7 Matthew Shirlaw

A plausible theory of musical structure should combine older insights with recent research, and balance contributions from humanities and sciences. Which music theories of the past could serve as foundations? Many nineteenth- and twentieth-century scholars attempted to explain harmony scientifically. This chapter focuses on a Scottish contribution: that of Matthew Shirlaw from the early twentieth century. He addressed many pertinent issues, including the origin of harmony in harmonic complex tones, the role of the 7th harmonic, the origin of the minor triad (despite its complex frequency ratio), the origin of the major and minor scales, and the relationship between scales and harmony. From a modern perspective, Shirlaw's discourse was often problematic. Today, we can construct a more realistic theory by asking similar questions and taking advantage of late-twentieth-century developments in psychology and psychoacoustics.

Context

An impressive example of positivist theorizing about MmT was that of Scottish organist and musicologist Matthew Shirlaw (1873–1961). His book (Shirlaw 1917) was a comprehensive critical survey of theories of harmony, starting with Zarlino, Rameau, and Tartini and proceeding to Kirnberger, Hauptmann, Helmholtz, Oettingen, and Riemann before closing with some lesser-known English theorists. The book was mysteriously reprinted in 1955, when Shirlaw was more than eighty years old, as if nothing in musicology and music theory had changed in the meantime.

Soon after the reprint of his book, Shirlaw published a more concise statement of his position in *Music Review* with the confident title "The Science of Harmony" (Shirlaw 1957). In retrospect, it is surprising that the article was

published at all. By the 1950s, music-theoretical speculation had become unfashionable, especially when it addressed questions about MmT. Music theory and musicology had moved on. Leonard Meyer (1957) was wondering about the relationship between information theory and musical meaning. Helen Mull (1957) was interested in the psychological effect of musical repetition. Heinz Kohut (1957) was asking about music's psychological functions. Kazu Nakaseko (1957) was investigating symbolism in ancient Chinese music theory. Lejaren Hiller and Leonard Isaacson (1957) had started to use computers to compose music.

Amid this broadening of musicological and music-theoretical interest, Shirlaw was still wondering about the origin of the minor triad. Was it less natural than the major? What general principle lay behind major and minor triads? What general principle could explain dominant and subdominant harmony? If Shirlaw's manuscript had been subject to anonymous peer review, the reviewers may have considered it too naive for publication, even if they themselves were unsure how to answer Shirlaw's questions.

Many twentieth-century music theorists have complained about positivism of this kind. Norton (1984) commented: "The message to the modern music theorist and musicologist is clear: we cannot do music theory—past or present—in a positivistic vacuum. Until the political, philosophical, social, economic, physical, and cognitive forces of any age are brought properly to bear upon the nature of polyphony, harmony, and tonal consciousness, there can be no adequate description of that music's true historical dimension" (137). Along similar lines, Richard Goldman (1965) asserted: "One of the central facts about our harmonic system or language is, as Tovey points out, that it is invented. Although certain basic elements are taken from the natural overtone series, the developed relationships that form the language are, in a sense, arbitrary. The basic or fundamental tonal relationship, that of dominant and tonic, on which all further development rests, corresponds to no acoustical law, and has no 'scientific' basis. The musical relationship is wholly invented, or 'created by art'" (4).

Norton and Goldman were on the right track, but their rejection of positivism was a little too brazen. Within Western culture, we can hardly imagine an alternative version of MmT, in which the subdominant has the function of the dominant and vice versa—although it has been argued that chords such as IV, ii, or ♭VII can in certain contexts have dominant function (e.g., in rock; Nobile 2016). Nor can we imagine an alternative MmT

in which major and minor are symmetrically interchanged. We can hardly conceive of some kind of historical tipping point, when the language of music could have developed along one of two equally likely but totally contrasting paths. Instead of claiming that the dominant–tonic relationship is arbitrary, Goldman might more realistically have claimed that a convincing scientific explanation for this phenomenon, if one exists at all, had not yet been formulated (cf. chapter 20).

Consider empirical findings about the perception of Western music by Western and non-Western listeners (Bai et al. 2016; Fritz et al. 2009). From an ethnomusicological viewpoint, studies of that kind are problematic, focusing on responses of non-Western listeners to Western music from a Western perspective, but not vice versa. For that reason alone, we might reject them out of hand. But despite their ethnocentricity, these studies do demonstrate that aspects of Western music (and by implication of any music) may be universally perceptible, including the basic emotions that the music expresses.

Looking back on Shirlaw (1957) from today's perspective, his article was not only a source of misleading statements. On the contrary, it systematically listed some perennially interesting questions about MmT, for which it should now be possible to formulate appropriate answers. In the following, I will attempt to do that. While my answers will often be problematic due to the unpredictability of cultural contents of any kind, my tentative answers may also approach the truth (in a hermeneutic sense) more closely than corresponding previous attempts in music theory and music psychology. As such, they may serve as an introduction to the rest of this book. They also demonstrate the extent to which scientific research can (or cannot) help us understand how tonality works.

Harmony

Shirlaw (1957) was not alone in claiming that "major harmony arises in harmonic resonance, in the primary set of overtones" (266) and "harmony is generated upward, not downward" (267). Rameau (1737) had introduced the idea of *corps sonore* and explained that a chord is generated by its root, considered as a *son générateur*, an idea that many later repeated. But the term "generation" is misleading. Riemann (1905) noted that a harmonic series of pitches only belong together insofar as a vibrating string or air column can produce them simultaneously (I. Bent 2011).

But even that is not how musical chords originated in musical practice. Chords originated when musicians played different tones simultaneously in musical contexts. They then aurally evaluated the resultant sound, usually while respecting existing compositional rules or conventions. Later, they repeated simultaneities that they liked, or those that worked well in musical contexts. There is nothing particularly generative about that process. If spectral analysis is relevant to this question, we need to consider the spectrum of the whole chord—not that of a single tone.

The Natural 7th

One can hardly deny that a relationship of some kind exists between musical harmony and the harmonic series, even in a modernist context (Väisälä 2002). In that limited respect, Rameau was surely right, despite his positivist, scientifically inspired approach. But Rameau's theory raised an interesting question that has bothered theorists ever since: How many elements of the harmonic series are musically relevant? How many partials of a harmonic complex tone should we consider? As Shirlaw (1957) wrote, "Why stop at number six, why should the higher harmonics be excluded? Why not at least include the natural 7th?" (267).

The question is again misleading because it suggests that intervals are ratios and that Just intonation is superior. Modern empirical psychoacoustics has offered alternative answers that mainstream music theory has hardly considered, perhaps because of their complexity:

- The 7th harmonic is usually audible (aurally relevant) in typical harmonic complex tones such as voiced speech sounds (see chapter 6).
- A partial can be perceived as part of a harmonic complex tone, contributing to the salience of the virtual pitch at the fundamental (Terhardt et al. 1982b), even if it is mistuned relative to harmonic series by as much as semitone (B. C. J. Moore et al. 1986). The 7th harmonic is about 1/3 semitone flat relative to an equally tempered minor-7th interval above the 4th harmonic. It is mistuned enough to sound out of tune in music performance (when realized as a complex tone within a chord), but not enough to be perceived as not belonging to a harmonic series (when realized as a pure tone within a complex tone). To reinforce the root, the minor-7th interval above it need not be tuned exactly to the natural ratio 7:4 but can deviate by a quarter tone or more.

- Similarly, musical pitch is perceived categorically. Tones in the chromatic scale can be mistuned by up to a quarter tone and still be perceived as belonging to the scale step in question.
- To sound in tune, today's performers normally intone close to 12-EDO because it is familiar. Whereas intonation depends on many factors, and good intonation is generally a compromise among different criteria, empirical studies suggest that proximity to familiar interval sizes is important.

These observations are consistent with the root-supporting function of the minor-7th interval above the root in regular 7th chords. They can explain the clarity (non-ambiguity) of the root of the Mm7 (e.g., GBDF) chord by comparison to other 7th chords (Parncutt 1988; Parncutt and Radovanovic, 2023), and why several other tetrads feature a minor 7th above the root. But the exact size of the "natural 7th" interval does not affect the tuning of the minor-7th interval in music performance. That tuning is primarily determined by familiarity with 12-EDO.

The Minor Triad

Like many other theorists, Shirlaw (1957) complained that "the primary overtone series provides us with a major harmony, but no minor" (275). But the relationship between musical chords and the harmonic series is not that simple, and in any case, the overtone series does not "provide" anything. Historically, musical chords arose when musicians listened to and evaluated tone combinations in their music-structural and historic-cultural contexts. New tone simultaneities that passed this informal test, often over a long period of decades or centuries, were eventually accepted as chords.

Chords tend to be more consonant than non-chords. But the perception of consonance also changed historically. Today, in retrospect, we can infer that three main psychological factors contributed (and continue to contribute) to the consonance and dissonance of tone simultaneities in Western culture: smoothness, harmonicity, and familiarity (see chapter 14). Harmonicity is the degree to which a given spectrum perceptibly resembles a harmonic spectrum; roughness is due to fast beating. The major triad is closer to the harmonic series than the minor triad and therefore has greater harmonicity. The Mm7 chord is even closer, but the roughness of its tritone (due to a clash between the 3rd harmonic of the lower tone and the 2nd of the higher) makes it less consonant. The major and minor triads are the most consonant and

hence most prevalent trichords in MmT because they are the only trichords in the chromatic scale that include perfect 5ths (making them relatively harmonic) and lack 2nds (making them relatively smooth; Parncutt 1988).

Like many theorists before him, Shirlaw (1957) also claimed that the "minor is simply a clouded or camouflaged major harmony" (275). That is tantamount to saying, "I can't explain why the minor triad is so important, so let me invent something." The "clouded" idea is hardly convincing, given that any chord can be created by shifting one tone of a more familiar chord by a semitone. An augmented or suspended triad is not a "clouded or camouflaged" major triad.

It is more convincing to argue that major and minor triads are the most consonant three-tone subsets of the twelve-tone chromatic set (i.e., the most consonant trichords), their consonance depending primarily on smoothness and harmonicity. The third trichord in order of consonance is the suspended-4th triad (or suspended triad), which is less suitable as a tonic triad, for two reasons. First, it is considerably more dissonant than the major or minor triad due to the roughness of the major-2nd interval. Second, the triad's dissonance can be reduced by moving one tone (the suspended 4th) by a semitone (resolution to a major triad) or a whole tone (resolution to a minor triad)—all the while remaining within the same diatonic scale. That makes the suspended triad unstable; in Schenkerian theory, it cannot be prolonged.

The minor triad is clearly less consonant than the major due to its perceptible departure from harmonicity. But the difference in consonance is smaller, and the minor 3rd cannot be resolved to a major 3rd without introducing a non-diatonic tone. Thus, both major and minor triads make suitably consonant and stable tonic triads, whereas other possible trichords do not. This explanation is surely the best available for the predominance of major and minor triads, being both logically parsimonious and based on widely accepted general theory that is in turn based on replicable empirical data. An additional explanation is not necessary.

Another feature of major and minor triads is the almost equal spacing of their chord tones around the pitch-class circle (e.g., on a clock face, a major triad corresponds to twelve, four, and seven). Music theorists have argued that almost-equal spacing facilitates voice leading from one chord to another (Cohn 1997; Tymoczko 2010). But an argument based on vertical consonance as a combination of psychoacoustic smoothness and harmonicity may be more powerful and more appropriate for two reasons. First, there is a strong empirical scientific literature on the perception of smoothness, harmonicity,

and the musical consonance of Western sonorities. Second, a theory based on vertical consonance explains the importance of major and minor triads for MmT more parsimoniously because it ignores horizontal context.

Ignoring context may at first glance appear to be a weakness, but it can also be seen as a strength. A theory based on voice leading should attempt to enumerate and account for all voice-leading situations in which a given chord can appear. To my knowledge, no existing theory does that. Whereas horizontal context certainly affects consonance, the enormous number of voice-leading possibilities in the chromatic scale means that differences between voice-leading contexts for different chords may cancel each other out. If so, such a theory would not make clear predictions.

The claim that "minor is a chromatically altered major mode" (Shirlaw 1957, 267) is as misleading as the idea that the minor triad is a "clouded" version of the major. The minor scales have their own character and identity, to some extent independent of the major. A more promising approach is to consider passages of music in major and minor keys as prolongations of their tonic triads. The major mode arises when the major tonic triad is prolonged, and the minor mode arises when the minor tonic triad is prolonged.

The Tonic

Shirlaw (1957) wondered—again, like many before him—why the tonic of the C-major or C-minor scale is C rather than F. "The three fundamental sounds of C major then, were *f*-*c*-*g*, and the three triads . . . from which the sounds of the C major diatonic scale were derived. *C* is tonic. It generates its 5th, *g*. What, then, of *f*?" (266).

Here, Shirlaw again sided with Rameau, thinking that musical elements are "generated" by natural sounds. In that approach, the tone C "generates" G because G corresponds to its 3rd harmonic. But that is not how new musical elements emerge historically. Instead, different possible sounds are tried out in different contexts. Today, taking advantage of the possibilities created by three independent theories—Schenker's hierarchical approach to music analysis, Terhardt's theory of virtual pitch, and Leonard Meyer's and Eugene Narmour's theory of implication and realization—we can answer his question in a new way.

- A passage of music in MmT is a prolongation of its tonic triad. A C-major triad implies chroma F more strongly than F♯, because two chord tones (C and G) correspond to harmonics of F, whereas only one (E) corresponds to

a harmonic of F♯ (see chapter 15). Therefore, the C-major scale includes F rather than F♯ (although F♯ does occur frequently, as the leading note of $\hat{5}$).

- A passage of music whose tonic is C generally includes the tone B because rising leading tones tonicize more strongly than falling (see chapter 11).

Taking those two points together, it becomes clear why the tonic of a C-major scale is C and not F.

Scales and Harmony

Inspired by theorists such as Rameau, Fétis, and Riemann—possibly also by Tartini, Hauptmann, and Helmholtz—Shirlaw (1957) claimed that "our scales owe their existence to harmony, which arises independent of any scale" (267). In other words, harmony comes before melody. This old music-theoretical idea seems to imply either that melody is derived from harmony or that melody is generally harmonized; hence, melody is inseparable from its harmonization. But Shirlaw was also thinking of the origin of diatonic scales in musical practice, which involved octave, 5th, and 4th intervals. Their emergence must have involved human sensitivity to those intervals, whether the tones were simultaneous (in which case they could be tuned by minimizing roughness) or successive (tuned by maximizing pitch commonality).

The ancient Greek word *ἁρμονία* or *harmonía* (to join, fit, or fix together) referred, in music, to octave, 5th, and 4th intervals, both in practice and in theory. It also referred to mathematical ideas about interval ratios. In the everyday modern sense, "harmony" does not necessarily refer to ratios; instead, it implies MmT. Harmony is "agreement or accord. A pleasing combination of elements, or arrangement of sounds. The academic study of chords" (Wiktionary "Harmony," accessed March 9, 2022).

In a different text, and based on a detailed study of ancient Greek theory, Shirlaw (1951) had written: "One may observe how, in the course of musical history, a multiplex order of scales tends to give way to some simpler system of a few scales. Such a development is brought about by tonal relationship, concord, harmony. While inharmonic scales may exist literally in their hundreds, those determined by harmony, concord are brought within well-defined limits. It was thus that the Greeks made use of the concords of the fifth and fourth. Nevertheless, they never entirely lost their love of 'free'

melody. Their tetrachords were harmonic. But within the tetrachord the sounds were 'free,' might vary indefinitely, were indeed inharmonic" (134).

Today's standard diatonic scale (white keys on the piano in transposition) owes its existence to harmony in the ancient Greek sense but not in the modern sense. The earliest modern harmony, one might argue, was the polyphony that emerged in the twelfth century in the Saint Martial and Notre-Dame schools, eventually including 3rd/6th intervals and triads. Over a period of a century or more, that led to a new feeling of sonority, which according to Sarah Fuller (1986) was "a significant structural resource in the advanced polyphony of fourteenth-century France and, in particular, in the music of Guillaume de Machaut" (38). That resource had previously been lacking, although scales had not. In that sense, scales came before harmony.

In the musics of the world, if there is harmony, melody is older. Even within Western culture and from a historical perspective, we can hardly speak of harmony before polyphony got started in the twelfth century. Even if the word "harmony" is confined to an earlier definition, such as men and boys singing in octaves, or even if it is about pitch relationships regardless of whether simultaneous or successive (e.g., in ancient Greece), we may still safely assume that melody came historically before harmony, contrary to Shirlaw's claim.

Psychoacoustic Foundations of Major-Minor Tonality

By: Richard Parncutt

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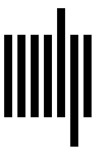

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