speech and music. The nPVI is a measure of degree of contrast between successive durations in either an utterance or a musical piece. It is higher for English than for French speech (Ramus, 2002), and this extends to musical themes of English and French composers (Patel, Iversen, & Rosenberg, 2006), suggesting that the composers have their "linguistic rhythms … 'in their ears' " (p. 165). Searching for processes shared by the two domains leads to new hypotheses for future research: Do Greek native speakers (with Greek tolerating more irregular alternations between stressed and unstressed syllables than does English) learn irregular meters of Balkan songs more easily than do English native speakers? Does the perceptual habit of a listener (i.e., segmentation tendencies based on the native language) extend not only to the learning of a foreign language (Cutler, 2000), but also to the segmentation of nonlinguistic rhythmic patterns? Iversen, Patel, and Ohgushi (2008) show differences in the perception of simple rhythmic sequences of tones (long-short vs. short-long patterns) in native Japanese and English speakers, an outcome suggesting that the perception of rhythmic grouping can be modulated by cultural (linguistic) backgrounds instead of obeying universal principles.

Chapter 4 on melody brings together pitch and time information in music and speech. It emphasizes that melody perception is a constructive process involving the sequential organization of pitches and the discovery of the resulting meaningful relationships. After a brief introduction to linguistic intonation (which also presents useful tools, such as the prosogram), Patel considers important structural aspects of musical melodies and investigates to what extent they may apply to pitch variation in speech: grouping structure, beat and meter, melodic contour, intervals (and related Gestalt principles), motivic similarity, tonality relations (pitch hierarchies, event hierarchies, and implied harmony) and meta-

relations on a more global level. The review of research on speech melody also reveals how the investigation of underlying mechanisms has developed thanks to new tools and technologies. The chapter shows that "melody" refers to different features in music and speech, but the key link is statistical learning in both domains. For example, recent data suggest that implicit learning of prosodic linguistic patterns influences the creation of rhythmic and tonal patterns in music. Patel also discusses congenital amusia (Peretz et al., 2002; Peretz & Hyde, 2003), which he refers to as musical tone-deafness (mTD). This is a lifelong disorder of music processing that occurs despite normal cognitive functioning (e.g., memory, attention, and language). It is thus particularly interesting for studying music vs. language processing, and current research gathers information to characterize this phenomenon better and find the underlying causes. Patel presents here the "melodic contour deafness hypothesis". Because the main deficit described up to now is on the pitch dimension, Patel also raises the possibility of rhythm-deaf individuals, those having "two left feet" in dancing or being unable to clap to the beat of music. Preliminary evidence suggests support for this variant of amusia (Thompson, 2007).

Chapter 5 deals with syntax, referring to the "principles governing the combination of discrete structural elements into sequences" (page 241). It first presents syntactic structures in music (i.e., tone, chord, and key structures, followed by event hierarchies; Lerdahl & Jackendoff, 1983) and then discusses formal differences and similarities between musical and linguistic syntax. Patel is not searching for direct equivalences, (such as "nouns" or "verbs" in music) but instead acknowledges the formal differences between the two systems and then focuses on functional similarities, which lead him to a discussion of the "shared syntactic integration resource hypothesis" (SSIRH), originally presented by Patel (2003) and extended here. The SSIRH proposes that processing of musical and linguistic syntax draws on common neural resources, while using separate representation networks. This hypothesis is based on cognitive theories in music and language postulating that listeners build structural representations (of sentences and sequences), develop expectations for future events, and use processing resources for the syntactic integration of events (e.g., Gibson, 1998, for language, and Lerdahl, 2001, and Bharucha, 1987, for music). The SSIRH reconciles neurophysiological data showing neural correlates overlapping for music and language (e.g., Patel et al., 1998) with cases of double dissociation between amusia and aphasia (pointing to modularity, Peretz & Coltheart, 2003), notably by suggesting damage to the representation networks (i.e., the warehouses in the factory metaphor presented earlier in the book). The SSIRH has generated new hypotheses that have led to recent research investigating the interference between linguistic and musical syntax processing, as well as musical syntactic deficits in aphasic patients.

Chapter 6 deals with meaning in music and language. It proposes a taxonomy of musical meaning, going from "intramusical" (e.g., musical structures, expectations, emotions) to "extramusical" meanings (e.g., tone painting, social and cultural associations). While searching for meaning in music might be considered controversial, Patel carefully introduces the concept of meaning and acknowledges the differences between linguistic meaning and possible musical meaning. For example, music lacks semantic content, but can suggest semantic concepts. Patel reminds the reader that linguistic meaning can refer to semantics (i.e., mental representation of concepts and reality) and pragmatics (i.e., adding of contextual information and drawing inferences on the basis of a sentence). Most research comparing linguistic and musical meaning has focused on semantics (e.g., Koelsch et al., 2004). Patel proposes here that pragmatics might represent an even more adequate level of comparison between the two domains. A discussion of cognitive aspects of discourse coherence in language and its parallels to musical discourse as well as of the expression and appraisal of emotion in language and music brings the author to new research questions: Are patients with affective aprosodia impaired in their perception of musical affect? Are patients with problems in linguistic inference impaired in their perception of musical coherence? Research on the latter question would probably have to focus on relatively short time spans since even in healthy listeners, global large-scale structural organization influences music perception only weakly or

not at all (e.g., Karno & Konečni, 1992; Lalitte & Bigand, 2006; Tillmann & Bigand, 1996). In sum, this chapter proposes various ways to conduct comparative research on music and language with the goal to further our understanding of how listeners derive meaning from structured acoustic sequences.

The final chapter (Chapter 7) on evolution is thorough and thought-provoking, even if it is certainly the most speculative one in the book and reflects the author's perspective on the topic. Two sections discuss natural selection (first for language, then for music). The proposed key link for music-language relations is focusing on beat-based rhythm processing, which leads to the "vocal learning and rhythmic synchronization hypothesis". The author's hypothesis of shared neural resources has also shaped this chapter. In light of SSIRH, Patel discusses debates about the alternative interpretations arguing for natural selection for either language or music. Patel then suggests considering music as a by-product of other cognitive skills, rather than as a biological adaptation or a direct target of natural selection. Instead of choosing between "frill" and "adaptation", Patel proposes to see music "as something that we invented that transforms human life" (p. 401). Beyond being a "transformative technology" (i.e., one that we do not want to give up, like fire making or the Internet), music "has the power to change the brain" (p. 412). This power has been shown in basic research in which early music training alters brain structure (e.g., Pantev et al., 2001) and finds application in rehabilitation (Särkämö et al., 2008). The hypothesis of shared neural resources thus opens up new promising research avenues with clinical implications (see also Overy, 2003). These research avenues will have to go beyond the comparison between music and language and include other cognitive activities as well as motor activities (e.g., Altenmüller, Wiesendanger, & Kesselring, 2006).

"Music, Language, and the Brain" by A. D. Patel addresses a current topic, presents an up-to-date review of research, and is published at the right time, when conferences specifically dedicated to music and language are emerging ("Language and Music as Cognitive Systems" in Cambridge 2007 and "Music, Language, and the Mind" in Boston 2008) and publications on the topic are multiplying (e.g., Besson, Schön, Moreno, Santos, & Magne, 2007; Patel & Iversen, 2007; Schellenberg & Peretz, 2008; Zatorre & Gandour, 2008). The book fills a need of this growing research area and serves as an important reference for scholars in this domain, next to S. Handel's (1989) classic book "Listening – An Introduction to the Perception of Auditory Events", which has served for almost 20 years as a handbook for investigators of the perception of sound structures in music and language.

Patel's book is accessible for readers who are neither linguists nor musicologists. Each chapter introduces thoroughly and in parallel the required concepts and structures for both music and language and points to websites dealing with related topics or useful software. Each chapter can stand on its own, notably for readers interested in one specific topic or for course readings. Noteworthy also is the special website presenting sound examples to illustrate the described phenomena and experimental manipulations (including some spectacular movies). The book addresses not only established researchers, but also students aiming to develop critical thinking, theoretical approaches, and experimentation. The organization and presentation is didactic. Patel introduces basic concepts and methods, he outlines rationales leading from one study to the next or points to limitations of a given study, which then leads to a follow-up study or the need for one. He is also sharing his personal expert views on interesting questions and areas calling for more research, whether this concerns broad domains with new, intriguing hypotheses or more specific detailed experiments.

In sum, the book is for those who are interested in studying relations between music and language from a cognitive perspective, with the goal of shedding light on cognitive and neural correlates of structured sound processing. The introduction states, "The comparative approach is opening up entirely new avenues of research, and we have just started the journey" (p. 2). The book will certainly become a landmark: Beyond providing a road map for the landscape of current research, it provides tools for exploring new terrain and outlines some of the possible directions in which to go.

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BIOGRAPHIES

Reviewer of the book

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After a PhD in cognitive psychology (1999, Dijon) and postdoctoral research in cognitive neuroscience Dartmouth College), **Dr. Barbara Tillmann** joined the laboratory CNRS-UMR 5020 (Lyon) as a CNRS researcher in 2001. Her research is in the domain of auditory cognition and uses behavioral, neurophysiological, and computational methods. More specifically, she is investigating how the brain acquires knowledge about complex sound structures, such as music and language, and how this knowledge shapes perception. Her research has appeared in numerous journals, including *Psychological Review, Journal of Experimental Psychology, Cognition, NeuroImage,* and *Music Perception.*

Author of the book

Dr. Aniruddh (Ani) Patel received a bachelor's degree in biology from the University of Virginia in 1987 and a Ph.D. in biology from Harvard University in 1996. He joined The Neurosciences Institute in 1997, where he is now the Esther J. Burnham Senior Fellow. His research focuses on how the brain processes music and language, especially what the similarities and differences between the two reveal about each other and about the brain itself.

He has pursued this topic with a variety of techniques, including neuroimaging, neuropsychology, behavioral studies, and theoretical analysis. His research has appeared in numerous journals, including *Nature, Nature Neuroscience, The Journal of Cognitive Neuroscience, Cognition, Brain* and *Language,* and *Music Perception.* He has served on the Executive Committee of the Society for Music Perception and Cognition and was the President during 2009.

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