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Review of The Musicians' Guide to Perception and Cognition by David Butler

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Reviews

David Butler, *The Musician's Guide to Perception and Cognition.* New York: Schirmer Books, 1992. xv, 265 pp.

Reviewed by Elizabeth West Marvin

The Musician's Guide to Perception and Cognition belongs on every music theorist's bookshelf. For those with a specialized research interest in music cognition, it provides extensive bibliographic references, an overview of research areas that may lie outside one's specialization, excellent compact disc examples of stimuli like those used in a number of classic studies, and a very readable ("no more jargon than is absolutely necessary," p. ix) introductory text for teaching music cognition classes. But this book is not intended solely for the specialist, but also for a more general reader—"the musician," as its title indicates. Indeed, there is something of interest for musicians from many musical disciplines, and for theorists teaching a variety of courses (harmony, acoustics, history of theory, analysis and performance, and pedagogy of theory, for example).

What does it mean for the structure and content of this book that its intended primary audience is musicians? First, its language assumes basic musical knowledge, but assumes no specialized scientific, psychological, acoustic, physiological, or statistical knowledge. So, for example, basic principles of controlled experimentation (such as dependent and independent variables, or psychophysical testing's just-noticeable differences, method of adjustment, and magnitude estimation) are all defined; acoustical principles, from divisions of the string and the harmonic series to tuning and temperament, are presented at an introductory level and aurally demonstrated; the parts of the ear are carefully diagrammed and labelled, with their various functions explained; and experimental findings are summarized without detailed statistical data on probability or numerical significance.

Second, the author understands that musicians often learn best by ear; hence he has included an invaluable teaching tool: the CD of musical examples. Butler notes that "hearing a stimulus pattern often reveals more to a music student than repeated readings of the description of an experimental procedure, and the listening experience often provokes students into valuable critical evaluation and 'what if' conjecture" (pp. ix-x). Indeed, these first two points (the book's acces-

sible language and its musical examples) work together to place Butler in the role of "translator" for the musician interested in reading the experimental literature. It is not easy to read an article that describes its stimuli in terms of hertz, decibels, and milliseconds and then to imagine how those stimuli must sound. Butler's realizations enable the reader/listener to focus quickly on the perceptual issues raised by the study without puzzling over the design of the stimuli.

Third, Butler voices many musicians' criticisms of psychophysical and cognitive experimentation in music, but he does so in an even-handed way that actually addresses musicians' incomplete understanding of just why these experiments are designed as they are. He explains that scientists' objectives in designing "music" experiments are often quite different from those that musicians would read into them, and he notes that scientific experiments are designed to yield results that can be generalized to large populations of listeners who are not necessarily as musically literate as our students and colleagues. While some are quick to blame psychologists for results that seem to us to be unmusical, Butler notes that the problem may actually lie with those who seek to draw musical conclusions from what are essentially non-musical stimuli. His even-handed treatment of both the musicians' and the psychologists' possible areas of weakness is demonstrated in passages such as this one, drawn from the book's Preface (p. x):

> There are a number of ways to become ensnared by problems in this research area. The most obvious way is methodological: to be careless or unknowing about experimental design or procedure, to misapply statistical procedures or misinterpret statistical reductions, to become a bit zealous in drawing inferences from test results. Another way to encounter problems is to be musically innocent: to miss hidden variables in musical stimuli and in response tasks or, conversely, to mistake unmusical stimuli or responses for valid musical ones; to ask inexpert listeners to make sophisticated musical judgments, or the reverse.

The Musician's Guide to Perception and Cognition is divided into two parts; the book's title reflects this organization, which from the outset clearly separates perception from cognition. The author defines "perception" as "the awareness and judgment of a sensation, mediated by prior knowledge" (Glossary, p. 232) and "cognition" as a "perception based on, or affected by, knowledge" (p. 223). This distinction is wisely maintained throughout the book, as is the distinction between the sen-

sory attributes of sound treated in the first part of the book ("Psychophysics of Musical Sound") and the cognitive aspects of sound in music treated in the second ("Mental Representations of Musical Relationships").[1] Even the chapter titles, which have an organization that is parallel from Part One to Part Two, reflect this distinction: "The Sensory Attributes of Pitch" parallels "Cognitive Aspects of Pitch in Music"; "The Sensory Attributes of Timbre" parallels "Cognitive Aspects of Musical Timbre"; and "The Sensory Attributes of Time and Space" parallels "Cognition and Time in Music."[2] The text concludes with a chapter on the development of cognitive awareness in music from prenatal responses onward, followed by two appendixes ("Frequency Equivalents for Twelfth-Octave Equal Temperament [A=440Hz]" and "The Humane Treatment of Human Subjects"), notes for each chapter, a glossary of terms, references, and an index.

The book's two main parts are preceded by two introductory chapters that give an overview of the field of music psychology and present basic acoustic principles. Chapter 1 presents a topical outline of music psychology, drawn from the subject indexes of a dozen texts that survey the field. The breadth of the field is demonstrated by this six-part outline:

I. Psychoacoustics and Musical Sound
II. Musical Systems and Cognition
III. Affective Responses to Music
IV. Ability (e.g., Performance, Creativity, Intelligence, Heredity)
V. Applications (Clinical, Industrial, Educational, Social)
VI. Testing, Experimental Methodology[3]

Butler's book is limited to just the first two of these; he wisely does not attempt to cover all six within the confines of this introduc-

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[1]To Butler's credit, he is careful throughout the book to use appropriate language to distinguish between the sensory and cognitive aspects of pitch, timbre, and so on—clearly defining terms that musicians might confuse or attempt to use interchangeably. Intensity, for example, is a physical attribute of sound energy, measured in decibels, while amplitude is "the peak value attained by a sound wave during a single vibratory cycle" (p. 221). Together, intensity and amplitude contribute to what we perceive as loudness. Similarly, frequency is "the rate at which a vibration completes a full cycle, measured in hertz (Hz)" (p. 227), which we perceive as pitch.

[2]The author notes that the chapters are designed so that they need not be read consecutively; some readers may wish to reorder the chapters so that the sensory and cognitive aspects of pitch, of timbre, and of time are paired.

[3]Butler's outline is presented in Table 1-1, pp. 2-4.

tory text. Even within these two subject areas, the author has chosen to treat some subjects in less depth, and notes that the "limited scope of this book" precludes more detailed coverage (see, for example, pp. 193 and 159). In the chapter on cognition of time in music, for instance, Butler devotes only one page each to the issues of tempo, rhythm and meter, and proportionality. Indeed, the book is just too short to cover every topic with the level of detail it deserves. If the book finds a sufficient market to justify a second edition, Butler should consider expanding his discussions of the experimental literature, especially in the latter portions of Part Two.

Further, there are at least two missing topics that really belong in this book—even given its self-imposed limitation to topics of sensory perception and musical cognition. The first of these is an introduction to the neurology of music perception. The physiology of the ear, presented in Chapter 3, ought to be complemented by physiological diagrams of the brain and discussion of brain function, especially given the wealth of research that exists on brain lateralization and hemispheric dominance among musicians and non-musicians.[4] The second of these topics, psycholinguistics and its parallelisms to music cognition, could easily have become a part of Butler's discussion (pp. 161-163) of the perception of hierarchical levels in musical structure. In this connection, he discusses Schenker's and Lerdahl and Jackendoff's music-analytical theories; yet not even in the discussion of the latter authors, who are heavily influenced by linguistic theory, does he con-

[4]For an overview of this literature, see *Music and the Brain: Studies in the Neurology of Music* , ed. M. Critchley and R.A. Henson (London: William Heinemann Medical Books, Ltd., 1977) and Oscar Marin's contribution (Chapter 15) to Diana Deutsch's *The Psychology of Music* (New York: Academic Press, 1982). Researchers frequently cited in connection with hemispheric asymmetry are Thomas Bever, Doreen Kimura, and Isabelle Peretz. See, for example, Bever's "Broca and Lashley Were Right: Cerebral Dominance is an Accident of Growth," in *Biological Studies of Mental Processes* , ed. David Caplan (Cambridge, MA: MIT Press, 1980); Bever and Robert J. Chiarello's "Cerebral Dominance in Musicians and Nonnusicians," *Science* 185 (1974): 536-539; Kimura's "Left-Right Differences in the Perception of Melodies," *Quarterly Journal of Experimental Psychology* 16 (1964): 355-358 and "Functional Asymmetry of the Brain in Dichotic Listening," *Cortex* 3 (1967): 163-178; Peretz and José Morais's "Modes of Processing Melodies and Ear Asymmetry in Non-Musicians," *Neuropsychologia* 18 (1980): 477-489 and Morais, Peretz, Marc Gudanski, and Yves Guiard's "Ear Asymmetry for Chord Recognition in Musicians and Non-Musicians," *Neuropsychologia* 20 (1982): 351-354. None of these articles is cited in the list of references that concludes Butler's book.

nect the analytical theories with psycholinguistic research.[5] Butler does effectively demonstrate connections between music and psycholinguistic research in discussing two of his listening examples, however (Examples 5.4 and 5.5, pp. 84-85). Here listeners are asked to write down four sentences in which the initial consonants of key words are interrupted by noise; predictably, listeners are influenced by the context of the sentence in identifying the obscured words. The "musical" analog is a gliding sine tone that is interrupted periodically by white noise; when the white noise is removed, listeners discover brief gaps in the tone. Yet the glide sounds uninterrupted and continuous in the white-noise condition because of the context provided by the rising or falling glide.

Butler's *Musician's Guide* would be my first choice as a required text for student purchase in a music cognition course. However, because of the brevity with which some subjects are treated (and because of the few omissions cited above), I would supplement with readings drawn from other books and collections (most notably Deutsch, Sloboda, Dowling and Harwood, and Howell, Cross, and West)[6] and from articles in *Music Perception* and other scientific journals reporting on experimental research. If the course were to attempt to cover developmental issues, Butler's too-brief final chapter would be supplemented with readings from Hargreaves's book-length treatment of the

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[5]Butler's discussion cites Heinrich Schenker, *Free Composition*, trans. Ernst Oster (New York: Schirmer Books, 1979) and Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* (Cambridge, MA.: MIT Press, 1983). In contrast to Butler, John A. Sloboda's *The Musical Mind: The Cognitive Psychology of Music* (Oxford: Clarendon Press, 1985) contains an extended section comparing Schenker with Chomsky (pp. 11-23). More to the point, however, are experimental studies that merge issues of musical and linguistic interest, such as the study of rhythm and contour in speech. See, for examples in the rhythmic domain, *Rhythm in Psychological, Linguistic and Musical Processes*, ed. James R. Evans and Manfred Clynes (Springfield, IL: Charles C. Thomas Publisher, 1986); speech contour studies often examine "motherese," as in D.N. Stern, S. Spieder, and K. MacKain, "Intonation Contours as Signals in Maternal Speech to Prelinguistic Infants," *Developmental Psychology* 18 (1982): 727-735. Issues of hierarchical versus serial processing of sentences as heard or read would seem to have direct analogies to the cognition of music. Replication of experimental models drawn from this line of psycholinguistic research and adapted to musical stimuli appear to be a ripe area for study.

[6]W. Jay Dowling and Dane Harwood's *Music Cognition* (Orlando, FL: Academic Press, 1986), like Butler's text, comes with recorded musical examples (on cassette). Deutsch and Sloboda are cited in footnotes 4 and 5. Peter Howell, Ian Cross, and Robert West are editors of a collection of essays by

subject.[7] Finally, if the course were designed to conclude with a research project that might take the form of an experimental study, then a good psychology methods book would also be required.[8]

Why does the Butler stand above the others cited here? Because it is written from a musician's point of view, with a musician's vocabulary; because it is organized and written as a textbook (not solely as a research publication); and because its CD can be put to use in a variety of ways. Here is a book that does not define "interval" or "dominant seventh," but instead defines "amplitude," "dichotic listening," "Fourier analysis," and "mel scale." Every technical acoustical, psychological, physiological, or statistical term of importance is given in boldface on its first appearance; the boldface signals its inclusion in the book's glossary. The glossary does not merely repeat information given in the body of the text, but expands upon it and refers the reader to related glossary entries.

The book's textbook orientation is reflected not only in the author's decision to compile a glossary, but also in his inclusion of chapter summaries and sets of problems, which vary from requests for definitions to class discussion questions, from library research tasks to mathematical calculations.[9] Some questions might be assigned and

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some thirteen English contributors, entitled *Musical Structure and Cognition* (Orlando, FL: Academic Press, 1985). Another new volume that might also be included on a library reserve list is *Psychology and Music: The Understanding of Melody and Rhythm*, ed. Thomas J. Tighe and W. Jay Dowling (Hillsdale, NJ: Lawrence Erlbaum Associates, 1993).

[7]D. Hargreaves, *The Developmental Psychology of Music* (Cambridge: Cambridge University Press, 1986).

[8]I suggest William J. Ray and Richard Ravizza's *Methods Toward a Science of Behavior and Experience*, 3rd ed. (Belmont, CA: Wadsworth Publishing Company, 1988) because it presents not only a good introduction to scientific method and experimental design, but also some elementary statistics and detailed information on writing and reading scientific articles in APA (American Psychological Association) style.

[9]An *Instructor's Manual*, available on disk from the book's author, provides answers for each chapter's problems; these answers are particularly helpful for Chapters 2 and 3, where mathematical calculations are required. The manual also contains ideas for class demonstrations and discussions, as well as additional references. Readers interested in obtaining a copy of the manual (available only in Macintosh format) should send a blank 800K diskette and two 29-cent stamps to: Prof. David Butler, School of Music, 1866 North College Road, The Ohio State University, Columbus, OH 43210. Two references which may be of interest to readers of this journal are additional CDs of acoustical examples available for purchase. Philips CD No. 1126-061, which includes the decibel scale and stretched and compressed scales, among other demon-

collected by the instructor, and later form the core of a class discussion. In the introductory chapter, for example, he asks: "Suppose that you are interested in finding whether listeners can distinguish the timbres of two different violins with better than chance levels of accuracy. What is the dependent variable of the study? List at least six independent variables, and explain how you would control them" (pp. 13-14). Some questions force students to use technical information covered in the chapter to solve musical problems; for example: "Assuming that sound travels at about 1,150 feet per second, how long would it take for the sound of a trumpet at an outdoor concert to reach a flautist sitting 60 feet away? Expressed as a note value, what would be the duration of this time lag, given that the music was currently proceeding at MM. quarter note = 132?" (p. 33). Most of the chapter problems are good opportunities for students to put psychological or acoustical information into musical context, and are worth assigning and discussing in class.

Butler's text and CD are also full of "self-tests," which make for enjoyable reading and involve the reader directly with the perceptual issues under discussion. For example, in the second chapter's introduction to acoustics, Listening Example 2.5 presents "four complex tones in which all partials other than the fundamental have been removed by filtering" (p. 22). The tones are produced by a French horn, violin, sine wave, and piano, but not necessarily in that order; readers are invited to determine by sound the order in which the four tones are presented, and then check their responses with the list given in one of the problems that concludes the chapter. The problem then asks students to consider further the listening strategies used to make their determinations. Visual self-tests are also given, such as an occluded figure that is seen only partially as a slit moves from left to right (Figure 9-1). Readers try to identify the visual pattern from these partial images as the "narrow 'window' passes from left to right in each succeeding frame" (p. 144); they are given the complete image in one of

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strations, is available from the Acoustical Society of America for approximately $20 (500 Sunnyside Blvd., Woodbury, NY 11797); *The Space-Sound-CD Dummy Head Recording* was available for about $45 in 1990 from Audio Electronics, P.O. Box 1401, D-4000, Düsseldorf 1, Germany. Among the class demonstrations that Butler suggests in the manual is a very effective graphic demonstration of the difference between arithmetic, exponential, and logarithmic scales that is carried out physically by having the class line up in a single column and then vary the patterns with which individuals step away from the straight-line starting point.

the notes to this chapter. This visual exercise is an effective demonstration of the perceptual "now."

As stated above, the CD that accompanies this text is one of the reasons this book is such a strong teaching tool. This valuable resource will be underutilized if it is put it to work only the music cognition classroom. Many listening examples would be appropriate for an acoustics course, especially those in Chapters 2-4.[10] Filters are applied to acoustic instrumental sounds to allow only certain partials to be heard together or successively; tones with partials that are integral multiples of their fundamental are compared to tones comprised of equal-tempered partials; combination tones are demonstrated; sustained tones of orchestral instruments are presented with their attack transients removed; and chord progressions in C major and F# major are compared in equal temperament, Pythagorean tuning, quarter-comma meantone temperament, and just intonation. In fact, these tuning examples and the text's discussion of their derivation (not to mention the earlier chapter on acoustics) would be appropriate reading and listening for classes in history of theory: to clarify early treatises' treatments of musical proportions, divisions of the string, and tunings, for instance, or to demonstrate the *Affect* associated with specific keys.

As students in history of theory classes read Mattheson's *Der vollkommene Capellmeister* (1739), they can hear a musical realization (Listening Example 7.2) drawn from this treatise to illustrate the concept of compound or polyphonic melody. This same example would be perfectly appropriate in any undergraduate harmony class, as would Listening Example 7.9 (examples of changing-note and gap-fill melodies) in a unit on melodic analysis. Listening Examples 7.10 and 7.11 (examples of "consonant" and "dissonant" intervals, and several interval pairs that imply different tonal centers) could be included in a class discussion that attempts to define "tonality." Butler's text stimulates such a discussion: for example, he asks "do these classifications [consonant and dissonant] adequately describe the pleasantness or unpleasantness of the combinations? Do all 'consonant' chords sound intrinsically stable? Do all 'dissonant' chords sound unstable?" (p. 119).

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[10]This is not to imply that only the listening examples are appropriate to an acoustics course. Chapter Two ("Essentials of Acoustics") is good introductory reading. In fact, the entire first part of the book ("The Psychophysics of Musical Sound") could prove useful in such a course—particularly the chapters dealing with the sensory attributes of loudness, time, and space. Some discussion of stereo mixing and room acoustics is included in the sections entitled "Auditory Localization" and "Spatial Cues" (pp. 91-99).

Indeed, a wealth of examples in this book could be used in undergraduate theory and aural skills courses, depending on the creativity and resourcefulness of the teacher.[11] Listening examples can form the point of departure for class discussion in the rhythmic domain. For instance, Listening Example 9.4 presents an ear-training question to students who hear an adaptation of Beethoven, Symphony No. 5 (III): "the example may be in 3/2, 3/4, 3/8, 6/4, 6/8, or 12/8 meter. If you decide which meter the example is 'really' in, what would prevent someone else from arguing just as successfully for another choice? What effect(s) would a change of tempo have on your choice?" (p. 160). Teachers of set-theoretical analysis classes can demonstrate the distinction between pitch and pitch class by means of the "Shepard's Tones" illusion (Listening Example 3.8) and the octave-displaced pitches of the melody presented in Listening Example 7.5.[12] Even studio teachers or theorists who teach classes relating analysis to performance can use Butler's discussion of expressive timing (pp. 156-159) and Listening Example 9.3, which compares renditions of a performance of Beethoven's Sonata No. 30, Op. 109 (III) using a computer-controlled Bösendorfer piano. The first rendition is unaltered, the second is "the same performance, but with all notated simultaneities adjusted [by computer] so that their onsets are actually synchronous," and the third is "the same performance, but with all key velocities equalized" (p. 157).[13]

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[11]It is clear from numerous references in the text that Butler has taught his share of aural skills courses, and has learned about music cognition from the experience. He notes, for example, that "it can evidently be disconcerting for someone with absolute pitch. . .to complete a melodic dictation exercise in, say, the key of G while a diabolical aural training instructor plays the melody in some other key" (p. 50). In reference to some psychological studies of rhythm, he notes "this is not likely to interest musicians who observe much more complex perception and production activity in the aural training classroom and in the performance studio" (p. 159). In the chapter on the development of cognitive awareness in music, he notes with some humor: "Anyone who has ever taught a 'homogeneous' group of students in a college-level aural training class will appreciate how widely the levels of cognitive skill within, say, a kindergarten classroom might vary" (p. 218).

[12]These examples are drawn from the work of Roger Shepard and Diana Deutsch. See, for example, R. N. Shepard, "Circularity in judgments of relative pitch," *Journal of the Acoustical Society of America* 36 (1964): 2345-2353, and his "Structural Representations of Musical Pitch," in Deutsch's *The Psychology of Music* (see footnote 4). See also D. Deutsch, "Octave Generalization and Tune Recognition," *Perception & Psychophysics* 11 (1972): 411-412.

[13]This example is based on experimental research by Caroline Palmer; see, for example, her "Timing in Skilled Music Performance" (Ph.D. diss.,

Clearly, the inclusion of the CD and the text's discussions surrounding these listening examples are among the book's strongest suits; these alone justify the opening statement of this review.[14] But this text has far more to offer than entertaining aural sleights of hand (or "sleights of ear"). The *Musician's Guide* is an excellent overview of the field of music cognition; it represents the breadth of research in this area while managing to balance (mostly with success) the presentation of basic terminology and concepts at an introductory level with more advanced discussions and critiques of classic and recent experimental studies. Moreover, it is well written and well organized.[15] Musicians will enjoy reading this text and will probably find classroom materials here that they can draw on for many years.

Cornell University, 1988) and "Mapping Musical Thought to Musical Performance," *Journal of Experimental Psychology: Human Perception and Performance* 15 (1989): 331-346.

[14]One advantage of the CD format (over the cassette that accompanies Dowling and Harwood's music cognition book, for example) is the availability of CD-ROM technology. Teachers with some HyperCard experience could write audio stacks for use in classroom demonstrations or for a computer listening lab where students might explore topics in music cognition at their own pace, of course with proper documentation and citations to the publisher of the text and CD! Users of the CD should be forewarned (as Butler does repeatedly, pp. 39 and 78, for example) not to turn the volume too high; even with the warnings, I found myself pulling off the earphones mid-example at least once.

[15]In addition, the book is remarkably free of errors. I found no typographical errors, except that Listening Example 7.11 cites Figure 7-10 when it probably should cite Figure 7-14. Listening Example 8.3 is played three times, not twice as the text states; and Listening Example 7.2 is longer than the notation presented in Figure 7-3. These are small errors, easily fixed if there is another edition. The CD that accompanied my book was not error free, however, since there was some distortion on the final two tracks. I have not yet attempted to compare this disc with other discs or to have it replaced; even so, this CD will get many repeat listenings and much classroom use.