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The Consecutive-Semitone Constraint on Scalar Structure: A Link Between Impressionism and Jazz[1]

Dmitri Tymoczko

The diatonic scale, considered as a subset of the twelve chromatic pitch classes, possesses some remarkable mathematical properties. It is, for example, a "deep scale," containing each of the six diatonic intervals a unique number of times; it represents a "maximally even" division of the octave into seven nearly-equal parts; it is capable of participating in a "maximally smooth" cycle of transpositions that differ only by the shift of a single pitch by a single semitone; and it has "Myhill's property," in the sense that every distinct two-note diatonic interval (e.g., a third) comes in exactly two distinct chromatic varieties (e.g., major and minor). Many theorists have used these properties to describe and even explain the role of the diatonic scale in traditional tonal music.[2]

Tonal music, however, is not exclusively diatonic, and the two nondiatonic minor scales possess none of the properties mentioned above. Thus, to the extent that we emphasize the mathematical uniqueness of the diatonic scale, we must downplay the musical significance of the other scales, for example by treating the melodic and harmonic minor scales merely as modifications of the natural minor. The difficulty is compounded when we consider the music of the late-nineteenth and twentieth centuries, in which composers expanded their musical vocabularies to include new scales (for instance, the whole-tone and the octatonic) which again shared few of the diatonic scale's interesting characteristics. This suggests that many of the features

[1]I would like to thank David Lewin, John Thow, and Robert Wason for their assistance in preparing this article.

[2]See, for example, Carlton Gamer, "Some Combinatorial Resources of Equal-Tempered Systems," *Journal of Music Theory* 11 (1967): 32–59; John Clough and Jack Douthett, "Maximally Even Sets," *Journal of Music Theory* 35/1 (1991): 93–173; Richard Cohn "Maximally Smooth Cycles, Hexatonic Systems, and the Analysis of Late-Romantic Triadic Progressions," *Music Analysis* 15/1 (1996): 9–40; and John Clough and Gerald Myerson, "Variety and Multiplicity in Diatonic Systems," *Journal of Music Theory* 29 (1985): 249–270.

of the diatonic scale, while theoretically remarkable, may be of limited analytical significance. It should further prompt us to ask whether there are other noteworthy properties shared by the most commonly used musical scales.[3]

In this regard, it is interesting to consider the set of scales that do not contain consecutive semitones. This group includes the scales most common in Western music—major, harmonic minor, melodic minor, octatonic, and whole-tone—and contains no "extraneous" members that do not appear frequently. More significantly, the collection is derived from principles that can plausibly be attributed to composers themselves. Scales in which no consecutive semitones appear are recognizably similar to the major and minor scales of the classical tradition. We can contemplate the possibility that the no-consecutive-semitone scales are musically familiar, at least in part, *because* they do not contain consecutive semitones. I will suggest that the close correspondence between the scales derived in Section I, below, and the scales featured in the subsequent analyses, in Sections II and III, supports this hypothesis. The "consecutive-semitone constraint" seems to be deeply embedded in the practice of both the impressionists and contemporary jazz musicians; indeed, it may be one of the factors that help to explain why music has developed as it has.

[3]In "Coordination of interval sizes in seven-tone collections," [*Journal of Music Theory* 35/1 (1991): 33–60] Jay Rahn derives four scales from the requirement that the chromatic length of a scale's intervals always be greater than or equal to the chromatic length of smaller diatonic intervals. Four of the 38 septachords have no "contradictions" in this sense: diatonic, the harmonic minor, the overtone, and the "whole-tone plus one" collection. This collection admirably approximates scales in common practice, though it leaves out two (whole-tone and octatonic) that are common, and includes one (whole-tone plus one) that is not. Furthermore, it is doubtful that these properties would have been valued by composers of the late nineteenth and early twentieth centuries.

I. Scales in Theory

A. The four "locally diatonic" scales

The formation of the ascending melodic minor scale has often been described as a two-stage process: first, the seventh degree of the natural minor scale is raised to create a leading tone; then the sixth degree is raised to avoid the "melodically awkward" augmented second between scale-degrees six and seven.[4] From the perceived awkwardness of the harmonic minor scale, and from the unsuitability of those hypothetical alternatives in which the augmented second between degrees six and seven is filled by an extra note, we can extract two general principles of equal-tempered scalar organization.[5]

(A1) the interval between any two consecutive scale degrees should be either one or two chromatic semitones; and

(A2) no three consecutive degrees should be joined by successive semitones.

Let us further restrict the concept of scale by stipulating that a scale is a subset of *pitch classes* (rather than pitches) that can be ordered according to conditions A1–2, and that the first note of the scale "follows" the last note in the natural sense. This rules out Slonimsky's "plural" scales, which occupy more than a single octave, and ensures that our scales combine seamlessly with their octave transpositions.[6] (These stipulations ensure that the various modes of a scale also have this property.) Finally, let us declare

[4]See, for example, the entry under "scale" in *The New Harvard Dictionary of Music*, ed. Don Michael Randel (Cambridge: Harvard, 1986), 729.

[5]These criteria assume a diatonic set embedded within a twelve-tone chromatic scale, and thus depend on Western convention rather than, say, the physics of the overtone series. For discussions relating common scales to the overtone servies, see Rudolf Rasch and Reinier Plomp, "The Perception of Musical Tones," and Edward M. Burns, "Intervals, Scales, and Tuning," both in Diana Deutsch, ed., *The Psychology of Music* (New York: Academic Press, 1999).

[6]Nicolas Slonimsky, *Thesaurus of Scales and Melodic Patterns* (New York: Amsco, 1975), iv.

that two scales are "of the same kind" when they differ only by ordering and/or transposition, so that we can call C major and G phrygian "the same kind of scale." *Modes* will be unidirectional, stepwise orderings of scales (again, to within transposition).

There are, surprisingly, only four kinds of scale which satisfy our two criteria: the whole-tone, the diatonic, the ascending form of the melodic-minor (or "overtone" scale), and the octatonic.[7,8] The whole-tone scale has only one mode, the octatonic two, and each of the seven-note scales has seven. All four scales are *locally diatonic* within a three-note span: that is, any three adjacent pitches of any of these scales are enharmonically equivalent to three adjacent pitches of some diatonic scale. (This is because the diatonic scale contains every two-interval sequence permitted by the criteria: "whole tone, whole tone," "whole tone, semitone," and "semitone, whole tone.")[9] We can therefore expect significant and audible similarities between music based on the

[7]The "overtone" scale is so-called because it approximates the first seven pitch-classes in the harmonic series. The pitches {G, A, B, C♯, D, E, F}, for example, are approximately equal to the 1st, 8th, 4th, 10th, 2nd, 12th, and 6th overtones of G.

[8]To see this, consider that no qualifying scale can have an odd number of semitones, since we are including the interval between the last note and the first. Now if a scale has no semitones it will be one of the two whole tone scales. If the scale has exactly two semitones it will be either a diatonic scale or an "overtone scale." Call the notes connected by the first semitone B and C. Since no three notes can be connected by successive semitones, the mode must contain the ordered tetrachord <A, B, C, D> sequentially. (Remember that a scale's modes must also meet conditions A1–2.) Now suppose the second semitone occurs between D and the note above it, or between A and the note below it. In either case you end up with an "overtone scale"—respectively, C and A melodic minor ascending. Now suppose that the second semitone occurs neither between D and E♭ nor between G♯ and A. The tetrachord is therefore embedded in the ordered hexachord <G, A, B, C, D, E>, and the span <E…G> must be filled either by an F or by an F♯. Both alternatives produce a diatonic scale. Finally, it is clear that the only modes containing four semitones are defined on the octatonic scale, and that no mode can have more than four semitones.

[9]Since the overtone scale contains every permissible *three-interval* sequence of intervals, we could also say that the four scales are "locally overtone" within a four-note span.

locally diatonic scales and traditional diatonic music: locally diatonic scales will bear some perceptible resemblance to traditional scales, while chords of locally diatonic thirds will resemble diatonic triads and seventh chords, and so on.[10]

These four scales have also been the subject of a tremendous amount of intuitive musical exploration. Debussy, for instance, is often associated with the whole-tone scale. Octatonic collections have been associated with Debussy, Bartók, Scriabin, and Stravinsky, among others.[11] At least one theorist has pointed to importance of the "overtone scale" in Bartók's music, which can also be found in the works of Debussy and Ravel.[12] And as I will explore below, the peculiar sound of bop and post-bop jazz—its "Chinese" quality in Cab Calloway's alleged description—is in large part a function of the use of whole tone, octatonic, and overtone scales to represent dominant harmonies. The notion of "local diatonicism" may reveal the structural facts underlying this intuitive exploration. The concept adds specific content to the notion that various musicians, from Debussy to Herbie Hancock,

[10]More precisely: the two criteria ensure that melodies composed out of taking successive notes of the locally diatonic scales will be composed out of intervals that we classify (with reference to the traditional diatonic scale) as "seconds." Likewise, chords formed by taking every other note of a locally diatonic scale will be formed out of intervals that we classify as "thirds." Note that this is not true of larger intervals, such as fourths or fifths.

[11]Allen Forte, "Debussy and the Octatonic," *Music Analysis* 10 (1991): 125–169; Richard S. Parks, *The Music of Claude Debussy* (New Haven: Yale, 1983); Richard Cohn, "Bartók's Octatonic Strategies: A Motivic Approach," *Journal of the American Musicological Society* 44 (1991): 262–300; Elliott Antokoletz, *The Music of Belá Bartók* (Berkeley: The University of California Press, 1984), chapter 7; George Perle, "Scriabin's Self-Analyses," *Music Analysis* 3 (1984): 101–122; and Pieter C. van den Toorn, *The Music of Igor Stravinsky* (New Haven: Yale University Press, 1983).

For essays on nineteenth-century octatonicism, see Forte, "Liszt's Experimental Music and the Music of the Early Twentieth Century," *19th-Century Music* 10 (1987): 209–228; Forte, "Moussorgsky as Modernist: the Phantasmic Episode in *Boris Godunov*," *Music Analysis* 9 (1990): 3–45; and Richard Taruskin, "Chernomor to Kashchei: Harmonic Sorcery; or, Stravinsky's 'Angle,'" *Journal of the American Musicological Society* 38 (1987): 262–300.

[12]Ernö Lendvai, *Bela Bartók: An Analysis Of His Music* (London: Kahn & Averill, 1971).

have engaged in a similar sort of musical activity: extending traditional tonal vocabulary by finding new scales that both "sounded like" and "were different from" the scales in traditional tonal music.

B. Extending the four-scale system

Many common scales, such as the pentatonic and the harmonic minor, include an interval of three semitones (henceforth a "minor third," even when an enharmonic spelling as an augmented second is expected) between adjacent degrees. It is natural, therefore, to think about relaxing condition A1 by permitting that interval as well. Our new criteria would read:

(B1) the interval between any two consecutive scale degrees should be either one, two, *or three* chromatic semitones; and

(B2) no three consecutive degrees should be joined by successive semitones.

Unfortunately, this produces a "scale explosion." Instead of a neat group of four scales, we are left with a chaotic plurality that includes dozens of collections, some of which—like the diminished-seventh chord—have only a dubious claim to scalarity. We can restore order by adding a *maximality* constraint:

(B3) A scale cannot be a subset of any larger scale that meets criteria (B1) and (B2).

The reasoning here is that large, scale-like subsets will have much in common with their parent sets: a scale from which one or two notes has been removed is perceptually close to the original. There is an important loss of precision involved, for instance in assimilating the pentatonic scale to the diatonic and overtone scales, but this loss is arguably outweighed by our need for a manageably small collection of fundamental scales.

The maximality constraint reduces the number of qualifying scale-types to seven. Besides the four locally diatonic scales

already mentioned, there are three new kinds of scales: the harmonic minor scale; its inversion, the "harmonic major scale," so called because it is equivalent to the harmonic minor scale with a raised third scale degree; and the "hexatonic" or "symmetric augmented" scale, composed of alternating half-steps and minor thirds.[13] These new scales are again quite familiar. The harmonic minor scale is, of course, ubiquitous in music of the classical period. The harmonic major scale, which can be decomposed into major tonic, major dominant, and minor subdominant triads, traditionally appears in major-key contexts involving modal mixture—for example, no. 24 of Brahms's *Handel Variations*, op. 24. The symmetric augmented scale often appears as a middleground collection in passages involving triadic chord progressions in which roots move by major third.[14]

None of these three new scales is "locally diatonic," since each contains a "semitone, minor third" sequence. All seven scales, however, conform locally (within a three-note span) to the looser intervallic constraints of the harmonic minor and harmonic major scales, and could thus be termed "locally harmonic." This is because the harmonic major and harmonic minor scales both contain all five of the two-interval sequences permissible under B1–3 ("whole tone, whole tone," "whole tone, semitone," "semitone, whole tone," "minor third, semitone," and "semitone, minor third") appear within the harmonic minor scale and the harmonic major scale.[15]

[13]The name "harmonic major" originates, I believe, with Slonimsky. The term "symmetric augmented" comes from jazz practice.

[14]See Cohn, "Maximally Smooth Cycles."

[15]Reflecting on this list of permissible interval sequences, we can see that any scale which meets B1–3 will either be locally diatonic or contain a consecutive [0145] tetrachord. We can use this to demonstrate that there are only three new scales, along the lines of footnote 8. There are two possibilities: either this tetrachord is bounded by minor thirds, or it is bounded by major seconds. (Minor seconds would create consecutive semitones.) Suppose the [0145] tetrachord C–D♭–E–F is bounded on one side by a minor third: if this minor third is to be maximal, then it must itself be bounded on either side by semitones. We end up with the set C–D♭–E–F–G♯–A, which is itself maximal. (One obtains this same set no matter whether the minor third is initially added to the F or to the C.) Thus, if the [0145] tetrachord is bounded on one side by a

C. The seven scales as maximal non-chromatic sets

One might think that we could expand our scale collection further by dropping B1 altogether and allowing *any* successive interval sequence, subject only to the maximality constraint and the no-consecutive semitones rule:

(C1) A set cannot contain consecutive semitones; and

(C2) A set cannot be a subset of a larger set that meets criterion (C1).

Interestingly, this new pairing of constraints produces exactly the same seven scales as we derived in the previous section, and no more.[16,17] Condition B1, in other words, turns out to be irrelevant: our seven scales are the only maximal set classes that do not contain consecutive semitones. Therefore, they contain *every set* that does not itself contain an [012] subset. Embedded within some or all of these seven scales are 11 of the 12 trichordal set classes, 24 of 29 tetrachords, 22 of 38 pentachords, 18 of 50 hexachords, 4 of 38 septachords, and 1 of 29 octachords. This means that we can expect to find our seven scales appearing even

minor third, then it is bounded on both sides by minor thirds, and the tetrachord is part of a symmetric augmented scale. If, on the other hand, it is bounded by major seconds, then our scale contains the consecutive hexachord B♭–C–D♭–E–F–G. This set is not maximal. It can be filled either by an A♭ or an A, producing, respectively, the harmonic minor or the harmonic major scale.

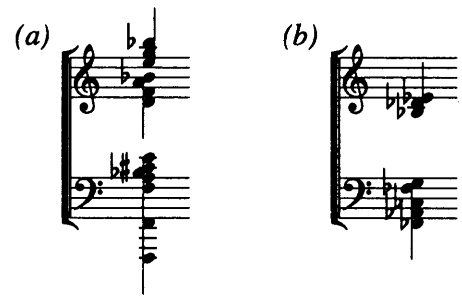
[16]Jeff Pressing used a computer to discover this fact in the late 1970s. See "Towards an Understanding of Scales in Jazz," *Jazz Research* 9 (1978): 25–35, and "Pitch Class Set Structures in Contemporary Jazz," *Jazz Research* 14 (1982): 133–72.

[17]The reason is that any set that meets criteria C1 and C2 can have "gaps" of at most a minor third. That is because intervals larger than a minor third can always be filled in without creating consecutive minor seconds: C–E, for instance, can be filled in by a D, C–F by D–E♭, C–F♯ by D–E, and so on. But, as we saw in the previous section, the maximality constraint also rules out the interval patterns "whole-step, minor-third" and "minor-third, whole-step." Thus any minor thirds must be bounded by semitones on both sides, and we can apply the argument of the preceding section.

in contexts where composers may not have been thinking in explicitly scalar terms. The purely *harmonic* avoidance of consecutive semitones (expressed by principles C1–2) necessarily generates subsets of the seven scales we derived from the *melodic* principles B1–3.

One important corollary is that any superimposition of two triads of any quality (major with major, augmented with diminished, etc.) belongs to one of the seven scales. That is because it is impossible to form consecutive semitones by superimposing two triads, or indeed, by superimposing a triad (or diminished seventh chord) onto a diminished seventh chord.[18] (Similar, but weaker, statements are true of larger collections. For instance, 36 of the 48 possible combinations of a triad with a dominant-seventh chord belong to one of the seven scales.) Thus we should not be surprised to find our seven scales serving as harmonic points of convergence for composers working in very different musical idioms. Compare, by way of illustration, the famous superimposition in the last movement of Beethoven's *Ninth Symphony* with the chord that Stravinsky used, almost a hundred years later, in the "Dance of the Adolescents."

Example 1. Large, non-chromatic chords
(a) Beethoven, Ninth Symphony, *IV, m. 208.*
(b) Stravinsky, Rite of Spring, *rehearsal 13.*

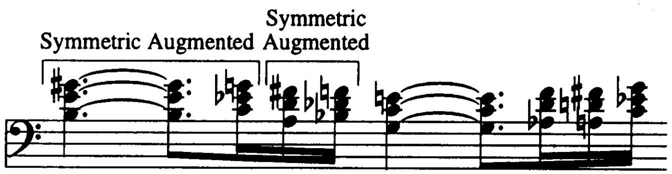


[18]This, in turn, is due to the fact the major/minor triad, the augmented triad, and the diminished-seventh chord are the maximal sets that do not contain seconds.

Stravinsky's chord is, modulo a little re-orchestration and re-registration, the tritone-transposition of Beethoven's: both are forms of the harmonic minor scale. Note that Beethoven arrived at the collection via an explicitly scalar process: D minor is the initial key of the last movement, and the harmonic-minor version of that scale is presented in measure 204, as a single cacophonous sonority. Stravinsky was not likely to have been thinking in scalar terms. Registration and spelling suggest that his chord is a thirteenth chord on F♭, and, as we have seen, such chords tend to belong to one of the seven scales. That such different compositional processes—one scalar, the other harmonic—should lead to similar results may help to explain why these seven scales have been such frequent objects of compositional attention.

Likewise, composers who use triadic but non-diatonic chord progressions will produce subsets of the seven scales across any two-chord span.

Example 2. Debussy, Prelude to the Afternoon of a Faun, *m. 107.*



We can thus use scale membership to sort all the possible two-chord triadic progressions (or superimpositions) into seven categories. In Table 1, the interval is measured upwards from the root of triad 1 to the root of triad 2, in semitones. The two triads are numbered so as to make the interval a positive number less than six. For example, using the first two chords of the Debussy excerpt above, C minor would be taken as "triad 1" and E major as "triad 2", since the interval from C to E is less than the interval from E to C.

On the basis of Table 1 we might say that half-step triadic progressions tend to belong to the harmonic-major/harmonic-minor complex, whole-step progressions tend to be

Table 1. Classification of triadic progressions according to scale membership.

Triad 1 Quality	Triad 2 Quality	Interval Between Roots (semitones)[19]	Parent Scale
M	M	1	harm-min
m	m	1	harm-maj
M	m	1	harm-maj, harm-min
m	M	1	diatonic
M	M	2	diatonic, overtone
m	m	2	diatonic, overtone
M	m	2	diatonic
m	M	2	harm-maj, harm-min
M, m, d	M, m, d	3	oct (and others)
M	M	3	oct, harm-maj
m	m	3	oct, harm-min
M	m	3	oct only
m	M	3	oct, overtone, diatonic harm-maj, harm-min
M, m, A	M, m, A	4	augmented (and others)
M	M	4	oct, harm-maj
m	m	4	oct, harm-min
M	m	4	diatonic, augmented, harm-maj, harm-min
m	M	4	augmented only
M	M	5	diatonic, harm-maj
m	m	5	diatonic, harm-min
M	m	5	overtone, harm-maj, harm-min
m	M	5	diatonic, overtone
M, m	M, m	6	octatonic only
A	d^7	any	harm-maj, harm-min

[19]Measured upwards, from the root of triad 1 to the root of triad 2.

"diatonic," minor-third progressions "octatonic," and major-third progressions "symmetric-augmented." These last two characterizations are the most general, as well as the most important. Indeed, many listeners already use the symmetric-augmented and octatonic scales to classify chord progressions: the major-third related triads in Debussy's *Faun* (E-major and C-minor) may well recall similar progressions in Wagner's music (e.g., G♯-minor to E-minor in the third scene of *Das Rheingold*). In comparison, triads separated by a minor third or tritone sound distinctly octatonic and may be classed in a separate aural category.

II. Scales in Practice: Jazz

A. Nondiatonic scales in contemporary jazz theory

Jazz is a complex, improvisatory tradition, involving numerous scales of various kinds. Some of these—such as the pentatonic, the "blues," and the various so-called "bebop" scales—do not meet any of the sets of criteria proposed in the previous section. Nevertheless, conditions A1–2 and B1–3 do single out scales that are extremely important in modern jazz. These collections have been incorporated into the tradition's vernacular, to the point where they are part of every competent player's basic vocabulary. Furthermore, these scales are not used to provide alternatives to the system of traditional functional tonality, as they often were in early twentieth-century music. Instead, they *extend* that system, serving to expand rather than annul our sense of root functionality.

Jazz players often describe the rules associating scales and chords as the principles of "chord-scale compatibility." Underlying these rules is the basic tenet that scales can be used to express the function of chords that they contain as subsets. Thus an improviser can build a melody using the pitches of the whole-tone scale that begins on the root of any dominant-seventh chord with a lowered fifth, since that chord is a subset of the whole tone scale. But one would not normally play a whole-tone scale over an unaltered dominant-seventh chord, since the fifth of that chord falls outside of the scale. (Using scales that do not contain the notes of the underlying harmony is called "playing outside.") Jazz textbooks often codify these principles in lists that associate the most common jazz chords with the scales used to express them. These lists vary somewhat from book to book, but there is basic agreement on a number of points. (Refer to my Appendix for the rules of "chord-scale compatibility" as they appear in a number of well-known contemporary jazz text-books.)

The outlines of the system are borrowed from traditional tonality: in major, the ionian mode is used to express traditional tonic-major function, the dorian mode to express minor ii chords, and mixolydian mode for dominant chords. (Modes are here understood to begin on the root of the chord: one uses, e.g., G mixolydian to express a G^7 chord.) But there are a couple of important divergences from traditional theory. First, diminished-seventh chords tend to be associated with octatonic scales rather than harmonic minor scales. Second, half-diminished seventh chords can be harmonized either with the locrian mode (as in the classical tradition) or with a form of the overtone scale equivalent to the traditional locrian mode with a raised second degree. (This mode is sometimes called "locrian ♯2.") Dominant chords can be represented in a number of ways. Whole-tone scales can be built on the root of dominant-seventh chords that have been modified so as to conform to the whole tone scale in question: $C^{7\sharp5}$, C^9 (no 5th), and so on. An octatonic scale (beginning with a semitone) can be built on the root of unaltered dominant-seventh chord, the root of a dominant-seventh with a minor or "sharp" (i.e., augmented) ninth, or that of any other seventh chord compatible with the octatonic scale.

Overtone scales are used in two distinct forms. The first, which is equivalent to a mixolydian mode with raised fourth degree, is sometimes called the "lydian dominant" scale.[20] It can be used to represent dominant-seventh chords with a flattened fifth or a raised eleventh. ("Lydian dominant" scales are most often used

[20]Jazz textbooks often use the term "scale" where "mode" would be most appropriate. At the risk of confusing the reader, I am following common usage.

for II^7 chords that do not progress directly to V, as in Strayhorn's "Take the A Train," and for $\flat VII^7$ chords that move to I or iii.) The second, which is equivalent to the locrian mode with a lowered fourth degree, is often called the "altered scale." It is used to represent dominant seventh chords that have lowered or raised fifths, minor or augmented ninths, lowered thirteenths, and so on.

The preceding rules, which are by far the most central, involve the four locally diatonic scales that meet conditions A1–2. Some more peripheral rules involve the other three scales derived in Section I-B. Tonic major chords can be expressed by the harmonic major scale; tonic major chords with raised fifth degrees can be expressed either by a mode of the overtone scale (equivalent to the lydian mode with a raised fifth) or by the symmetric augmented scale (in the minor-third, half-step arrangement). Minor triads, or minor chords with a major seventh, can be expressed either by the overtone scale (in the standard ascending-melodic-minor form) or by the harmonic minor scale. Other principles specify pentatonic scales that can be played over various chords: in the textbooks I have examined, these pentatonic scales are invariably subsets of locally diatonic scales that conform to the rules in the preceding paragraph.

Finally, there are those scales that do not meet our criteria: the "blues" scale (which is primarily used in melodic contexts) and David Baker's "bebop scales," both major and minor (which really represent systematic ways of adding chromatic passing tones to standard diatonic scales).[21] Mindful of these exceptions, we can say: (1) virtually all of the common rules of "chord-scale compatibility" involve our seven scales; and (2) all seven of our scales are covered by one or more of the rules of chord-scale compatibility. Jazz practice, in other words, involves a comprehensive, practical exploration of the collections that we derived theoretically in Section I.

The four non-diatonic scales commonly used to express dominant harmonies can all be understood as mixtures of whole-tone and octatonic scale fragments. Using "whole-tone tetrachord" (or WTT) to refer to transpositions of the tetrachord

[21] Please refer to the appendix for a list of Baker's "Bebop" scales.

{C, D, E, F♯} and "octatonic tetrachord" (or OT) to refer to transpositions of the tetrachord {C, C♯, D♯, E}, we can reconstruct these four rules of dominant chord "chord-scale compatibility." Let T1 be the first tetrachord of the scale, beginning on the root of the chord. Let T2 be the second tetrachord of the scale, beginning on the pitch a tritone away from the root. Let M be the mode that results. Then if T1=WTT and T2 = OT, M = the "lydian dominant" mode of the overtone scale. If T1=WTT and T2 = WTT, M = the whole-tone scale. If T1 = OT and T2 = WTT, M = the "altered" scale. And finally, if T1 = OT and T2 = OT, M = the semitone-whole tone mode of the octatonic scale. The seemingly complicated choice of four scales can thus be reduced to a simple choice of two tetrachords.

Example 3. The chromatic representations of V^7, simplified.

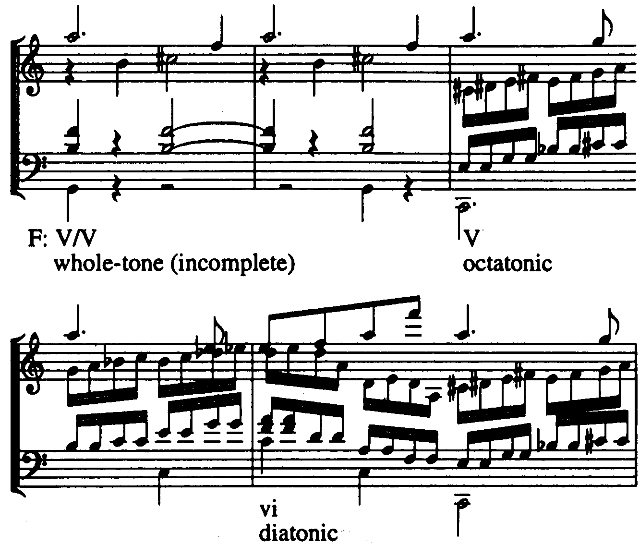
The neatness of this representation suggests that the scales might indeed originate with the $V^{7\flat 5}$ chord, enharmonically equivalent to the "French sixth" chord of classical practice. This chord (set-class [0257]) is in fact the only four-note collection common to the whole-tone, octatonic, and overtone scales. It is also a chord closely associated with the early pioneers of bop. ("We drink our fifths, the beboppers flat theirs," an older player is said to have quipped.) One might hypothesize that the use of these four scales originated with the problem of "filling out" the ♭5 chord with diatonic scale-fragments—a problem very much like the one which led to the origin of the ascending form of the melodic minor scale. It is natural to imagine that the "lydian dominant" scale came first, as it differs by only one note from the standard mixolydian mode. From there, the tritone symmetry of the chord would lead to the "altered" scale, while the tetrachord properties mentioned above would lead to the whole-tone and octatonic scales. Though there are good reasons to doubt that this speculative genealogy is completely correct, it may still help to explain some of the appeal of the system. Given the ♭5 dominant chord, one is naturally led to the four locally diatonic scales; they are there, where the fingers naturally fall.

Musicological evidence indicates that the whole-tone scale was the first to enter jazz, having most likely been borrowed from the impressionists via Duke Ellington. (Ellington plays whole-tone scales in "Ko-Ko" and "Sepia Panorama," both recorded in 1940.[22] Several commentators speculate that Thelonious Monk, who popularized the scale, borrowed the scale from Ellington.[23]) The other scales may also have been taken from Debussy and Ravel. Ravel, in particular, tended to use the four locally diatonic scales in ways that anticipate contemporary jazz practice. For example, in measures 22–25 of the first movement of his 1904 *String Quartet* (shown in Example 4), there is a standard V^7/V–V–vi chord progression expressed by successive whole-tone, octatonic, and diatonic scales. At measure 32 (Example 5) he uses the octatonic scale to express a diminished sonority—exactly as a jazz player would. (The E♮ in the soprano voice is an embellishment entirely typical of Ravel's style.) At measure 92 (Example 6), he uses "locrian ♯2" over a half-diminished seventh chord. And at measure 119 (rehearsal H; shown in Example 7), the climax of the development section, he uses the "altered" scale to express what is essentially a ♭5 chord: a "French sixth" chord of dominant function. (Notice that the C♯ in the cello, which does not belong to the scale, "resolves" to C♮ in the second half of the measure.)[24]

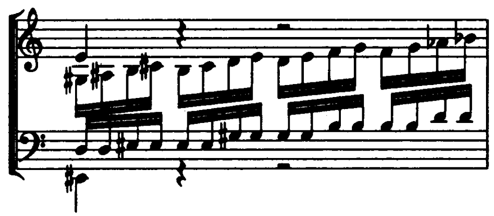
[22]See the transcription of "Ko-Ko" in Ken Rattenbury's *Duke Ellington: Jazz Composer* (New Haven: Yale, 1990), ch. 6. See also Gunther Schuller, *The Swing Era* (New York: Oxford, 1989), 131.

[23]See Schuller, 131; also Thomas Owens, *Bebop: The Music and Its Players* (New York: Oxford, 1995), 264 n. 2, where he cites Schuller.

Example 4. Ravel, String Quartet, *measures 22–25.*

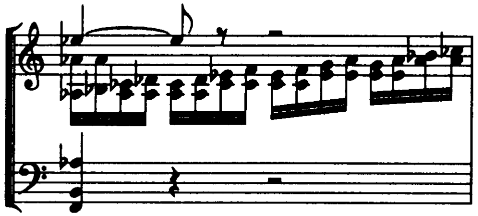


Example 5. Ravel, String Quartet, *measure 32*

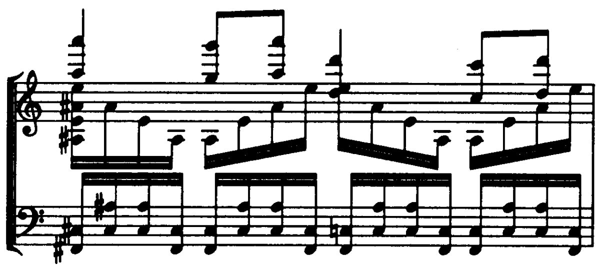


[24]Ravel uses unadulterated "altered" scales in his "Ondine." See the analysis in Section III-B, below.

Example 6. Ravel, String Quartet, *measure 92.*



Example 7. Ravel String Quartet, *measure 119.*



Here, then, in just a few short minutes of music, we find Ravel exemplifying five of the most common principles of "chord-scale compatibility." Whether jazz musicians stumbled upon these principles independently or whether they were actually imitating impressionist practice is not easy to tell. On one hand, the detailed nature of the correspondence argues for genuine influence. At the same time, however, the thrust of my argument so far has been that the scales in question are natural objects of musical exploration. To the extent that this is true, it becomes possible to imagine their independent discovery.

B. Two jazz solos

1. Bud Powell's solo on "Collard Greens and Black-Eyed Peas"

Bud Powell recorded Oscar Pettiford's "Collard Greens and Black Eyed Peas" in 1953.[25] A standard G-major blues with a VI^7–ii–V progression at measures 8–10, the tune (Example 8) consists of three repetitions of a three-bar melodic figure, with one-bar solo breaks in between. Powell plays it twice. His first two breaks, in measures 4 and 8, both involve locally diatonic scales. The run at measure 4, over a I^7 harmony, uses the overtone scale, an example of more-or-less standard modal. The descending chords at measure 8, made up of consecutive diminished triads with major sevenths, are a common jazz trope, clearly derived from the octatonic scale.

Example 8. Pettiford, "Collard Greens and Black Eyed Peas" (as played by Bud Powell), measures 1–12.

[25]Bud Powell, piano; George Duvivier, bass; Art Taylor, drums. The recording appears on *The Amazing Bud Powell,* Volume 2 (Blue Note CDP 7 81504 2).

The break in measure 12 is a generic chromatic figure, as are the first two breaks in the second chorus. But the improvised line at measure 24 (Example 9), which leads into the first chorus of Powell's solo, begins with a passage that suggests an altered scale on D.

Example 9. Pettiford, "Collard Greens and Black Eyed Peas" (as played by Bud Powell), measures 24–35. (Starred notes are very faint and difficult to hear at full speed.)

In measure 28, we find another altered scale over the G dominant chord, leading to C^7 in measure 29. Measure 32 features an octatonic scale fragment which moves from A♯ to F, the raised fourth (or eleventh) and flat-ninth of the underlying E^7 chord. (It is also possible to hear an overtone scale, G–A–B–C♯–D–E–F, across the barline between measures 31–32,

but I doubt that this reflects Powell's thinking.) There is another stretch of octatonicism over the D^7 in measure 34.

The second chorus of Powell's solo is mainly diatonic. The one exception is measure 44 (Example 10), where an augmented triad (D–F♯–A♯) represents the upper regions of an extended dominant chord (the seventh, ninth, and sharp-eleventh of E^7). This could imply either a whole tone scale or the lydian dominant (on E), and it is noteworthy because it illustrates the close connection between the extended harmonies of jazz and the locally diatonic scales.

Example 10. Pettiford, "Collard Greens and Black Eyed Peas" (as played by Bud Powell), measure 44.

Jazz players tend not to use the unaltered dominant-eleventh chord (E–G♯–B–D–F♯–A in the key of A), since it contains both a tritone and one of the pitches of the tritone's resolution. The ♯11 dominant chord, which Powell plays in measure 44, is strongly preferred. This chord virtually spells out an overtone scale—it contains six of the seven notes of the "lydian dominant" mode—and is quite possibly one of the routes by which the overtone scale first entered jazz.[26]

Following Powell's two solo choruses, there are two choruses of bass solo, and two in which Powell and Art Taylor present four-

[26]Cf. Charlie Parker, who claimed he discovered his sound by playing the "higher intervals" of a chord—presumably the 9ths, 11ths, and 13ths—and "changing the chords accordingly" [See Levin and Wilson, "'No Bop Roots in Jazz': Parker," *Downbeat* 16–17 (1949)]. This "changing of the chords" could conceivably involve raising the 11th, to avoid anticipating the tonic note in the dominant harmony.

measure solos alternately (as shown in Example 11; this is known as "trading fours"). In the first of these drum/piano choruses, Powell's use of chromaticism reaches a climax of intensity. In measures 74–76 we get a puzzling passage that involves quasi-traditional modal mixture (measure 74 and the last beat of measure 76), inexplicable chromaticism (measure 75), and the altered scale (measure 76, second and third beats). Measure 81 presents an unadulterated and, for once, complete octatonic scale over a V chord; the octatonicism dissipates into an upwards diatonic gesture.

Example 11. Pettiford, "Collard Greens and Black Eyed Peas" (as played by Bud Powell), measures 73–85.

After another chorus trading fours, there is a final Monkish chorus of piano solo (largely diatonic and chromatic; reproduced in Example 12), and then a return to the tune. The altered run from measure 28 reappears, extended to two octaves, as does the octatonic passage from measure 8. The performance closes with a whole-tone "ripple" over a G^7 chord.

Example 12. Pettiford, "Collard Greens and Black Eyed Peas" (as played by Bud Powell), measures 109–122.

2. *McCoy Tyner's solo on "Pursuance"*

John Coltrane's "Pursuance" is a B♭-minor blues with ♭vii (A♭ minor) substituting for iv, a secondary dominant at measure 9 (C^7 or $F\sharp^7$), and a two-bar (usually i–V) turnaround at 11–12. Recorded in 1964, the tune appears as Part III of Coltrane's *A Love Supreme.*[27] The tempo is fast and the harmonies are sometimes disregarded in the service of what Tyner once described as "freer melodic invention."[28] Tyner's solo (shown in Example 13), which begins in the third bar of the first chorus, opens with three rising pentatonic runs balanced by a descending overtone figure (an incomplete altered scale on C) which leads to a V^7 arpeggio. (The D in the seventh measure of the solo is passing.) Note that the arpeggio in measure 8 implies either a whole-tone scale on F or an altered scale on F.

[27]John Coltrane, tenor sax; McCoy Tyner, piano; Jimmy Garrison, bass; and Elvyn Jones, drums. The CD is released by MCA/IMPULSE as John Coltrane, *A Love Supreme* (MCAD-5660; JVC-467).

[28]Liner notes to Tyner's 1967 recording, *The Real McCoy* (Blue Note CDP 7 46512 2).

Example 13. McCoy Tyner's solo from the first chorus of Coltrane, "Pursuance," measures 1–9.

The second chorus (Example 14) begins with a three-note pentatonic pickup that leads into a beautiful out-of-key octatonic passage (measures 1–2). Measure 4 of the chorus contains hints of an overtone scale (assuming the B♮ is a mistake), but does not clearly state it. A second rising pentatonic run (measures 7–8) leads to a climactic whole tone release (measure 9), spiced by two passing tones (B♮ and C♯). The chorus ends with a perfunctory cadential formula.

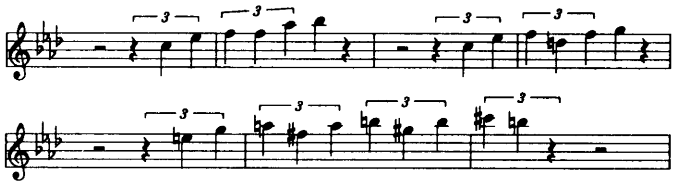
Example 14. McCoy Tyner's solo from the second chorus of Coltrane, "Pursuance," measures 1–11.

Most of the rest of the solo features a number of trademark Tyner procedures that do not involve our scales—pentatonic scales "outside" the harmonic structure (choruses 3 and 13), free non-tonal sequencing of motives from the tune (choruses 4 and 7), sophisticated polyrhythms (chorus 9), and spontaneous motivic invention (choruses 8 and 10). However, there are two passages from the body of the solo where the locally diatonic scales are implied in an interesting way. In the first two measures of chorus 5 (Example 15), the tune's main motive is sequenced along the notes of a diminished triad. This octatonic passage serves as a bridge between the free atonality of chorus 4 and the more tonal music that follows. The passage is a spontaneous, improvisational demonstration of the transpositional symmetry of the octatonic scale.

Example 15. McCoy Tyner's solo from the fifth chorus of Coltrane, "Pursuance," measures 1–12.

There is a related passage at the beginning of chorus 7 (Example 16), in which the whole-tone scale determines the successive transpositions of the motive. The effect is non-tonal, but it is possible to hear the whole-tone scale acting in the middleground. Finally, near the end of the solo in chorus 13 (Example 17), Tyner includes a long passage of whole-tone material, perhaps to help clear the aural "palate" at the end of the improvisation.

Example 16. Coltrane, "Pursuance," seventh chorus, measures 1–7.



Example 17. McCoy Tyner's solo from the thirteenth chorus of Coltrane, "Pursuance," measures 1–8.

III. Scales in Practice: Impressionism

Schoenberg once wrote that "epochs in which the venture of experimentation enriched the vocabulary of musical invention have always alternated with their counterparts, epochs in which the experiences of the predecessors were either ignored or else abstracted into strict rules which were applied by the following generations."[29] Schoenberg was most likely thinking of his own compositional experiences here, but his statement accurately describes the relationship between impressionism and later jazz. Like contemporary jazz musicians, Debussy and Ravel made frequent use of the four locally diatonic scales, while more occasionally deploying the other three "locally harmonic" scales

[29]Schoenberg, *Structural Functions of Harmony*, ed. Leonard Stein (New York: Norton, 1969), p. 192.

as well. (Both composers were especially partial to modal rearrangements of the ascending melodic minor scale, as we shall see below.) The impressionists' use of the seven scales is, however, less systematic than that of contemporary jazz musicians. To some extent, the scales serve to extend traditional tonal functionality, as in jazz practice. Yet they can also provide an alternative to tonality—as in Debussy's "Voiles," where the whole-tone scale represents not just a dominant sonority but also a stable tonic entity in its own right. These differences no doubt reflect the distinction between a self-conscious, avant-garde tradition of "art music" and the improvisatory, vernacular tradition of jazz, but they also attest to the process of musical "standarization" to which Schoenberg alluded.

A. Debussy's "Footprints"

Debussy's "Des pas sur la neige," the sixth of his first book of *Preludes* (1909–10), proceeds by presenting its three-note ostinato in the context of a number of different scales and modes. The ostinato is a locally diatonic scale fragment (D–E–F), belonging to nine distinct scale-forms that meet criteria B1–3. As enumerated in Table 2, these include two diatonic (C and F major), two overtone (D and F ascending-melodic-minor), two harmonic-major (C and A), two harmonic-minor (D and A), and one octatonic (the whole-step/half-step arrangement starting on D). All but two of these forms (D melodic-minor and A harmonic-major) appear over the course of the piece's 36 bars.

The piece is divided into two parallel phrases (measures 1–15 and 16–36), which are themselves composed of a number of similar subphrases. The first begins in measure 2, with a three-measure tune in D aeolian. The second subphrase (measures 5–7) features descending parallel triads, and switches to D dorian, the second of the two diatonic collections that contain the ostinato scale fragment. In the third subphrase (measures 8–11; shown in Example 18), the ostinato is harmonized with two dominant-seventh chords related by half-step. I hear the harmonic pattern continuing through the third measure of the subphrase.

Table 2. Scales containing the D–E–F ostinato, as they appear in "Des pas sur la neige"

Scale-type	Scale	Measure
diatonic	D aeolian	2–4, 19
	D dorian	5–7, 20–21
overtone	D melodic minor	—
	F melodic minor	16–18
harmonic major	C harmonic major	11
	A harmonic major	—
harmonic minor	D harmonic minor	32–36
	A harmonic minor	27–28
octatonic	D–E– ...	8–9 (?)

Example 18. Debussy, "Des pas sur la neige" (from Preludes, *book I), mm. 8–11.*

According to this hearing, the C^7 is expressed by a complete "lydian dominant" scale: C–D–E–F♯–G–B♭ in the first two measures of the passage, and A–B♭–D–E in the third. It is also possible to hear the passage as octatonic: if we consider the notes in left hand on the first beat to be non-harmonic neighbor tones, then measures 8–9 each present a complete octatonic scale.

The last measure of the passage shifts the harmonic pattern up a fifth—to G^7, expressed by a complete "harmonic major scale" on C. On the third beat, Debussy moves to what at first sounds like an inverted G♭ major-seventh chord. In the next measure, however, it is revealed to be an $A\flat^{13}$ chord with an unprepared 4–3 suspension in the bass.[30] The ostinato disappears in the final sub-phrase (measures 12–15), which features a lyrical bass melody expressing a complete A♭-mixolydian scale. This is followed in the last two measures by a modified C^7 chord, an incomplete expression of the even whole-tone scale.

The second large phrase begins with a short section (mm. 16–19; Example 19) recalling measures 1–4. Debussy adds a counter-melody in the bass, and reharmonizes the entire passage in the "locrian ♯2" mode of the overtone scale. In measure 19 he reverts suddenly to D aeolian.

Example 19. Debussy, "Des pas sur la neige," mm. 16–19.

The next six measures (measures 20–25) extend the descending triads of measures 5–7. In measure 21, the composer shifts suddenly into D♭ mixolydian. For three measures, the ostinato is reduced to its last two pitches, the E here acting as a non-

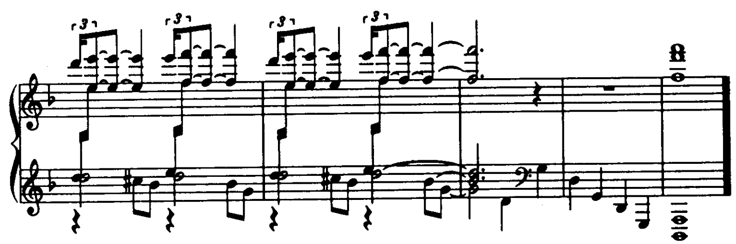
[30]Notice the sequence in the middle register of mm. 10–12: B♭–A–A♭–D♭ in the alto in m. 10, C–B–B♭–E♭ in mm. 11–12, the last note of the sequence being delayed until the beginning of the next sub-phrase. Measure 11 thus stands at the intersection of three independent patterns: the harmonic oscillation, which leads us to expect D♭ in the bass (reharmonized here as a suspended $A\flat^7$ chord rather than a $D\flat^7$), the harmonic *sequence,* which suggests $A\flat^7$, and the *melodic* sequence, which pushes the music forward to the beginning of the next phrase. Each of these serves to propel the music, albeit in slightly different directions.

harmonic tone. The phrase ends with parallel, rising seventh chords in the left hand, while the melody continues in D♭ mixolydian. The third subphrase (measures 26–28; Example 20) begins with minor triads descending by half-step, and ends with an oscillation between F minor and D minor that involves all the pitches of the harmonic-minor scale on A.

Example 20. Debussy, "Des pas sur la neige," mm. 26–28.

After a brief return to D♭ mixolydian (measures 29–31), Debussy ends with a striking four-bar passage (Example 21) in which all the pitches of D harmonic-minor are stated. I hear the passage as modal, with G minor as the local tonic: the final D-minor chord, when it arrives, sounds striking and unstable.[31]

Example 21. Debussy, "Des pas sur la neige," mm. 32–37.



[31] It is also possible to hear mm. 32–35, with Forte, as a six-note subset of the octatonic scale. (See Forte, "Debussy and the Octatonic," 167.) On Forte's analysis, the final D-minor chord represents a departure from the scale governing mm. 32–35; on mine it is part of the same collection.

B. "Ondine" from Ravel's Gaspard de la Nuit

Ravel's "Ondine" is based on four modes of the overtone scale: the familiar "melodic minor" arrangement; the mode that jazz musicians call the "altered" scale (see Example 3c, above); a little-used mode that could be called the "dorian ♭2" mode, and, most strikingly, a mode I will call "mixolydian ♭6."[32] It is this last form of the overtone scale that gives rise to the primary sonority of the piece, a major triad with an added minor sixth. This shimmering sound appears eight times in "Ondine" at five different pitch levels. Each time, it is accompanied by melodic material drawn from the overtone scale. Curiously, these melodies never state the entire overtone collection: in all eight appearances of the primary sonority, Ravel omits the pitch that would customarily serve as the tonic of the associated melodic minor scale.[33] Table 3 summarizes the appearances of the overtone scale in the piece.

Table 3. The Overtone/Melodic Minor Scale in Ravel's "Ondine"[34]

Measure	Mode	Collection
1–5	mixolydian ♭6	F♯ mm
7–9	melodic minor	D♯ mm
10–14	melodic minor	F♯ mm
15–16	mixolydian ♭6	F♯ mm
17–22	melodic minor	C♯ mm
29	locrian ♯2?	C♯mm?
30	lydian dominant?	F♯ mm?
31–33	mixolydian ♭6	C♯mm
34–36	melodic minor	F♯mm
37–39, 41	mixolydian ♭6	C♯mm
40, 41	dorian ♭2	E mm

[32] As their names suggest, these modes resemble the standard diatonic modes but for one note.
[33] This may represent Ravel's attempt to use the sonority as a tonic, rather than minor-mode dominant.
[34] Note that I count the initial half-bar as a full measure, so that the melody begins in measure 3.

Table 3 (continued).

Measure	Mode	Collection
42–45	mixolydian ♭6	G♯ mm
43–44	altered/lyd. dominant	E mm
46–50	mixolydian ♭6	F mm
46, 47–48	altered/lyd. dominant	C♯ mm
51–52	mixolydian ♭6	D mm
51	altered	B♭ mm
55	altered	B♭ mm
64	melodic minor	F♯ mm
65	melodic minor	E mm
69–72	melodic minor	B mm
81–82	altered	A mm
84–88	melodic minor	D mm[35]
89–92	mixolydian ♭6	F♯ mm

Many of the other six scales appear as well, including the diatonic, octatonic, harmonic-major, and harmonic-minor collections. Indeed the only one of the seven scales that is noticeably absent is the one most commonly associated with Ravel and Debussy—the whole-tone scale. (Though cf. measure 29.) Table 4 lists some of these other scales as they appear in the piece.

There are only a few places, such as measures 27–30, 54–55, 67–68, and 89, where Ravel changes harmonies before definitively implying a scale. Most of these passages involve strong root-functional chord progressions—by descending fifth in measures 27–30 and 54–55, by minor third and descending fifth in measures 67–68—and individual sonorities which do not contain consecutive semitones.[36] Indeed, the only figures that

[35] I hear the G♯ as a neighbor-note. If one hears it as part of the scale, then mm. 85–88 contain a harmonic major scale.

[36] Notice further that the pitches in mm. 29 and 30 belong to C♯ and F♯ melodic minor, the two scales that provided the primary harmonic material of the opening phrase.

Table 4. Other scales in "Ondine"

Measure	Scale	Collection
5–6, 9–10	diatonic	D♯ dorian
23–26	diatonic	G♯ maj.
24–25	octatonic	CC♯ ...[37]
29	whole-tone?	CD
50	harm-maj.	B harm-maj
53 (1st half)	harm-min.	D harm-min
53 (2nd half)	diatonic	D dorian
56	harm-min.	D harm-min
57	diatonic	D dorian
58–59 (l.h.)	octatonic	C♯D
58–59 (r.h., beats 1, 4)	octatonic	C♯D
58–60 (r.h. & l.h., beats 2–3)	harm-maj	B harm-maj
73–74	diatonic	C maj
75–76	diatonic	F♯ maj
81–83	diatonic	G♯ dorian

could not be derived from any one of the scales are the chromatic passages in the right hand of measures 45 and 61–62.

The piece opens with a series of gently rippling harmonies which begin in F♯ melodic-minor and slowly move through different scalar regions. Ravel changes scales one pitch at a time, implying a different scale with each alteration: in measure 5, for example, he waits a beat after the melodic B has moved to a B♯ (implying C♯ harmonic-major) before shifting the ostinato A to an A♯ (implying C♯ major). Table 5 summarizes the scales implied by the first 9 measures of music. (Note that all these scales are incomplete, since there is no F♯ until measure 9.)

Example 22 sketches the pitch content of measures 11–22 of the piece. At measure 11, Ravel returns to the piece's original F♯ melodic-minor, this time over an F♯-minor chord. At measure 15, he reverts to the primary sonority without changing scales.

[37] I.e., the octatonic collection that contains C and C♯.

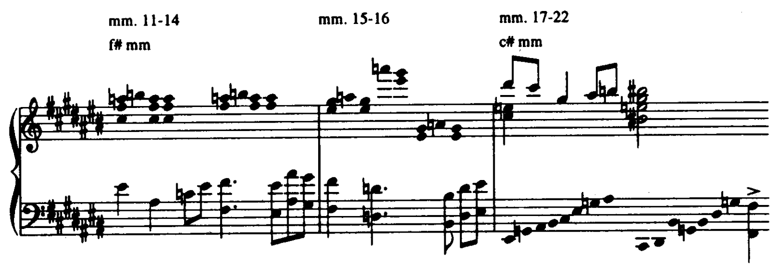
Two measures later, he does the opposite, switching modes—from F♯ melodic-minor to C♯ melodic-minor—without changing roots. (These two different kinds of movement, inherited from the classical tradition, produce striking effects in the context of Ravel's extended scalar vocabulary.) Measures 23–26 move from C♯ melodic-minor to G♯ major, spiced with octatonic sonorities in 24–25. At measures 27–29, Ravel moves by fifth through a series of chords that do not clearly imply any single scale.

The second large phrase of music (sketched in Example 23) begins in measure 31 with a return to the signature sonority of the

Table 5. Modulation by shifts of a single pitch class

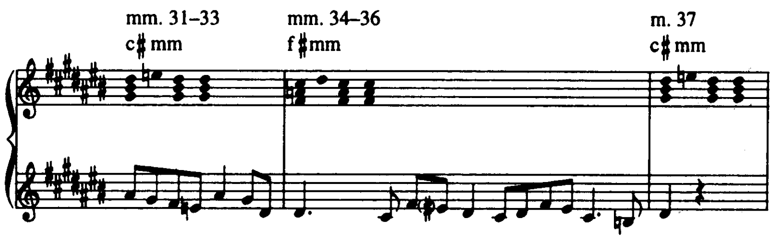
Measure	Enharmonic Change	Implied Scale
1–4		F♯ mm
5 (beat 3)	B -» B♯	C♯ harm-maj
5 (beat 4)	A -» A♯	C♯ major
6 (beat 1)	C♯ -» C𝄪	D♯ mm
6 (beat 4)	C𝄪 -» C♯	C♯ major
7	C♯ -» C𝄪	D♯ mm
9 (beat 2)	B♯ -» B	D♯ dorian
9 (beat 4)	A♯ -» A, B♯ -» B	F♯ mm

Example 22. Sketch of Ravel, "Ondine," mm. 11–22.



piece, here transposed down a fourth.[38] In the first half of the phrase, Ravel alters the pitches of the melody (E♮ to E♯, measure 34) so as to conform to the harmonic shift at measure 33. The accompanimental figure moves down by step, though the underlying scalar movement is by perfect fourth, back to the F♯ melodic-minor collection of the opening.

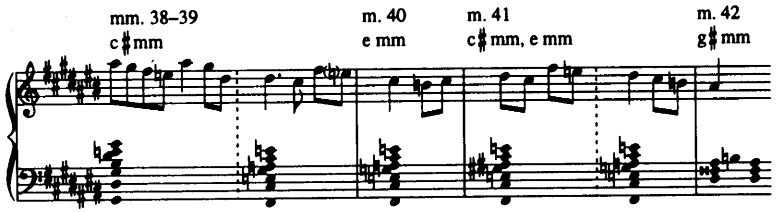
Example 23. Sketch of Ravel, "Ondine," mm. 31–37.



In the second half of the phrase, the melody remains in a single mode (A♯ locrian), the harmonies having been changed so as to conform to the melody. The difference between the subphrases suggests that Ravel occasionally uses melodic motion to dictate scale choice. It is unclear why Ravel sometimes alters his melodies to conform to the changing harmonies (as in measures 33–37) and why he sometimes chooses harmonies to support melodies that remain in a single scale. The choice may have been made on immediate aesthetic grounds; possibly, however, more systematic explanations await discovery.

[38]One might question whether traditional movement by fifths is appropriate to overtone-scale music. For while fifth-related diatonic collections share six notes in common, fifth-related overtone scales share only four. In music based on the overtone scale, the major second, not the perfect fifth, is the most natural interval of harmonic progression, as it preserves the maximum number of pitches, five. Alternatively, one might invert the argument, using the fact that Ravel's piece sounds flawless and convincing to suggest that theorists sometimes overstate the importance of transpositions that preserve maximal pitch-content.

Example 24. Sketch of Ravel, "Ondine," mm. 38–42.

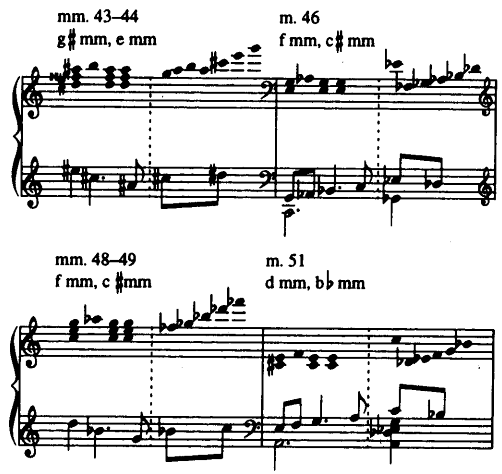


The harmonic movement in measures 39–42 (Example 24) again involves a striking use of modal shift. The change of scale (from C♯ melodic-minor to E melodic-minor) suggests a root progression from F♯^{7} to A^7, though in fact the left–hand figuration remains constant.[39]

The third large phrase, measures 43–52, begins with a return to the primary sonority of the piece, again transposed (upward) by a fifth, from C♯ melodic-minor to G♯ melodic-minor. The entire passage involves a sequential series of alternations between the mixolydian ♭6 and the "lydian dominant" modes of the overtone scale. The harmonies seem to progress by tritone, though the underlying scale-movement is by major third—e.g. G♯ melodic-minor to E melodic-minor in measures 43–44, supporting a harmonic shift from D♯^{7} to A^7. (It is also possible—indeed, for jazz players it might even be more natural—to hear the harmony as essentially static, moving between a "mixolydian ♭6" kind of D♯^{7} chord to an "altered" kind of D♯^{7} chord. The unchanging bass in measure 52 suggests that Ravel was capable of hearing the passage in this way.) Ravel here exploits the fact that major-third related overtone scales share four pitch classes which together comprise an altered dominant-seventh chord (set-class [0268]). G♯ melodic-minor and E melodic-minor, for instance, share D♯, G, B, and C♯, which can be understood as a D♯ dominant-seventh with a raised fifth degree (or, alternately, as the raised fourth, seventh, ninth, and third degrees of A^7). In measures 43–52 (Example 25), these common tones often remain in the same register across modal shifts, creating vivid effects.[40]

[39]Throughout "Ondine" Ravel moves among scales in ways that create a sense of root-progression by minor third and tritone. (For more examples, see mm. 24–25, 43–52, 58–62, and 76–78.) Interestingly, he does not always do this via the direct transpositions of mm. 39–42. Indeed Ravel is at least as likely to use root movements that conflict with the underlying scale transpositions, as in mm. 31–36.

Example 25. Sketch of Ravel, "Ondine," mm. 43–52.



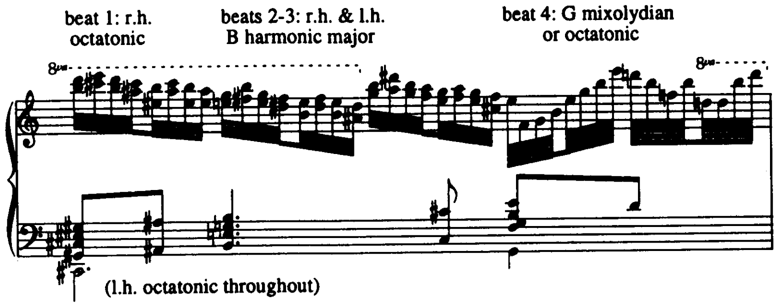
Notice that although many of the overtone scales are themselves incomplete, they are incomplete in different ways, suggesting that Ravel was indeed thinking in terms of scales rather than smaller sets. Measures 46 and 48, for example, each individually involve incomplete C♯ melodic-minor scales, though taken together they form a complete collection. (The B♭ melodic-minor collection in measure 51 is also complete.)

The next phrase begins in measure 53 with a series of extended chord progressions that center around D minor. At measure 58 (Example 26), we reach a *bravura* passage, in which the left hand plays a series of minor-third related triads that make up a complete octatonic scale. The right hand colors those triads with

[40]For example, C♯, D♯, G, and B in mm. 43–44, and A, G, C♯, and F in m. 51.

other scales: first, the octatonic (beat 1), then B harmonic major (beats 2–3), and then a five-note collection which represents the maximal intersection between the diatonic and octatonic collections (beat 4).

Example 26. Ravel, "Ondine," m. 58.



As in measures 38–41, the melody (here in the left hand) seems to determine the harmonic movement, remaining within a single scale while the accompaniment modulates by way of common tones. Thus, for example, the E-minor chord on the second beat is a member of two distinct collections—the horizontal octatonic collection in the left hand, and the vertical B harmonic-major collection at beats 2–3.

This fourth phrase builds to a striking climax in measures 67–68, a series of minor-third related dominant-tonic progressions whose roots outline a symmetric augmented scale: Bm^9–D^{13}–Gm^9–$B\flat^{13}$–$D\sharp m^9$–$F\sharp^{13}$. (John Coltrane later used a very similar progression, on the same roots, in "Giant Steps".)[41] The passage settles on B melodic-minor, whereupon follows a long diatonic passage, a brief recapitulation, and coda. This music uses the scales in ways that are familiar from the earlier parts of the piece.

[41]Coltrane seems to have taken the "Giant Steps" progression from Slonimsky, who was in turn no doubt influenced by Ravel. See David Demsy, "Chromatic Third Relations in the Music of John Coltrane," *Annual Review of Jazz Studies* 5 (1991): 145–180. (Note that Coltrane's progression substitutes major seventh chords for Ravel's minor ninths.)

C. Conclusion

Tonality is often described as a relationship between pitches and chords belonging to a single scale: in composing a melody to go with a (major) I–ii–V–I progression, the student of tonal music is taught to use pitches drawn from one diatonic collection. Minor-mode harmony, however, is invariably polyscalar. Both modal mixture and the use of secondary dominant chords increase the scalar density of tonal harmony. Impressionist composers and jazz musicians continued this process, regularly using all four of the locally diatonic scales, as well as (more sporadically) the other three scales derived in Section I-B. The result is a fascinating blend of middleground diatonicism and local chromaticism, a music in which the qualities of "tension" and "release" are the products both of shifts between different scalar collections and of background movement among the regions of a single, diatonic scale. Listening to Ravel's "Ondine" or to a sophisticated jazz musician improvise over standard tonal changes, one hears a curiously hybrid sound—a dense and difficult chromaticism that still seems rooted in elementary principles of tonal voice-leading.

One might conclude that the "common practice period" did not necessarily end with the nineteenth century. The scales derived in Section I, coupled with the rules of "chord-scale compatibility" discussed in Section II, represent a substantial addition to the tonal system which is not the creation of any single musician. Though the expanded system is theoretically elegant, it evolved over a number of years, in the hands of a number of figures—Debussy, Ravel, Stravinsky, Bartók, Messiaen, Thelonious Monk, Charlie Parker, John Coltrane. All of these have explored various of the seven non-chromatic scales, like mountaineers climbing the same mountain from different sides, often unaware of the others' progress. In recent decades, their explorations have crystallized in the vocabulary of the working jazz musician. To this extent, at least, we do have a genuinely "common practice." And to this extent, tonality is not a relic of previous times, but rather something that continues to change and grow.

Appendix A: Jazz pedagogues on chord-scale compatibility

I. Scott Reeves [from *Creative Jazz Improvisation* (Englewood Cliffs: Prentice-Hall, 1995)].

Chords	*Scales*
1. major 7th, major 6th, major 9th	major, lydian, major pentatonic, major pentatonic a perfect 5th above the root
2. major 7th/♭5, major 7th/♯11, major 13th/♯11	lydian, major pentatonic a major 2nd above the root
3. major 7th/♯5	lydian augmented [i.e., overtone][42]
4. minor 6th, minor 13th	dorian, minor pentatonic a major 2nd above the root, minor/added 6th pentatonic
5. minor 7th, minor 9th, minor 11th	dorian, aeolian, minor pentatonic, minor pentatonic a perfect 5th above the root, minor/added 6th pentatonic
6. minor/major 7	harmonic minor, ascending melodic minor
7. minor 7th/♭5, half-diminished 7th	locrian, minor pentatonic a perfect 5th above the root,[43] minor pentatonic a major 2nd below the root, locrian ♯2, minor/added 6th pentatonic a minor third above the root
8. minor 9th/♭5, half-diminished 9th	locrian ♯2, minor/added 6th pentatonic a minor 3rd above the root
9. dominant 7th, dominant 9th, dominant 13th	mixolydian, major pentatonic/added sixth pentatonic a perfect 4th below the root
10. dominant 9th/♭5	whole-tone, lydian dominant
11. dominant 9th/♯5	whole-tone
12. dominant 7th/♯9, dominant 7th/♭9	diminished (half-step), diminished/whole-tone [i.e., altered]
13. dominant 7th/♯9♭5, dominant 7th/♭9♭5	diminished (half-step), diminished/whole-tone, major pentatonic an augmented 4th above the root
14. dominant 7th/♯9♯5, dominant 7th/♭9♯5	diminished/whole-tone, major pentatonic an augmented 4th above the root
15. diminished 7th	diminished (whole-step)

[42]This is the lydian mode with a raised fifth degree.
[43]This scale conflicts with the chord, and may represent an error. "Perfect fourth" may be intended.

II. David Baker [from *How to Play Bebop,* Vol. 1 (Bloomington: Frangipani, 1985)].

Major Family

Chord Type	*Scale Form*
Major—1 3 5 7 9	Major 1 2 3 4 5 6 7 8
Major (♯4) 1 3 5 7 9 ♯11	Lydian 1 2 3 ♯4 5 6 7 8
Major (♯4♯5) 1 3 ♯5 7 9 ♯11	Lydian Augmented 1 2 3 ♯4 ♯5 6 7 8
Major (♭6♯9) 1 3 5 7 9 11 13	Augmented 1 ♯2 3 5 ♭6 7 1
Major 1 3 5 7 9	Diminished 1 ♭2 ♭3 ♮3 ♯4 ♯5 6 ♭7 8
Major 1 3 5 7 9	Harmonic Major 1 2 3 4 5 ♭6 7 8
Major 1 3 5 7 9	Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8
Major 1 3 5 7 9	Minor pentatonic 1 ♭3 4 5 ♭7 8
Major 1 3 5 7 9	Major pentatonic 1 2 3 5 6 8

Minor Family

Chord Type	*Scale Form*
Minor, tonic (I) Function	Dorian 1 2 ♭3 4 5 6 ♭7 8 Natural minor 1 2 ♭3 4 5 ♭6 ♭7 8 Phrygian 1 ♭2 ♭3 4 5 ♭6 ♭7 8 Ascending melodic minor 1 2 ♭3 4 5 6 7 8 Harmonic minor 1 2 ♭3 4 5 ♭6 7 8 Minor pentatonic 1 ♭3 4 5 ♭7 8 Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8
Minor 7th (II) Function	Dorian 1 2 ♭3 4 5 6 ♭7 8 Ascending melodic minor 1 2 ♭3 4 5 6 7 8 Harmonic minor 1 2 ♭3 4 5 ♭6 7 8 Minor pentatonic 1 ♭3 4 5 ♭7 8 Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8 Diminished (start with whole step)[44] 1 2 ♭3 4 ♯4 ♯5 6 7 8

Dominant Family

Chord Type	*Scale Form*
Dominant 7th unaltered 1 3 5 ♭7 9	Mixolydian 1 2 3 4 5 6 ♭7 8 Lydian Dominant 1 2 3 ♯4 5 6 ♭7 8 Major pentatonic 1 2 3 5 6 8 Minor pentatonic 1 ♭3 4 5 ♭7 8 Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8

[44]This scale conflicts with the chord, and reflects Baker's tolerance for playing "outside."

Dominant Family (continued)

Chord Type	*Scale Form*
Dominant 7th ♯11 1 3 5 ♭7 9 ♯11	Lydian Dominant 1 2 3 ♯4 5 6 ♭7 8
Dominant 7th ♭5, ♯5 or both 1 3 ♭5 ♭7; 1 3 ♯5 ♭7; 1 3 (♭5 ♯5) ♭7	Whole Tone 1 2 3 ♯4 ♯5 ♯6
Dominant 7th (♭9) 1 3 5 ♭7 ♭9	Diminished 1 ♭2 ♭3 ♮3 ♯4 5 6 ♭7 8
Dominant 7th ♯9 1 3 5 ♭7 ♯9	Diminished 1 ♭2 ♭3 ♮3 ♯4 5 6 ♭7 8 Diminished whole tone [i.e., altered] 1 ♭2 ♭3 ♮3 ♯4 ♯5 ♯6 8 Dorian 1 2 ♭3 4 5 6 ♭7 8[3] Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8 Minor pentatonic 1 ♭3 4 5 ♭7 8
Dominant 7th ♭9 and ♯9	Diminished 1 ♭2 ♭3 ♮3 ♯4 5 6 ♭7 8 Diminished whole tone 1 ♭2 ♭3 ♮3 ♯4 ♯5 ♯6 8 Minor pentatonic 1 ♭3 4 5 ♭7 8 Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8
Dominant 7th ♭5 and ♭9	Diminished 1 ♭2 ♭3 ♮3 ♯4 5 6 ♭7 8 Diminished whole tone 1 ♭2 ♭3 ♮3 ♯4 ♯5 ♯6 8 Minor pentatonic 1 ♭3 4 5 ♭7 8 Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8

Dominant Family (continued)

Chord Type	***Scale Form***
Dominant 7th	Diminished scale
♭5 and ♭9 13 ♭5 ♭7 ♭9	1 ♭2 ♭3 ♮3 ♯4 5 6 ♭7 8
♯5 and ♯9 13 ♯5 ♭7 ♯9	Minor pentatonic
♭5 and ♯9 13 ♭5 ♭7 ♯9	1 ♭3 4 5 ♭7 8
♯5 and ♭9 13 ♯5 ♭7 ♭9	Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8

Half-Diminished Chords

Chord Type	***Scale Form***
Half-diminished 7th	Locrian 1 ♭2 ♭3 4 ♭5 ♭6 ♭7 8
(ø7)	Locrian ♯2 1 2 ♭3 4 ♭5 ♭6 ♭7 8
or	
Minor 7th (♭5)	Diminished (start with whole step)
1 ♭3 ♭5 ♭7	1 2 ♭3 4 ♯4 ♯5 6 7 8
	Blues 1 ♭3 ♮3 4 ♯4 5 ♭7 8

Diminished Chords

Chord Type	***Scale Form***
Diminished 7th	Diminished scale
(°7)	(start with whole step)
1 ♭3 ♭5 6	1 2 ♭3 4 ♯4 ♯5 6 7 8

III. Mark Levine [from *The Jazz Piano Book* (Petaluma: Sher Music, 1989)].

Levine's list works the opposite way from the previous two. Chapter Nine of his book, entitled "Scale Theory," presents all the modes of four scales—diatonic, overtone, octatonic, and whole-tone—along with the chords that correspond to each mode. (He gives rules for harmonic major and minor scales on page 249, without mentioning the symmetric augmented scale.)

Scale	***Mode***	***Chord***
Diatonic	Ionian	C major 7
(Levine uses	Dorian	D minor 7
C major)	Phrygian	Esus♭9, F/E,E-7 on a III–VI–II–V
	Lydian	Fmaj+4
	Mixolydian	G7, Gsus
	Aeolian	A minor moving to F
	Locrian	B half-diminished
Melodic Minor	minor-major	Cmin/maj7
(Levine lists the	unnamed	Dsus♭9
modes of C mm,	Lydian augmented	E♭maj7+5
in ascending order,	Lydian dominant	F7+11
starting with C)	unnamed	no standard symbol (Fmin/maj7 over C?)
	half-diminished[45]	A half-diminished
	altered[46]	B7alt
Diminished	half step-whole step	Dominant 7th ♭9 on root
		whole step-half step
	Diminished on root	
Whole-tone	——	Dominant 7th sharp five, or Dominant 7th ♭13

[45]Levine also gives the name "Locrian ♯2."
[46]Levine also gives "diminished whole-tone."