Applying music psychology to music education: Can perceptual theory inform undergraduate harmony?

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Abstract

An undergraduate harmony course is presented that is grounded in recent research on the perception of harmony and tonality, and makes relevant aspects of that research accessible to music students. Perceptual theory can shed light on such general basic issues as intonation and the role of acoustics in harmonic theory, principles of chord construction, voicing and voice-leading in diatonic and chromatic progressions, stability and tension of harmonies in tonal contexts, modulation and tonicization, and the degree of finality of cadential progressions in different voicings. The proposed course is intended to complement and enrich more familiar historical and notational approaches. At various stages of the course, all possible chords, functions, or harmonic sequences conforming to clearly defined perceptual constraints are systematically enumerated using pitch-class set theory. Relevant perceptual properties (consonance, interrelationships) of the elements, calculated according to available models, are then compared with the both their musical function in conventional harmonic theory and with their frequency of occurrence in relevant musical literature. At every stage of the course, musical and perceptual theories are integrated with ear training, analysis, keyboard skills, and composition.

Introduction

Modern undergraduate harmony courses investigate compositional processes and devices by analyzing masterworks and by writing according to stylistic or generic models, often with the possibility of free composition and improvization. Traditional harmonic theory involves the labeling of chords in tonal chord progressions and the composition of chord progressions in mainstream tonal styles. Students are trained to identify and classify the pitch materials of tonal music, and to apply stylistic conventions with the aim of reproducing mainstream tonal styles. Aural and visual experience with a range of materials develops students' intuitive understanding of harmony, even if they cannot necessarily articulate the underlying principles. An important spinoff of traditional harmony courses is that they improve students' general fluency in score reading and transcription.

Seldom, however, do the pitched materials themselves receive systematic scrutiny. An alternative approach to the understanding of harmony might be first to explore how the elements of harmony (intervals, chords, scales) are *perceived*. The past two decades have seen considerable progress in understanding of

harmonic perception, in areas such as the perception of dissonance in individual sonorities (Huron 1991; Huron & Sellmer, 1992; Plomp & Levelt, 1965), the perceptual salience of pitches perceived within sonorities (Parncutt, 1988, 1989, 1993, 1997; Terhardt, 1976; Thomson, 1993); the perception of harmonic and melodic (voice-leading) relationships between pairs of sonorities (Bigand, Parncutt, & Lerdahl, 1996; Parncutt, 1989, 1993; Parncutt & Bregman, in preparation); the identification of major/minor key centers and the perception of closure in harmonic progressions (Huron & Parncutt, 1993; Krumhansl, 1990; Leman, 1995; Rosner & Narmour, 1992; Thompson & Cuddy, 1994); and the perception of individual voices within harmonic and contrapuntal contexts (Bregman, 1990; Huron, 1989, in preparation).

Perceptual theory has so far had surprisingly little impact on undergraduate music curricula. The purpose of the present contribution is to explore ways in which research of this kind may be made accessible, interesting, and useful to undergraduate students. This may be regarded as one of many ways in which recent research in the psychology of music may be applied in music education.

An additional aim of the proposed course is to develop theory that may be applied to a wider range of styles than more conventional harmonic theories. Lerdahl (1989, p. 66–67) has commented that:

> The conventional wisdom, at least in the United States, holds that Schenkerian theory explains diatonic tonal music and pitch-set theory explains atonal music (chromatic tonal music is a source of discomfort). This scenario is implausible from a psychological standpoint if only because it presupposes two entirely different listening mechanisms. We do not hear *Elektra* and *Erwartung* in completely different ways. There is a good deal of 20th-century music – Bartók or Messiaen, for instance – that moves smoothly between tonality (broadly speaking) and atonality. In short, the historical development from tonality to atonality (and back) is richly continuous. Theories of tonality and atonality should be comparably linked.

An approach to harmony based on the chromatic scale and pitch-class sets – along the lines of Forte (1973), but applied to tonal as well as atonal music – might help to bridge the gap between music theories based on the major-minor system and music theories associated with other styles: the impressionist tonalities of Debussy and Ravel, serial and non-serial forms of atonality, bebop jazz, and even harmonic and contrapuntal styles from the Middle Ages and Renaissance where clear mappings may be made between diatonic and (hypothetical) chromatic scale steps. Such a pluralistic approach is consistent with trends toward postmodernism and neotonality at the end of the 20th century.

The proposed course strives to be *systematic*, "deriving" aspects of harmonic syntax by considering all possible chords, functions, and harmonic sequences that exist within clearly defined perceptual constraints. Each musical element is entered into available perceptual models (consonance of sonorities,

relationships between sonorities). The results are compared firstly with the properties and functions of the musical elements in conventional harmonic theory, secondly with students' own intuitions, and thirdly with the frequency of occurrence of each element in relevant musical literature, which Meyer (1973) has regarded as one measure of style. The latter, if not already known from published analyses (Budge, 1943; Eberlein, 1994; McHose, 1947), may be determined directly by analysis of scores, either manually or with the assistance of a computer program accessing a large database (e.g., David Huron's *Humdrum* software). A systematic, perceptually oriented exploration of chords and progressions can also suggest musical devices that do not normally occur in tonal harmony but which may be useful in composition (cf. Parncutt & Strasburger, 1994).

Recent explorations of the relationship between perceptual theory and the historical evolution of tonal-harmonic syntax (Eberlein, 1994; Tenney, 1988) have highlighted the influence on harmonic syntax of social, perceptual, and physical influences, where social influences include the changing compositional conventions of different historical periods. The crucial role of history means that relationships observed between the predictions of perceptual models and modern harmonic language are best described as *indirect;* directly, our perception depends primarily on musical conditioning (Lundin, 1947; Parncutt, 1989). For example, the double-leading-tone cadence of the 15th century (e.g., D-F#-B to C-G-C) presumably sounded perfectly normal (consonant, final) at that time, but to modern ears it can come as quite a surprise. The cadence emerged from the application to three-part music of voice-leading rules that had originally been intended for music in two voices (Eberlein, 1994). In the proposed course, such a cadence may additionally be analyzed in terms of perceptual properties such as the sensory dissonance (roughness) of the chords, their harmonic stability (as reflected by the degree to which they fuse, or have clear roots), and the perceived strength of the relationship between the chords (broken down into melodic and harmonic components).

Perceptual models enable specific principles (axioms, assumptions, hypotheses) to be applied systematically to a range of stimuli, and their validity to be tested by comparing calculations with the results of perceptual experiments. The outputs of perceptual models may also be compared with the syntax (prevalence distributions) of music in specific styles, with the aim of accounting for basic elements of western tonality in reasonable detail, and on the basis of as few principles as possible (principle of parsimony).

Students in the proposed course would be encouraged to put various theories to the test themselves, both by listening exercises (some of which are computer-supported) and by analyses of musical scores. The exercises are designed both to facilitate learning and to allow students to appropriately evaluate the validity of presented models. Conventional approaches to harmony and tonality may then be appraised in a new light.

A tentative course structure

Perceptual theory may be presented to students of harmony in various ways. One way might be to preserve a traditional course structure, interleaving perceptually based explanations and exercises. Alternatively, a completely new course sequence may be adopted. An example is sketched below. The approach is essentially "bottom-up", beginning with the simplest musical elements and their interrelationships, and proceeding gradually to more complex and arbitrary "top-down" relationships. The major-minor system emerges as one of several possible frameworks.

The chromatic scale

Aim. Develop and critically examine perceptual explanations for the predominance of the 12-tone chromatic scale in tonal Western music. Explain the apparent independence of harmonic theory and tuning systems. Discuss implications.

Theory. Introduce the theory of roughness (Helmholtz, Plomp/Levelt). "Derive" chromatic intervals by graphing the calculated roughness of two simultaneous tones as a function of interval. Do peaks correspond to optimal tunings? Must scale steps be equally spaced? Must there be 12 per octave? What happens when tones do not have exactly harmonic partials? Closer examination reveals that optimal tuning is generally a compromise between a number of different forces (Terhardt, 1976). Variations in intonation relate in complex ways to musical structure and expression (Friberg, 1991; Fyk, 1995; Parncutt, in press; Sundberg, 1982) and rarely depend directly on the simplicity of frequency ratios, or on coincidences among harmonics. Tunings vary within perceptual pitch categories (Burns & Ward, 1978).

Listening exercise. Using computer software, listen to the same piece in three different temperaments. Which temperament do you prefer, for which piece? Why?

Intervals

Aim. Explore and explain the relative prevalence of different harmonic and melodic intervals in various styles. (Supported by theory, listening, aural, analysis, and composition exercises.)

Chords

Aim. Develop perceptually based explanations of the harmonic vocabulary of tonal music.

Theory. Like the consonance of intervals, the consonance of chords depends both on their roughness and on their frequency of occurrence in music. Other factors include voice-leading, dramatic implications or ambiguity (Why are there so many dissonant diminished-seventh chords in Beethoven?), and so on. Experimental data on pitch salience within musical chords (Krumhansl, 1990; Parncutt, 1993; Thompson & Parncutt, in preparation) may be compared with the

predictions of "bottom-up" theories (Parncutt, 1988; Terhardt, 1976; Thomson, 1993) and with examples of root ambiguity from musical and music-theoretical literature. The root also depends on context, and harmonic function depends both on the root and on voice-leading implications.

Listening exercise. Play all 19 triad qualities (12 prime forms + 7 non-symmetric inversions) at the keyboard in close position and in three different inversions. Estimate or rank their perceived dissonance. Compare calculated roughness and comment on discrepancies.

Aural training. Using game-like computer software, learn to spontaneously identify qualities (major, diminished, etc.) of triads of octave-complex tones (Parncutt, 1994; Shepard, 1964). Generalize to chords with specific instrumental timbres, and apply to real transcription.

Score analysis. Count how often specific chord qualities happen in a given tonal piece, and graph the resultant distribution. Comment on similarities and differences between the distribution, the results of the listening exercise, and the theory of roughness (cf. Danner, 1985).

Composition exercise. Compose a homorhythmic progression that moves gradually from consonant to dissonant and back to consonant, using good voice leading (small intervals) and avoiding traditional major/minor tonality (cf. Hindemith, 1942).

Chord progressions; Counterpoint; Musical structure

Teaching in these areas would proceed along similar lines to the above.

Conclusion

A creative survey of possibilities now available suggests that perceptual theory could enrich undergraduate music curricula in the following ways:

(1) by providing a solid theoretical foundation that meets the needs of contemporary composers, performers, analysts, and historians.

(2) by focusing attention on *perceived* sound, and encouraging creative work with sound. Here, auditory experience is regarded as superior to the visual experience of scores as a source of information about music.

(3) by the consistent use of computer technology (see above examples) to improve the course's pedagogical efficiency. Computers also allow experimental techniques to be borrowed from music psychology, suitably adapted, and applied in teaching.

(4) by encouraging an open-ended approach. If perceptual theories are non-prescriptive, the range of musical styles that may be analyzed or created within perceptually specified constraints is, in principle, unlimited. Even the chromatic scale is a flexible cultural artifact.

(5) by acting as a bridge to more advanced work and research either in music theory or in music psychology. The course may be especially interesting for music departments with a cross-disciplinary ethos.

The history of tonal theory (for an encyclopedic summary, see Darmschroder & Williams, 1990) is littered with metaphysical speculations that were later rendered obsolete by scientific developments. For example, theories based on frequency ratios are largely contradicted by the data and theories of Plomp and Levelt (1965), Terhardt (1976), and Krumhansl (1990). But metaphysical ideas continue to be taught to, or believed by, university-level music students. The present course may be regarded as a step in the direction of a "fundamental revision of music education based on modern auditory theory" as proposed by Walker (1991, p. 207). No musical structures are regarded as "natural"; instead, musical syntax is seen as a purely human construct whose development has always been constrained by the various capabilities and limitations of human perceptual and cognitive processes.

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