Marc LEMAN (ed., 1997). Music, Gestalt, and Computing: Studies in Cognitive and Systematic Musicology. Lecture Notes in Artificial Intelligence, no. 1317. Berlin, Heidelberg: Springer-Verlag, 1997. 524 pp. CD with sound examples included.

A musical problem was crucial to the very inception of the Gestalt movement, as is well known: the invocation by C. von EHRENFELS of melodic transpositional equivalence (following upon observations by E. MACH) provided the impetus for the subsequent development of Gestalt theory by M. WERTHEIMER, W. KÖHLER, K. KOFFKA, and many others (WERTHEIMER 1938, 4-5). The general laws of perception were principally formulated in terms of the visual domain, however, and it is only more recently that musicology and music psychology have returned to Gestalt theory to find in it a useful framework, a development that is set in relief in the volume under discussion. This book represents a selection from the proceedings of the Joint International Conference on Cognitive and Systematic Musicology, held at Brugge, Belgium, 8-11 September 1996. The collection was edited by M. LEMAN, assisted by a reading committee consisting of A. CAMURRI, J. LOUHIVUORI, R. PARNCUTT, and A. SCHNEIDER. In all, 33 papers are included, the majority of which make some reference to Gestalt theory; this review will of necessity deal only with those articles most seriously concerned with the theory.

The papers are divided among five chapters, organized according to common topics. The first chapter, "Gestalt Theory Revisited," will undoubtedly be of greatest interest to readers of this journal, along with several papers from the next two chapters, "From Pitch to Harmony," and "From Rhythm to Expectation." Pitch, harmony, rhythm, and expectation are the issues most thoroughly explored in the psychology of music hitherto. Expectation was first invoked in a thoroughgoing way with respect to music in L. MEYERs 1956 Emotion and Meaning in Music, which applied Gestalt principles and ideas from information theory. (Only two of the contributors, C. KRUMHANSL and J. FYK, cite MEYERs contribution to music theory and aesthetics.) The remaining musical issues treated have fewer points of contact with existing tradition: "From Timbre to Texture," and "From Musical Expression to Interactive Computer Systems." The possibilities for a deeper study of these more intractable musical domains—timbre, texture, and expression—largely arise from innovations in technology, especially the use of computers. Thus the second organizing principle of this collection, along with Gestalt theory: the use of computers, especially to model musical perception and cognition. The volume closes with a "List of Sound Examples" for the accompanying CD, followed by useful name and subject indexes.

The complexities of the musical stimulus itself and of our subjective experience of it are difficult to disentangle. The response of researchers seeking verifiable results has often been to simplify and decontextualize musical materials. While such approaches have permitted experimental control to be established, their

limitations have increasingly spurred efforts to take musical contexts into consideration, especially to deal with what LEMAN (1995) calls "tone semantics," the dynamic qualities of tones within the context of tonality or some other organizing principle. One can see that difficult matters of definition and control arise immediately, as do also the really interesting questions dealing with higher level mental organization. With the advent of the interdisciplinary field of cognitive science, a cognate and parallel subfield developed within systematic musicology, to finally establish itself as the somewhat separable discipline of cognitive musicology.

The first three papers take on the task of placing cognitive and systematic musicology in historical and disciplinary terms. LEMAN and SCHNEIDERs "Origin and Nature of Cognitive and Systematic Musicology: An Introduction" traces the development of these fields during the past century, together with the changing fashions in the reception of Gestalt theory. In the first decades of the century, systematic musicology pursued an ambitious program in the foundations of music, and there was cooperation between musicologists and psychologists at a time when Gestalt psychology was at its zenith, particularly in German-speaking centers. The authors cite the work from various schools of Gestalt psychology on audition in the 1920s. In the authors' view, after World War II both systematic musicology and Gestalt theory were in disrepair in Europe, not only on account of the effects of war, but also because of paradigm shifts in these disciplines, on one hand the dominance of behaviorism in American psychology, on the other the development of information theory/cybernetics. The limitations of behaviorism were exposed by a critique stimulated in part by the importation of information-theoretical ideas into psychology and linguistics. What has been called "the cognitive revolution" (GARDNER 1987) led in the 1970s to the reformulation of systematic musicology as a field to deal with issues in music cognition, along with the traditional areas of musical acoustics, theory, and aesthetics.[1] In the view of LEMAN and SCHNEIDER, the computational approaches that engendered the cognitive emphasis in the human sciences generally also gave Gestalt thought a new lease on life.

Classifying the musical disciplines and exploring the relationships among them in their current disposition is the burden of J. LOUHIVUORIs "Systematic, Cognitive and Historical Approaches in Musicology." The traditional division in Europe between systematic and historical musicology is usually ascribed to G. ADLER, beginning with his influential 1885 article, "Umfang, Methode und Ziel der Musikwissenschaft." As noted above, cognitive musicology begins as a subfield of systematic musicology, but has to some extent achieved a separate status, in

[1]The inception of cognitive science has been situated in 1956 (GARDNER 1987, 28-30). GARDNER especially cites the *frisson* experienced by one of the participants, G. MILLER, at a MIT conference that included now classic papers by A. NEWELL and H. A. SIMON, N. CHOMSKY, and MILLER himself. In the present context it is interesting to note again the appearance in that year of MEYERs book.

Europe at least. Historical musicology has always been rather detached in its methods and aims from the more scientific aspirations of the systematic branch.[2] LOUHIVUORI attempts to achieve a rapprochement between the systematic and historical branches and at the same time promote cognitive musicology by introducing the cognitive perspective into historical studies. There is a degree of naïveté in this effort, as evidenced in the following quotation: "It is possible to use for example artificial brain models in studying the development of musical styles, scales, modes, tonal systems, etc. Artificial brain models could be placed into different historical musical environments to study how the artificial brain organizes musical inputs and how the output of the system depends on the changing environment" (p. 34). It seems unlikely that existing technology could produce valid results for the products of cultural evolution, even if one accepts the premise that computers can model how individual brains process musical information. As we will see, this premise is implicit in a number of subsequent papers.

The third paper, M. WEBERs "Empiricism, Gestalt Qualities, and Determination of Style: Some Remarks Concerning the Relationship of Guido Adler to Richard Wallaschek, Alexius Meinong, Christian von Ehrenfels, and Robert Lach," traces the connections among leading figures at the establishment of musicology, including the comparative branch (WALLASCHEK and LACH). The discussion of the philosophical influences of MEINONG and EHRENFELS on ADLER will be of interest to the historians of Gestalt thought.

Two articles give a critical treatment of the application of Gestalt theory to music: M. REYBROUCK in "Gestalt Concepts and Music: Limitations and Possibilities" on balance takes a positive stance, while "Logic, Gestalt Theory, and Neural Computation in Research on Auditory Perceptual Organization" by R. EICHERT, L. SCHMIDT, and U. SEIFERT is a negative assessment. REYBROUCK provides an overview of various elaborations of Gestalt concepts. The summaries are cogent and concise, but necessarily so condensed that to follow REYBROUCK's argument closely one must refer back to the extensive literature cited. Read in this way, the paper is an excellent road map through many problematic issues in the application of Gestalt concepts to music. The temporal nature of music gives rise to many of these problematic issues. REYBROUCK takes pains to stress the discursive nature of listening to music, involving memory and imagination. Insights validated in the visual domain, where one may grasp a whole with some immediacy, may not transfer well into the domain of musical audition, where a figure unfolds step by step. Complexity of texture is another

[2]In North America, the disciplinary and institutional arrangements are somewhat different. Musicology proper has for the past quarter century been divided between music history and a newer stem, music theory. With its origins in music composition and analysis, music theory remains fairly close to the artistic concerns of music history. Cognitive studies in music are pursued by some music theorists, but more often by researchers within departments of psychology. The complementary discipline, ethnomusicology, arises from the European comparative musicology, which LOUHIVUORI subsumes within cognitive musicology. Ethnomusicology on this side of the Atlantic more and more finds a home within departments of music, but still often remains within the province of anthropology.

difficulty that a Gestalt approach must confront. This issue is taken up in other papers, by R. I. GODØY, E. UNGEHEUER, and D. COHEN and S. DUBNOV. I suspect, however, that their formulations do not satisfy the operational approach that REYBROUCK calls for in extending traditional Gestalt concepts.

EICHERT, SCHMIDT, and SEIFERT call into question the status of Gestalt theory as a paradigm for music research, and for research on perceptual organization generally. Again, the paper is in part a road map through the literature of previous critiques of Gestalt concepts. The authors first distinguish between Gestalt in the EHRENFELS sense of "Gestaltqualität" and in WERTHEIMERs sense of "Wirkungssystem" or "dependence system," following the work of P. OPPENHEIM and various coauthors, and submit both senses to logical examination. They insist that empirical scientists using such concepts must be precise as to their meanings.

The authors proceed to a summary of critiques that have been made of emergence. Emergence is attributed to a property of a whole that cannot be reduced to the properties of the component parts. Following HEMPEL and OPPENHEIM, the authors deny that emergence can have an absolute character. A property is emergent only relative to our knowledge and to a given theory, and relative to a particular decomposition of a whole into parts. The musical example that the authors give is perhaps oversimplified, however. As an example of differing decompositions of a whole they offer the problem posed by EHRENFELS: "Suppose we have two sequences of tones in different keys but with the same melody, and a decomposition of the sequences of tones provides two sets of tones which have no tone in common, i. e. the intersection of the sets is the null set. In this case, the same melody is an emergent property of the whole, and a sentence that ascribes the same melody to the different sets does not follow from a set of sentences that describe the properties of the parts. But there is no law, axiom, or rule that forbids us to decompose the sequences of tones into ordered sets of intervals. Now, the melody is no longer an emergent property of the whole, because it follows from a characterization of the parts of the whole" (p. 75). This explanation disposes of one of the EHRENFELS-criteria, "Transponierbarkeit," but not the other criterion, "Übersummenhaftigkeit," which may be understood as the aspect of emergence. The holistic property of a tonal melody that is preserved under transposition is its tonal meaning, that is, the characters of the constituent tones relative to the key center, which emerges from the configuration of the tones, against the background of the sense of tonality. The level of explanation has to be, then, at the level of tonality itself, and although I do not assert that an analytical explanation of tonality is not possible, it is clearly not so trivial a matter.

The various theories of Gestalten and the brain are summarized and criticized, from the psychophysical isomorphism asserted by W. KÖHLER to K. PRIBRAMs holonomic theory. Consideration of the latter theory leads to a discussion of artificial neural networks. Although the authors concede that such computers may indeed be powerful tools for exploring principles of the brain, they debunk the

ascription of mysterious properties to the computations performed by artificial neural networks—"emergent computation." All computers, the authors remind us, are at best universal Turing machines, that is, can be precisely defined in the limit within the same class of automata.

In summary, the authors "do not regard Gestalt theory as an appropriate paradigm," (p. 83), while conceding the heuristic value of Gestalt notions for the study of perceptual organization. I believe their stance coincides with the prevailing evaluation among psychologists, although theirs was clearly a minority view at this conference. It would be interesting if those who disagree with them were to take up their challenge in some future forum.

The final two articles in the chapter are examples of the metaphorical and heuristic use of Gestalt concepts. R. I. GODØY in "Knowledge in Music Theory by Shapes of Musical Objects and Sound-Producing Actions" and E. UNGEHEUER in "Statistical Gestalts—Perceptible Features in Serial Music" both use undefined Gestalt notions to stimulate interesting speculations on aspects of music that are resistant to traditional music theory: contour, texture, timbre. GODØY decries the abstract approaches of music theory and would supplement (if not replace) them with the notion of shape, quite literally in the visual sense of the word, a move he refers to as the "geometrization of musical objects." The metaphorical treatment of Gestalt notions is advanced very explicitly here, but in the absence of specific protocols for testing the suggestions it is hard to know how to evaluate them. One instance is a very interesting sound example ostensibly designed to evaluate modality, consisting of the Chopin C-major Prelude played in the various diatonic modes—C dorian, C lydian, etc., as well as in C major—keeping all other performance characteristics constant, along with a C-major version in which register has been erased by collapsing all pitches into one octave. Listening to this is a fascinating exercise, but no experiment is reported. The hypothesis seems to be that the small changes in the literal shape produced by the modal shifts should be less disturbing than the wholesale deformation of the contour: "This should give us some indication of the effects of such a drastic spatial deformation compared with the more modest spatial deformations of the modality variants" (p. 95). My intuition, on the contrary, is that the overriding importance of harmony in this particular Prelude will lead most musicians to judge the modal variants to be more of a betrayal of the piece than the variant in which all the pitch classes are correct, even if not represented in the correct register. This was my hearing in any case. I suspect that no experiment was performed in part because it is more a demonstration that could lead to a discussion of the possible effects of modality and contour deformation than the framework for a well-designed experiment.

UNGEHEUERs investigation of STOCKHAUSENs mid-century avantgarde masterpiece Gesang der Jünglinge shows how the composer's statistical procedures are exemplifications of Gestalten. The listener confronted with the mass phenomena devised by STOCKHAUSEN can only apprehend them qualitatively, as whole entities.

Chapter I, "Gestalt Theory Revisited," is foundational with respect to the program documented here, so the papers therein have been discussed in order and in some detail. In the sequel only some of the many interesting papers will be touched upon, and I will disregard the logical organization of the volume, bundling together some of the papers with similar methods.

The chapter on aspects of pitch begins with a substantial reconsideration of STUMPFs theories of consonance in A. SCHNEIDERs paper "'Verschmelzung', Tonal Fusion, and Consonance: Carl Stumpf Revisited." An example of control afforded by the older type of non-contextual study, this paper includes an experiment that tests STUMPFs assertion of the separability of the categories of roughness and dissonance, with negative results.

The application of artificial neural networks to model musical perception and cognition is taken up in five papers: "Schema and Gestalt: Testing the Hypothesis of Psychoneural Isomorphism by Computer Simulation," by LEMAN and F. CARRERAS; "Self-Organizing Neural Nets and the Perceptual Origin of the Circle of Fifths," by N. C. PETRONI and M. TRICARICO; E. ISAACSONs "Neural Networks for the Study of Post-Tonal Music"; P. TOIVAINENs "Optimizing Self-Organizing Timbre Maps: Two Approaches"; and U. MATTUSCHs "Emulating Gestalt Mechanisms by Combining Symbolic and Subsymbolic Information Processing Procedures." LEMAN and CARRERAS use very powerful computers with KOHONENs Self-Organizing Map Algorithm to simulate molar behavior in response to a realistic musical environment, an actual harpsichord recording of Book I of J. S. BACHs Das Wohltemperierte Klavier. Then, using a probe tone technique similar to that used by KRUMHANSL in a study with human subjects, they record some significant correlations between the responses of the neural network and the data from KRUMHANSL and others. In particular, the neural network seems to organize the pitch material in terms of the circle of fifths. Some of these results are reproduced by PETRONI and TRICARICO, also using KOHONENs SOM Algorithm, and a trivial explanation for the circle-of-fifths arrangement of the data is ruled out by them.

LEMAN and CARRERAS are attempting to reopen the question of psychoneural isomorphism, as propounded by KÖHLER. Certainly they have demonstrated a correspondence between the behavior of their artificial neural network and that of the human respondents. The circle of fifths may be an oversimplified way of characterizing the organization of this behavior. The way the material is arranged on the toroidal structure of their network seems closer to the Tonnetze of H. RIEMANN and other nineteenth-century theorists, and to the model proposed by WERTS (1983). Either way, the results are significant, but the question remains as to what extent artificial neural networks faithfully model mental activity.[3]

[3] For a critique of connectionist models, see EDELMAN (1987 & 1992).

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ISAACSONs paper is the first attempt to apply neural networks to atonal music. He tests the learnability of various constructions in atonal theory with interesting results, both positive and negative, then turns to a passage from WEBERN Op. 9, No. 3 to study the way an "interactive activation and competition network" or IAC network segments the musical score. The IAC network uses excitatory and inhibitory weights according to the model of biological neurons. Segmentation is a thorny problem in this literature, and because it is highly contextual, difficult to study empirically. ISAACSON demonstrates that contextual effects can be controlled in neural network models, through the assignment of different weights to various feature sets.

Two papers study melodic expectancies, C. KRUMHANSLs "Effects of Perceptual Organization and Musical Form on Melodic Expectancies," and S. LARSONs "Continuations as Completions: Studying Melodic Expectation in the Creative Microdomain Seek Well." KRUMHANSL makes more overt reference to Gestalt concepts. She documents an experiment that tests some of the hypotheses of the implication-realization model of E. NARMOUR. NARMOURs model is based on both bottom-up and top-down principles; this study focuses mainly on the bottom-up principles, which can be formulated in terms of the Gestalt concepts of similarity, proximity, and good continuation. KRUMHANSL emphasizes, however, that the Gestalt concepts are precisely expressed here in specifically musical terms, relating to interval size and direction. Earlier experiments by KRUMHANSL and others supported the model at the low, note-to-note level. This experiment tested whether the expectancies predicted by the model also operate on higher levels, between non-adjacent tones, and explored the way attention is directed by aspects of musical form to higher levels, with positive results.

LARSON suggests that "listeners' expectations are not merely for melodic continuations, but in fact for entire melodic completions" (p. 322). The agreement in the results of two experiments supports this conclusion. The stimulus in LARSONs experiments was a melodic fragment, C4-A4-G4, in equal note values, which the subjects (music majors or professional musicians) were asked to complete. The subjects were specifically discouraged from relying on any familiar melodies, but one wonders how many musicians were distracted by an echo of the opening of the slow movement of BEETHOVENs A-minor String Quartet, Op. 132. (This continuation was, in fact, one of the rarest responses given, so either the respondents did not hear this allusion or they followed the instructions in earnest.) Of course, any three-note diatonic incipit is likely to call forth some melodic memory, but here the specific register and undifferentiated rhythmic character seemed especially reminiscent.

A type of expectation is also examined in a study of chord progressions by D. WERTS, "'Good', 'Fair,' and 'Bad' Chord Progressions: A Regression-Analysis of Some Psychological Chord Progression Data Obtained in an Experiment by J. Bharucha and C. Krumhansl." WERTS was able to account for listeners'

evaluations of two-chord triadic progressions, as reported in the experiment, by weighting six musical factors, all of which were shown to be highly significant.

Among the articles on timbre, “Karl Erich Schumann's Principles of Timbre as a Helpful Tool in Stream Segregation Research” by C. REUTER is particularly impressive. REUTER’s experiment showed that when a melody is divided into two streams by timbre, the stream with the brighter timbre forms a Gestalt against the background of the other. In addition to a discussion of the basic principles of SCHUMANNs work, juxtaposed with that of his contemporary WERTHEIMER, REUTERs article gives information on obtaining SCHUMANNs hitherto virtually unavailable dissertation via the internet.

The interest this collection has for musicologists is only partially suggested by this summary, which omits discussion of many of the papers that are more speculative or that deal with applications of music technology. Two papers on rhythm particularly stand out, “A Framework for the Subsymbolic Description of Meter” by D. MOELANTS, and “Musical Rhythm: A Formal Model for Determining Local Boundaries, Accents and Metre in a Melodic Surface” by E. CAMBOUROPOULOS.

This book appeared in very timely fashion, within a year of the Joint International Conference, so its consistency from an editorial point of view is quite remarkable. The writing is usually clear, and there are only a few discrepancies such as missing references (e.g., WRIGHT, 1995 on p. 64), or figures without explicit references within the text (e.g., Fig. 1 on p. 486 and other figures in P. MODLERs paper). Music, Gestalt, and Computing provides an overview of some important trends in cognitive studies on music. On the evidence of this collection, the state-of-the-art is vital, with the most convincing empirical work finding ways of taking musical context into account without losing control of the myriad factors involved.

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References

ADLER, G. (1885). Umfang, Methode und Ziel der Musikwissenschaft. Vierteljahrsschrift für Musikwissenschaft, vol. 1, 5-20.

EDELMAN, G. M. (1987). Neural Darwinism: The Theory of Neuronal Group Selection. New York: Basic Books.

EDELMAN, G. M. (1992). Bright Air, Brilliant Fire: On the Matter of the Mind. New York: Basic Books.

GARDNER, H. (1987). The Mind’s New Science: A History of the Cognitive Revolution. New York: Basic Books.

LEMAN, M. (1995). Music and Schema Theory: Cognitive Foundations of Systematic Musicology. Berlin, Heidelberg: Springer-Verlag.

MEYER, L. B. (1956). Emotion and Meaning in Music. Chicago: University of Chicago Press.

WERTHEIMER, M. (1938). Gestalt Theory, in A Source Book of Gestalt Psychology, W. D. ELLIS, ed. and trans. London: Routledge & Kegan Paul.

WERTS, D. (1983). A Theory of Scale References, Ph. D. diss., Princeton University.