Chord-Scale Networks in the Music and Improvisations of Wayne Shorter

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Wayne Shorter's tune "E.S.P.," first recorded on Miles Davis's 1965 album of the same name, presents a number of fascinating challenges to harmonic analysis. Example 1 gives the tune's lead sheet, which shows its melody and chord changes. In the first eight-bar phrase, the harmony moves at a slow, two-bar pace, sliding between chords with roots on E, F, and E♭ beneath a repeating fourths-based melody that contracts to an A_4–F_4 major third in the last two bars. Shorter's melody quite often emphasizes diatonic and chromatic ninths, elevenths, and thirteenths against the passing harmonies, thereby underscoring the importance of those extensions to the chords. For example, the first two pitches, C_5 and G_4, would conflict quite pointedly with a basic E7 chord. As a result, authors of lead sheets typically notate this harmony as E7alt, a chord symbol that implies all possible dominant-chord alterations that may be voiced by a performer: ♭9, ♯9, ♯11 (♭5), and ♭13 (♯5). Many of the chord symbols in "E.S.P." include chromatic alterations of some or all of their upper extensions. The harmonic rhythm of the next three bars accelerates to one chord per bar, then to two chords in m. 12, and the chord roots chromatically ascend from D back to F. In contrast to these chromatic root motions, Shorter employs functional ii7–V7 progressions in the first and second endings, though often colored by chromaticism, such as in mm. 16, 17, and 19. "E.S.P." thus exhibits an interesting tension between two different musical languages, one chromatic and ambiguous and the other functional and tonally directed.

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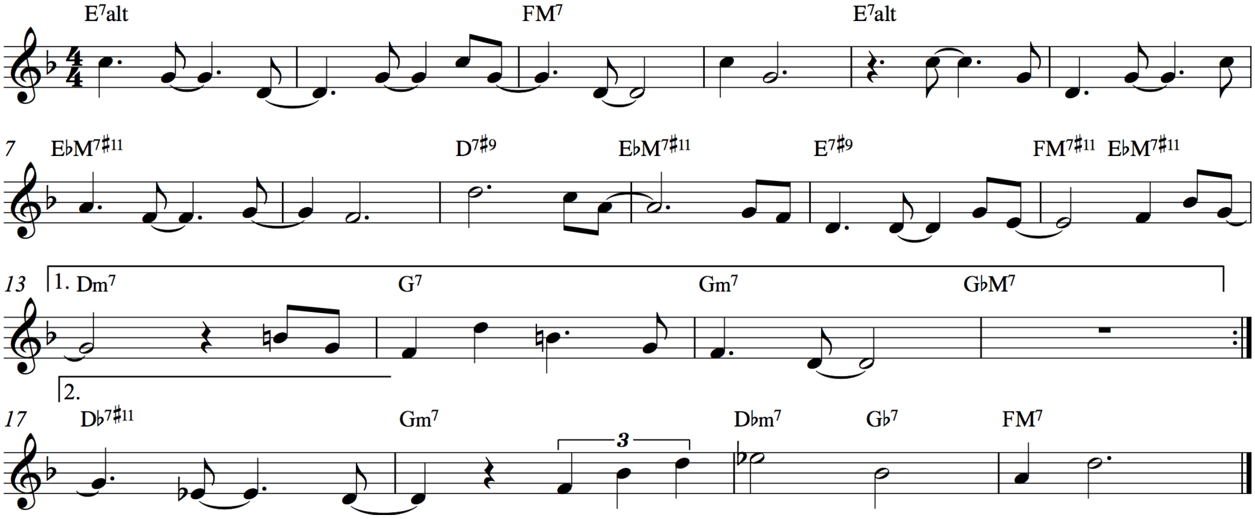
Example 1: "E.S.P." lead sheet. Major chord-quality indicated by "M" sign, minor by "m." "Alt" denotes dominant-seventh chords that contain any or all of the possible extended-tertian alterations (♭9, #9, #11/♭5, and ♭13/#5).



Tunes like "E.S.P." reflect changes in jazz compositional practice of the 1960s that led to the development of a "post-bop" style.[1] At this time, post-bop composers deemphasized the descending-fifths root motions integral to earlier jazz practice. They used a larger harmonic palette, often notating chords with a wide variety of chromatically altered extensions. In addition, they frequently employed a scale or set of scales as a central element of pitch organization.[2] While these aspects, among others, contribute to the style of post-bop jazz, jazz musicians and scholars have also used the term "nonfunctional harmony" to describe the lack of clear harmonic functions often found in post bop.[3] Nonfunctional harmony, as outlined by Patricia Julien, describes a harmonic succession that is "generally linear and does not rely on root relations of a fifth or the traditional resolution of active scale degrees" (2001, 53).[4] It employs triads, seventh chords, and other extended tertian chords, but tends to suppress those chords' typical harmonic functions. Tunes that predominantly employ nonfunctional harmony may imply tonal, scalar, or chordal centricity by emphasizing events in formally or hypermetrically salient positions, or by using techniques like repetition and return, or voice-leading processes. Or, tunes may remain purposefully ambiguous in regards to centricity. Without clear and omnipresent harmonic functions, the traditional tools for analyzing harmonic progressions are less valuable when dealing with nonfunctional successions.

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[1] This choice of the term "tune" to describe "E.S.P." and the other compositions discussed here is deliberate. For one, it is an emic term that jazz musicians would be more likely to use, rather than etic terms like "composition," "piece," or "work." Additionally, tunes may be thought of as genres in the jazz style. A tune is a lead-sheet based composition that consists of melody and chord changes that musicians realize flexibly in performance. A term like "composition" implies a greater degree of control over improvised performances than jazz composers actually have.

[2] See Waters 2005 for a discussion of the relationships and similarities between nonfunctional harmony and scale-based, or modal, jazz.

This article considers three compositions from the 1960s by Wayne Shorter, "E.S.P.," "Juju," and "Iris," from the perspective of transformational theory.[5] It shows how Shorter's nonfunctional, post-bop harmony may be conceptualized in terms of motions through pitch-class spaces. These motions may impart centricity through repetition or return, but they may also reveal transformational symmetries or other patterns without the need for a single center. The ambivalence transformational theory holds towards pitch centricity is thus a benefit in the analyses to come. In contrast to most traditional and transformational analyses of jazz harmony, chords such as triads, seventh chords, or other extended tertian chords are not the basic objects of these musical spaces. Rather, chord scales, or scales conceived of by jazz musicians and pedagogues as fields of harmonic and melodic possibility, constitute the bases of these transformational spaces. Using Dmitri Tymoczko's geometric theory of scale spaces (2004, 2008, and 2011), the article discusses the ways in which Shorter's compositions traverse chord-scale networks, providing a cogency in chord-scale succession in the absence of functional progressions. It then considers the scales performed by Shorter in his improvisations on these tunes, locating them on scale networks and comparing them to the chord scales expressed by each tune's chord symbols. The differences between the networks expressed by the lead sheets and Shorter's improvisations reveal the unexpected ways he—as both composer and performer—chose to manifest his nonfunctional, post-bop harmony.

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[3] Keith Waters defines "post bop" as jazz that often features "cyclic transpositional schemes," ambiguous tonal centers, transformations of harmonic schemata stemming from earlier tonal jazz eras, and "single-section formal designs," which are repeating chorus forms that have "no repeated … subsections" (2016, 38–39). The three compositions by Wayne Shorter considered here contain many, but not necessarily all, of these features as well. For more on post-bop style, see also Yudkin 2007 and Waters 2011.

[4] While Julien offers the most concise definition of "nonfunctional harmony," it is worth noting that Strunk described many of these features in his *New Grove Dictionary of Jazz* article on "Harmony" in 1988.

[5] "E.S.P." and "Iris" appear on Miles Davis's album *E.S.P.* (1965), while "Juju" is from Shorter's album of the same name (1964).

TRANSFORMATIONAL THEORY AND THE OBJECTS OF JAZZ HARMONY

Transformational theories have offered new ways of modeling harmonic succession that, as Steven Rings puts it, "simply provide generalized models of … musical actions" (2011, 2). Theories such as Neo-Riemannian theory have revealed insights into musical repertoires, such as nineteenth-century European art music, in which composers use conventional harmonic elements in unconventional ways. Hugo Riemann's initial conceptualization (1880) and David Lewin's formalization (1987) dealt solely with major and minor triads, both members of set class (037). Jazz harmony, and post-bop harmony in particular, uses a far wider harmonic palette. Indeed, some authors in the watershed *Journal of Music Theory* issue 42.2 were concerned with expanding Neo-Riemannian-like operations to harmonic objects beyond triads (Childs 1998, Douthett and Steinbach 1998, and Gollin 1998). A few writers have approached the problem from a jazz perspective as well. Steven Strunk has proposed an extension of the neo-Riemanian *Tonnetz* that encompasses major- and minor-seventh and ninth chords (2003 and 2016) and Keith Waters and J. Kent Williams have outlined a system encompassing most of the seventh- and ninth-chord qualities used in jazz by constructing a three-dimensional *Tonnetz* that derives harmonies from the diatonic, acoustic, hexatonic, and octatonic scales (2010). While these methods enlarge our understanding of how specific chord qualities often used in jazz might transform from one to the next, they gloss over an important aspect of jazz harmony: its essential variability.

There are two aspects to the variability inherent in jazz harmony. The first is that in contrast to fully notated compositions, jazz composers leave a lot open to the performers of their tunes. Jazz composers typically notate chord types in the form of chord symbols in lead sheets, and it is the performers' jobs to select pitches that fit those types. While this practice is similar to that of Baroque figured bass, jazz performers enjoy even more leeway in their realizations of chord symbols. For example, while "C7" implies a basic major-minor seventh chord rooted on C, chordal accompanists need not play this chord in basic root position. They might put it in any inversion, leave out some of its chord tones, or add any of its common upper extensions in selecting a particular chord voicing. The second is that beyond the freedom to select chord voicings that follow chord symbols, jazz musicians can fundamentally alter the notated chords. They may chromatically alter a chord's primary tones or its upper extensions, and they may even use other chords with similar functions as substitutes. This poses a problem to the analyst: what pitches should he or she consider to be "*the* harmony"? This article employs chord scales as a way to embrace the first aspect of this harmonic variability. By including the pitches that fall in between a seventh chord's tones, chord scales encompass a larger field of options expressed by a chord symbol. The article considers the second aspect, changing chords or their aspects altogether, in the context of the specific pitch choices Shorter makes in his solo improvisations and how these choices relate to the chord scales expressed by the tunes' chord symbols.

CHORD-SCALE THEORY

Jazz musicians and pedagogues have developed a system of chord-scale association in order to conceptualize the complexity of jazz harmony. This system, often referred to as chord-scale theory, received its first full-fledged conceptualization by pianist and composer George Russell in 1953.[6] Russell's *The Lydian Chromatic Concept of Tonal Organization for Improvisation* codified ideas about the connections between chords and scales that had been developing at least since the 1940s with bebop. The core of his method "deals with converting a chord symbol into the scale which best conveys the sound of the chord" (1959, 2). In his terms, each of the chords used in jazz has a "parent scale" that expresses its "prime color" (4). Russell is careful to frame his "concept" as not a restrictive and pedantic rule-based system, but rather "a view or philosophy of tonality in which the student, it is hoped, will find his own identity" (1). To this end, Russell outlines a panoply of scale options a performer can choose from when improvising over common chord types, eventually leading to the full chromatic scale. As he puts it, "we are reaching for a chromatic scale to have all the notes at our command. This is our ultimate goal. But of course, you had the chromatic scale before you began this course. What we are trying to give you is an organized, orderly way to develop the use of the chromatic scale for improvising" (22). Taken to its extreme, Russell's method enables musicians to express harmonies using any pitches they like.

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[6] Russell's text was self-published in 1953 and commercially printed for the first time in 1959. It has been revised numerous times, with a culminating fourth edition released in 2001 before his death in 2009. The overview of his theory given here refers largely to the 1959 first edition in order to present his ideas in the form that would have been spreading through the jazz community around the time that Shorter composed these tunes. While some of the terminology and manner of presentation differs between the first and fourth editions, the essentials of his theory remain consistent.

One of the more idiosyncratic aspects of Russell's *Lydian Chromatic Concept* is that he places the Lydian mode at the center of his scalar universe rather than Ionian. For instance, in his first lesson, Russell explains how an E♭7 chord is best represented by the second mode of D♭ Lydian, not the fifth mode of A♭ Ionian or major (1959, 2). Russell relates all chords to a parent Lydian scale and does not give its modal rotations unique names (e.g., "Mixolydian"). This Lydian centrality goes beyond a mere issue of labeling, however; to Russell, "[t]he Lydian Scale exists as a self-organized *Unity* in relation to its tonic tone and tonic major chord" (2001, 9, emphasis original). Russell's complex and often metaphysical justifications for this unity are beyond the scope of this article, but they manifest in Russell viewing Lydian as the ideal scalar representation for all major chords, whether or not they specify ♯4 or ♯11 additions.[7] Subsequent explications of chord-scale relationships such as John Mehegan's *Jazz Improvisation* (1959), Jerry Coker's *Improvising Jazz* (1964), and Jamey Aebersold's *A New Approach to Jazz Improvisation* (1967) differ from Russell's approach in three main ways: they construct the system from the starting point of the Ionian mode, not Lydian; they use the traditional Greek names to identify each major mode (e.g., Ionian, Dorian, Phrygian, etc.); and they describe Ionian as the preferred choice for unaltered major chords that express tonic function rather than Lydian.[8] In essence, they adapt Russell's concept of chord-scale relationships to functional tonality and leave out his claims about the primacy of Lydian. None of these jazz theorists and pedagogues explicitly refer to their ideas as "chord-scale theory," however. The term appears to have originated at the Berklee College of Music in Boston, Massachusetts, whose particular approach was first disseminated through class notes by Barry Nettles and later outlined in at least two texts, *The Chord Scale Theory and Jazz Harmony* (Graf and Nettles 1997) and *The Berklee Book of Jazz Harmony* (Mulholland and Hojnacki 2013).[9] As the first institution in the United States to offer instruction in jazz performance, Berklee's approach has made a significant impact on the way jazz pedagogy has been systematized.[10]

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[7] See Brubeck 2002, 190–94 for a summary of Russell's justifications. Russell's own arguments may be found in Russell 1959, i–iv and Russell 2001, 1–9.

[8] For instance, Mehegan describes how, "(i)n determining which of these two modes [Ionian and Lydian] to choose, the deciding factor must be the relative strength of these two major positions in diatonic harmony. On the basis of this, there can be no doubt of the overwhelming feeling of I

Russell's idea that scales may be thought of as representations of the same harmonic entities as chords spread like wildfire throughout the jazz community. Some scholars have voiced concerns about the conflation of the vertical and horizontal dimensions that undergirds chord-scale theory, however. In a review of jazz pedagogue Mark Levine's *Jazz Theory Book* (1995), Robert Rawlins argues that Levine's claim that "'the scale and the chord are two forms of the same thing' is an exaggeration and grossly misleading" (2000, 6). The core of Rawlins's argument is that "triadic progression is still the underlying harmonic force driving most of the musical examples presented in [Levine's] book." Rawlins also argues that viewing a scale as equivalent to a chord demotes the status of the chord tones and promotes that of the steps in

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when hearing a major chord. For this reason, the major chord takes the Ionian mode … except in cases where the bass line gives a strong feeling of IV" (1959, 81).

[9] The topic needs further research, but there may be a direct connection between the chord-scale curriculum at Berklee and George Russell's *Lydian Chromatic Concept*. As described in Brubeck 2002, Russell's ideas were initially disseminated at the Lenox School of Jazz, located in western Massachusetts, in the late 1950s (188–89). Additionally, Russell taught at neighboring New England Conservatory from 1969–2002 and lived in Boston until his death in 2009. It is possible that Russell's ideas took root most strongly at Berklee due to these connections in the Boston area.

[10] See Ake 2002, 112–45 for a discussion of the ways collegiate training, as well as a reverence for John Coltrane's "Giant Steps," has influenced jazz.

between, thereby ignoring the importance of functional root motions and scale-degree tendencies.[11] David Ake furthers this argument by pointing out how “the chord-scale system’s ‘vertical’ approach teaches players to outline chord structure rather than harmonic progression. In this way, the chord-scale system is ‘static,’ offering little assistance in generating musical direction through the movement of chords” (2002, 126). According to Ake, not only does chord-scale theory ignore important distinctions between chord and non-chord tones, but it also says nothing about the connections between chords.

Given these criticisms, how can we explain the seemingly unquestioned acceptance the jazz community has given to chord-scale theory? One answer is that jazz musicians do not consider chord-scale theory to be fully descriptive of their improvisatory practices. Considerations of chord tones, voice leading, and harmonic function are still integral to jazz pedagogy. Levine, for instance, discusses “The Major Scale and the II–V–I Progression” in chapter 2 (1995, 15–30), before “Chord/Scale Theory” in chapter 3 (31–94). His “Chord/Scale Theory” chapter includes copious examples of specific chord voicings and how each scale represents those chords. Mulholland and Hojnacki’s Berklee text layers precise consideration of scale-degree function on top of each scale by distinguishing between chords tones (1, 3, 5, and 7) and tensions (upper extensions) making the relation between scale and chord even more explicit than in Levine’s more implicit presentation (2013). The fact of the matter is that no jazz learner can reach mastery with chord-scale theory alone; its usefulness always resides in the way it interlocks with the many other pieces of jazz pedagogy.

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[11] Salley 2007 expands on Rawlins’s critique by discussing the inadequacy of using chord-scale theory to teach improvisation in the bebop idiom. He proposes a species approach to teaching bebop improvisation that focuses on progressively added chromaticism around chord tones.

Another answer is that chord-scale theory is not exactly a theory of harmony, as many scholars take it to be. When pedagogues like Levine state that "*the scale and the chord are two forms of the same thing*" (1995, 33; emphasis original), theorists like Rawlins bristle at the idea of treating chords and scales as equivalent, fearing that doing so strips away important information about harmonic function. From this point of view, that "same thing" which constitutes both scale and chord is closer to what a scale is than what a chord is. However, the "same thing" Levine refers to is what he calls the "*available pool of notes* to play on a given chord" (1995, 32; emphasis original), or what might be called a "potential macroharmony." "Macroharmony" is Tymoczko's term for "the total collection of notes used over small stretches of musical time" (2011, 15), and thus a potential macroharmony is the total collection of notes an improviser *may choose to use* over small stretches of musical time, typically the span of a single chord symbol or a diatonic progression in a jazz tune. Macroharmonies, whether potential or realized, can be thought of as "pitch-class clouds" that are blind to the specifics of function and centricity but that nonetheless linger over passages of music at a more abstract level. Analyses of successions of chord scales, the emic term in jazz theory for potential macroharmonies, are thus akin to analyses of successions of key areas in development sections of sonatas; while specifics such as local progressions, root motions, and melodic patterns are ignored, interesting background patterns may emerge that complement other ideas about how a composition or improvisation is structured.

Beyond these epistemological issues, when applying chord-scale theory to the music of Wayne Shorter many of the failings noted by Rawlins and Ake become positive attributes. The term "post bop" that is often applied to the music of Shorter and others in the mid-1960s is apt because—unlike musicians such as Ornette Coleman and John Coltrane who took an avant-garde turn around the same time—this music retained a stronger harmonic and melodic connection to bebop.[12] But while this music was in dialogue with bebop, it was also informed by hard bop, modal jazz, soul jazz, and—to a certain extent—the avant-garde. Although Shorter's music might seem outwardly similar to bebop, "triadic progression" (to use Rawlins's words) is not always the "underlying harmonic force" behind Shorter's nonfunctional, post-bop harmony. Frequently altered upper extensions are integral to many of Shorter's chords and these chords often do not progress in functional ways. Privileging the members of the seventh chord for chords such as the opening E7alt in "E.S.P." would result in an incomplete understanding of all the harmonic and melodic possibility implied by the chord symbol. More complete representations of the sound complexes expressed by Shorter's chord symbols, such as chord scales, are in many cases superior to seventh-chord reductions. The chord-scale networks introduced below also address Ake's complaint about chord-scale theory's lack of "assistance in generating musical direction." Tymoczko's geometric models of scale relationships reveal the voice leading pathways from scale to scale. These voice leadings serve as metaphorical signposts on the transformational roads between scalar destinations, thereby addressing the very lacuna Ake notes. Indeed, these networks have the potential to offer learners and performers not only a model of distance between scales, but also of embodied actions such as "moving" or "reaching" from one scale to the next with their fingers or vocal chords. They are a next conceptual step for the theory and pedagogy of chord scales.

Another common criticism of chord-scale theory is that it limits musicians' creativity by mapping chords to scales in a one-to-one relationship. Furthering this critique, Chris Stover imagines a world in which musicians "explore what possibilities arise when *no* scales are considered; when the notes that comprise a harmonic space are taken as points of orientation and the improviser imagines any number of linear paths to get from one point to another, including those that leave twelve-note [equal-tempered] space to consider microtonal possibilities" (2014, 187–88). This is an intriguing notion that resonates with Russell's "ultimate goal": "an organized, orderly way to develop the use of the chromatic scale for improvising" (1959, 22). When confronted with Shorter's music, however, it is not always clear what the "notes that comprise a harmonic space" should be. Sufficiently complex chord symbols, such as "alt" chords, can imply up to a seven-note collection. While the isographic mappings of particular-chord-symbols-to-particular-scales inherent in many pedagogical explications of chord-scale theory can seem limiting to performers' creativity, determining an underlying and relatively fixed referential structure for jazz performances is essential to understanding improvisations. Many of the musical parameters in jazz, including meter, phrase structure, form, and harmonic framework, remain stable and consistent across a performance. Rather than limiting creativity, these repeating elements give musicians something to play with. Musicians can depart from, return to, allude to, ignore, alter, uphold, or subvert them. Many of the expressive effects of jazz improvisation stem from musicians' convergences with and divergences from the tunes they improvise over, and thus pinning down the core aspects of these tunes throws musicians' improvised statements into relief. Therefore, the analyses below discuss the traversal of a chord-scale network as expressed by a tune's chord symbols and melodic pitches first; then, they compare Shorter's choices against this backdrop.

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[12] While Coleman and Coltrane both performed more clearly bebop-influenced music in the 1950s, their respective large-ensemble recordings *Free Jazz* (1961) and *Ascension* (1966) largely left bebop behind and helped define the avant-garde style that emerged in the 1960s. See Jost 1994 for more on these two musicians and their relationship to the avant garde.

Unlike musicians such as Miles Davis who explicitly based some of their tunes and performances on scales, there is no direct evidence to suggest that Wayne Shorter conceptualized his music of the mid-1960s in terms of scales.[13] The study of scales had become a central aspect of jazz by the 1940s, however, so even if Shorter had not yet been directly exposed to Russell's *Lydian Chromatic Concept*, he would certainly have understood most of the scales discussed below.[14] Given that Shorter recorded two of the tunes analyzed below as part of the Miles Davis Quintet, it is even more likely that Shorter would have been aware of the theories about scales that were germinating at this time. Even if he was never directly exposed to Russell's concept, chord-scale theory can still offer insights into Shorter's music for two main reasons. First, even if the musicians were not explicitly considering chord-scale relationships, they often preferred to fill the gaps between chord tones using what Tymoczko calls "locally diatonic" scale snippets: "any three adjacent pitches … [that] are enharmonically equivalent to three adjacent pitches of some diatonic scale" (1997, 138).[15] By performing locally diatonic patterns to fill chord-tone gaps, musicians end up playing the scales discussed below whether conceived of as scales or not, allowing them to make a clear distinction between diatonic or "inside" and chromatic or "outside" ways of playing. Second, due to chord-scale theory's prominence today, contemporary performances of these tunes are inevitably informed by the theory. Even if the application of the theory to Shorter's music is possibly anachronistic, it can offer insight into a modern interpretation of it. While the pitches Shorter performs in his solo improvisations do not always corroborate the chord-scale readings offered here, they often do. And, the pathways they take through the same scale networks as the tunes have their own notable patterns and tendencies.

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[13] In fact, Russell credits Davis with spurring his initial vision for the *Lydian Chromatic Concept*: "In a conversation I had with Miles Davis in 1945, I asked, 'Miles, what's your musical aim?' His answer, 'to learn all the changes (chords),' was somewhat puzzling to me since I felt—and I was hardly alone in the feeling—that Miles played like he already knew all the chords. After dwelling on his statement for some months, I became mindful that Miles's answer may have implied the need to relate to chords in a new way. This motivated my quest to expand the tonal environment of the chord beyond the immediate tones of its basic structure, leading to the irrevocable conclusion that every traditionally definable chord of Western music theory has its origin in a parent scale" (2001, 10).

[14] Musicians often attribute a newfound focus on scales to the pioneers of bebop. As Paul Berliner recounts, "[a]s youngsters, [bebopper] Barry Harris and his peers 'just thought about chords. We didn't know about scales until later.' Many musicians became aware of the value of scales through the practices of Dizzy Gillespie and Charlie Parker, whose interest in creating phrases of longer lengths and greater rhythmic density than their predecessors' led the innovators to combine chord tones with additional material, emphasizing at times a linear concept in their improvisations" (1994, 161).

[15] Berliner's ethnographic research provides evidence for this line of thinking: "For learners, the discovery of scales and their theoretical relationship to chords constitutes a major conceptual breakthrough with immediate application. They can construct a scale or mode that is compatible with each chord by filling in the diatonic pitches between its tones, increasing the chord's associated pitch collection from four to seven, and grouping optional tonal materials together as a string of neighboring notes. Images of scales or scale fragments provide ready combinations of pitches inside and outside the chord for creating smooth linear phrases. Furthermore, rather than

CHORD-SCALE NETWORKS

Since the analyses below rely on Dmitri Tymoczko's geometric theory of scale spaces (2004, 2008, and 2011), it is important to clarify how a "chord scale" relates to his definition of "scale."[16] For Tymoczko, a scale "is a means of measuring musical distance—a kind of musical ruler whose unit is the 'scale step' " (2011, 15). Furthermore, Tymoczko focuses on "*octave-repeating* scales, which contain each of their pitches in every possible octave" (2011, 117; emphasis original), and which form "unique circular ordering[s] of pitch classes" (2004, 221). While he uses conventional labels for scales that index them to specific pitch classes (e.g., "C diatonic"), these labels should not be taken to impart centricity. "Modes," then, are scales that are centered on a single pitch class. In this article, "chord scales" are essentially equivalent to

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addressing chords individually, improvisers can use the scale as a compositional model over the span of a diatonic progression" (1994, 162).

[16] Tymoczko's method of presenting this theory has evolved over the years. In his 2004 article, he defined a number of scalar constraints to arrive at a list of scales most commonly used in jazz. In his book *A Geometry of Music* (2011), Tymoczko incorporated his scale theory into a larger geometric conception of music. Because the details of his larger theory are not needed to understand the chord-scale networks, this article largely builds upon his 2004 article.

Tymoczko's "scales," except that they are the abstract potential macroharmonies discussed above.[17] Thus a chord scale is a unique circular ordering of pitch classes (i.e., a scale) *expressed* by a chord symbol. This article uses the terms "chords" and "scales" when discussing the pitches actually performed by the musicians and "chord scales" when discussing the potential macroharmonies expressed by chord symbols.

The process of determining the chord scales expressed by a jazz tune's chord symbols is complex and often thorny. Two primary sets of sources help to determine the chord scales on which the analyses are based. The first set consists of the published lead sheets for each tune. Authors of lead sheets often have differing intentions; some aim to present a simplified version of a tune in order to facilitate real-time realization by performers, while others precisely transcribe what is played in an original or influential recording. This article privileges sources that favor comprehensiveness over simplicity and that most closely match these tunes' original recordings. The second set of sources consists of the original recordings, which provide the pitches the musicians actually chose to play. Musicians are more likely to depart from a tune's harmonies during solo improvisations than they are when performing the "head" (the presentation of the melody typically performed at the beginning and ending of a performance). Therefore, musicians' utterances during the head take priority over what they play at other times in order to determine a tune's basic structure. The overall goal is to represent the chord scales expressed by the chord structures that underlie each tune's first recording.

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[17] In fact, Tymoczko calls into question the need for distinguishing between the concepts of scale and chord: "Fundamentally, a scale is a large chord, and a chord is just a small scale: both participate in efficient voice leadings, and both can be represented by the same basic geometries; composers develop musical motifs by transposing them along familiar chords, as if chords were just very small scales…; and efficient voice leading frequently involves interscalar transposition or strongly crossing-free voice leadings. … Thus there are significant theoretical advantages to adopting a unified perspective that treats chords and scales similarly" (2011, 153).

In constructing his theory, Tymoczko defines a series of constraints that give him seven scales he dubs the "Pressing scales" after the scholar Jeff Pressing who codified them and described their usage in jazz (1978). These scales are given in Figure 1.[18] The seven scales—diatonic, acoustic, octatonic, whole-tone, harmonic minor, harmonic major, and hexatonic—provide the necessary "pool of notes" to produce most, if not all, jazz chords.[19] Tymoczko constructs networks of these scales using a property he calls "maximal intersection." Two scales maximally intersect with one another when they share all but one pitch class. If the scales are of different cardinalities, such as the acoustic and whole-tone, they must share all but one pitch class of the scale of smaller cardinality (e.g., five pitch classes of the whole-tone's six must be in common with five of the acoustic's seven). Figure 2 graphs the maximal intersections between the "Pressing" scales. Each line represents a maximal intersection, and gives the number of pitch classes (called "notes" in Tymoczko's figure) shared between the two scale categories and the number of scales with which an individual scale maximally intersects. For example, each diatonic scale intersects with two unique acoustic scales, while each acoustic scale also intersects with two diatonic. These intersections are not always so balanced, however; each acoustic scale intersects with only one whole-tone scale, but each whole-tone scale intersects with six different acoustic scales.

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[18] Tymoczko uses an idiosyncratic labeling system for the octatonic, whole-tone, and hexatonic collections that is used here: "'Whole-Tone Collection I' is the whole-tone collection containing C♯ (=1, in integer notation). 'Whole-Tone Collection II' is the collection containing D♮ (=2). 'Octatonic Collection I' is the octatonic collection containing the dyad C♯–D (= 1, 2). 'Octatonic Collection II' contains D–D♯ (= 2, 3), and 'Octatonic Collection III' contains D♯–E (=3, 4). 'Hexatonic Collection I' contains the dyad C♯–D, 'Hexatonic Collection II' contains D–D♯ and so forth" (2004, 283–84).

[19] Indeed, these scales, minus the comparatively rare whole tone, harmonic major, and harmonic minor, also form the basis of Waters and Williams's jazz chordal space (2010).

FIGURE 1: The “Pressing” scales (after Tymoczko 2004, 228)

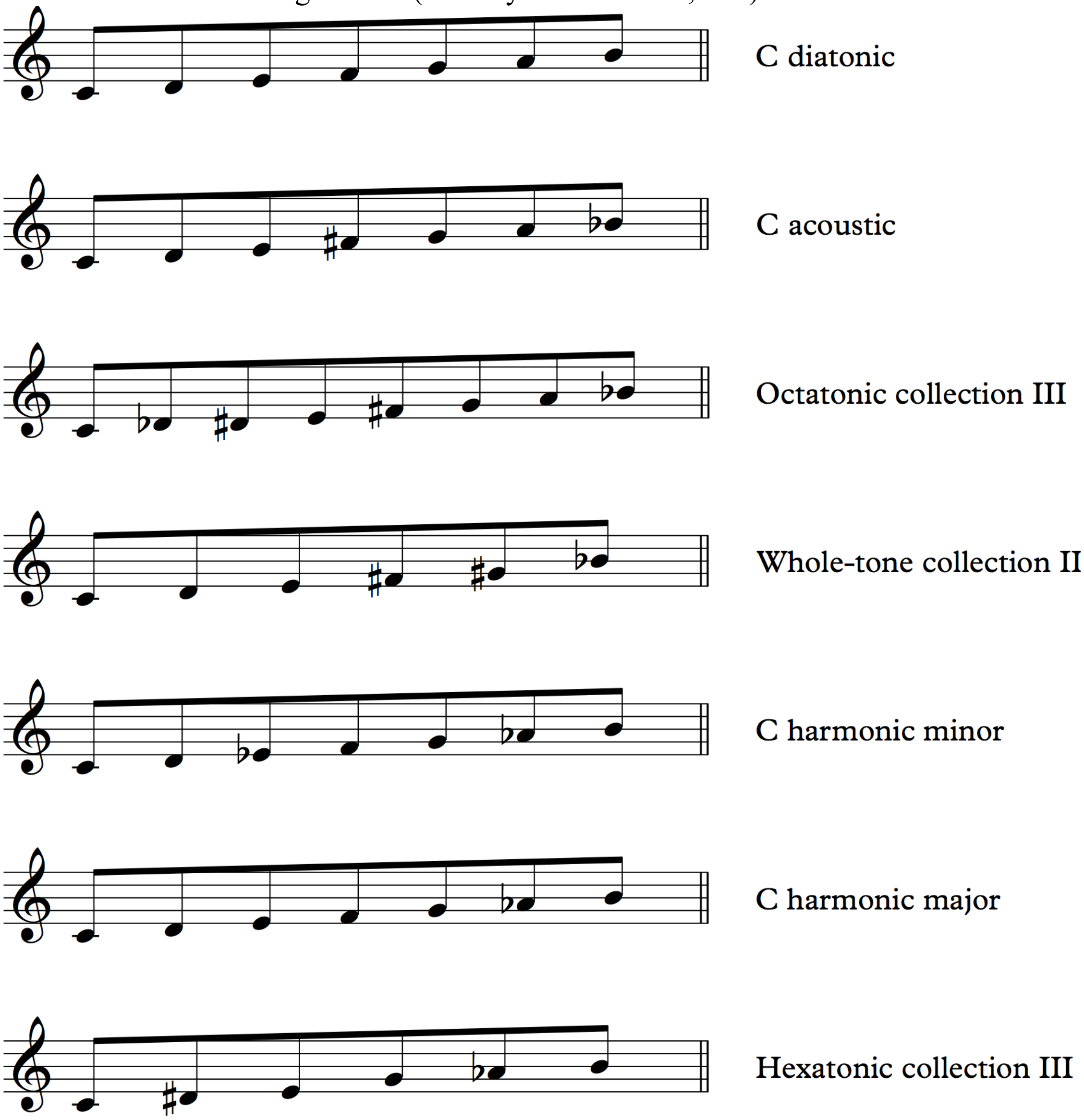
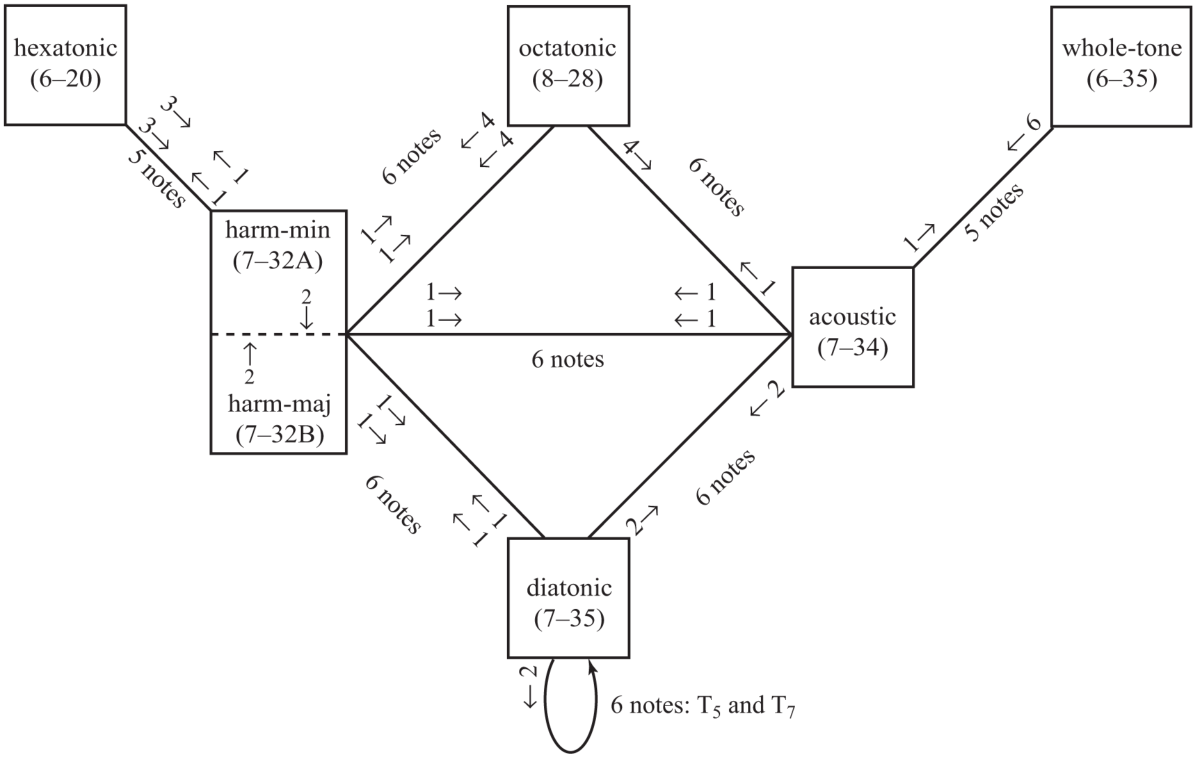

C diatonic
C acoustic
Octatonic collection III
Whole-tone collection II
C harmonic minor
C harmonic major
Hexatonic collection III

FIGURE 2: Maximal intersections between the "Pressing" scales (Tymoczko 2004, 236)


hexatonic (6–20)
octatonic (8–28)
whole-tone (6–35)
harm-min (7–32A)
harm-maj (7–32B)
acoustic (7–34)
diatonic (7–35)
5 notes
6 notes
6 notes
5 notes
6 notes
6 notes
6 notes
6 notes: T_5 and T_7

Tymoczko next creates networks of specific scales based on parsimonious voice leading. Figure 3 shows the six scales that maximally intersect with C diatonic and the specific pitch classes that shift by half step between each. The network shown in Figure 3 is used often in the analyses to come due to its particular focus on the diatonic and acoustic scales. Indeed, these two scales form the core of chord-scale theory in much jazz pedagogy. Figure 4 provides the seven modes derived from the C diatonic scale, along with samplings of chord symbols that commonly express these modes. Figure 5 lists the seven modes of the C acoustic scale, again with common chord symbols. In jazz pedagogy, these modes are typically presented as rotations of the ascending form of the melodic minor scale, but this article uses the name "acoustic," following Tymoczko. The names given in Figure 5 for these modes are common in jazz circles, but are not as standardized as those of the diatonic modes. With a few additions that will be discussed as they arise, the diatonic and acoustic scales provide much of the chord-scale content found in Wayne Shorter's three tunes.

FIGURE 3: Specific voice-leading connections between diatonic, acoustic, harmonic major, and harmonic minor scales (Tymoczko 2004, 238)

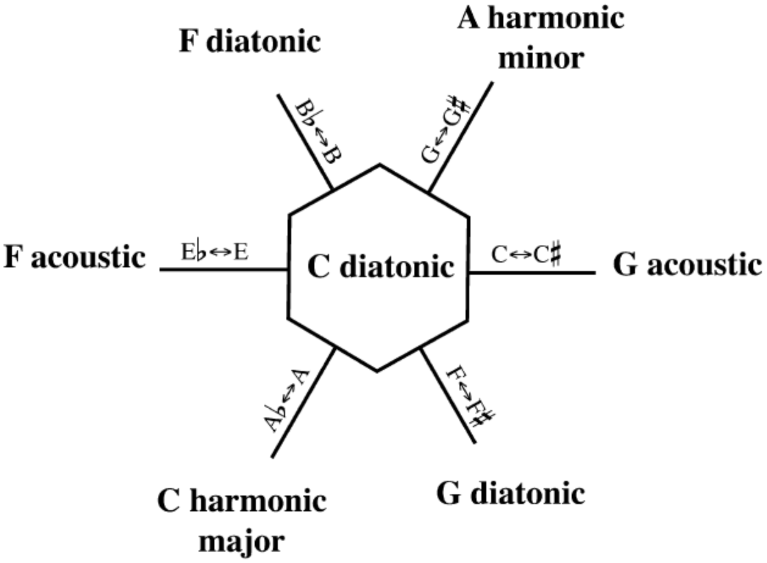

F diatonic
A harmonic minor
B♭↔B
G↔G♯
F acoustic
E♭↔E
C diatonic
C↔C♯
G acoustic
A♭↔A
F↔F♯
C harmonic major
G diatonic

FIGURE 4: Modes of the C diatonic scale and common chord symbols that express them

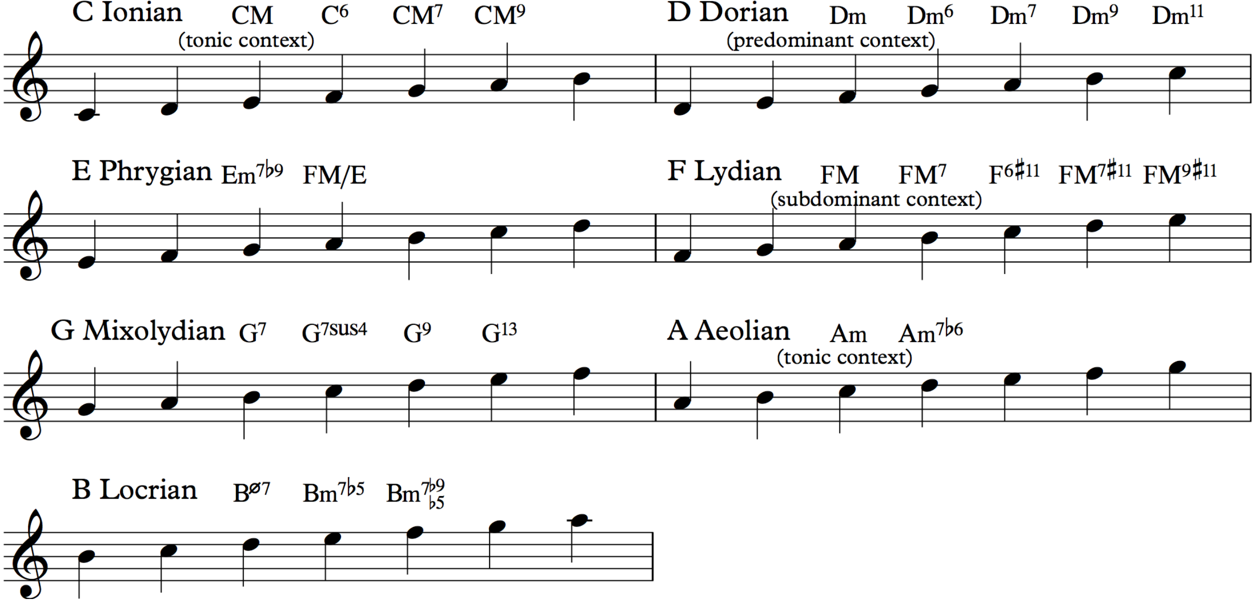
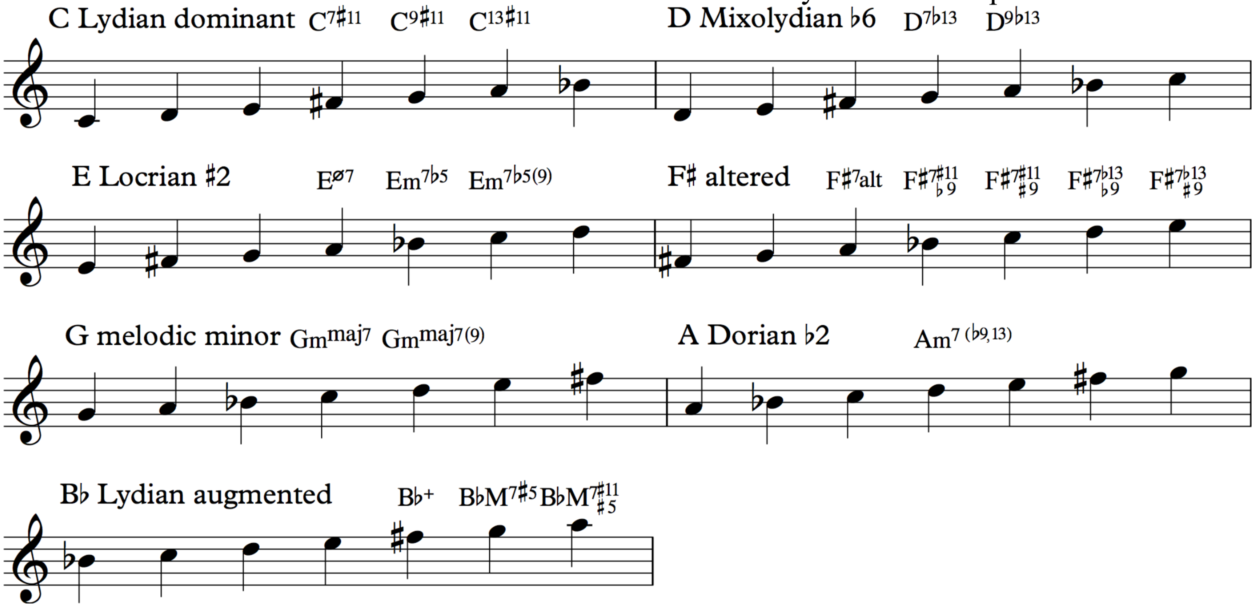

C Ionian
CM
C^6
CM^7
CM^9
(tonic context)
D Dorian
Dm
Dm^6
Dm^7
Dm^9
Dm^{11}
(predominant context)
E Phrygian
$Em^{7\flat9}$
FM/E
F Lydian
FM
FM^7
$F^{6\sharp11}$
$FM^{7\sharp11}$
$FM^{9\sharp11}$
(subdominant context)
G Mixolydian
G^7
G^{7sus4}
G^9
G^{13}
A Aeolian
Am
$Am^{7\flat6}$
(tonic context)
B Locrian
$B^{ø7}$
$Bm^{7\flat5}$
$Bm^{7\flat9}_{\flat5}$

FIGURE 5: Modes of the C acoustic scale and common chord symbols that express them


C Lydian dominant
C7♯11
C9♯11
C13♯11
D Mixolydian ♭6
D7♭13
D9♭13
E Locrian ♮2
Eø7
Em7♭5
Em7♭5(9)
F♯ altered
F♯7alt
F♯7♯11♭9
F♯7♯11♯9
F♯7♭13♭9
F♯7♭13♯9
G melodic minor
Gmmaj7
Gmmaj7(9)
A Dorian ♭2
Am7(♭9,13)
B♭ Lydian augmented
B♭+
B♭M7♯5
B♭M7♯11♯5

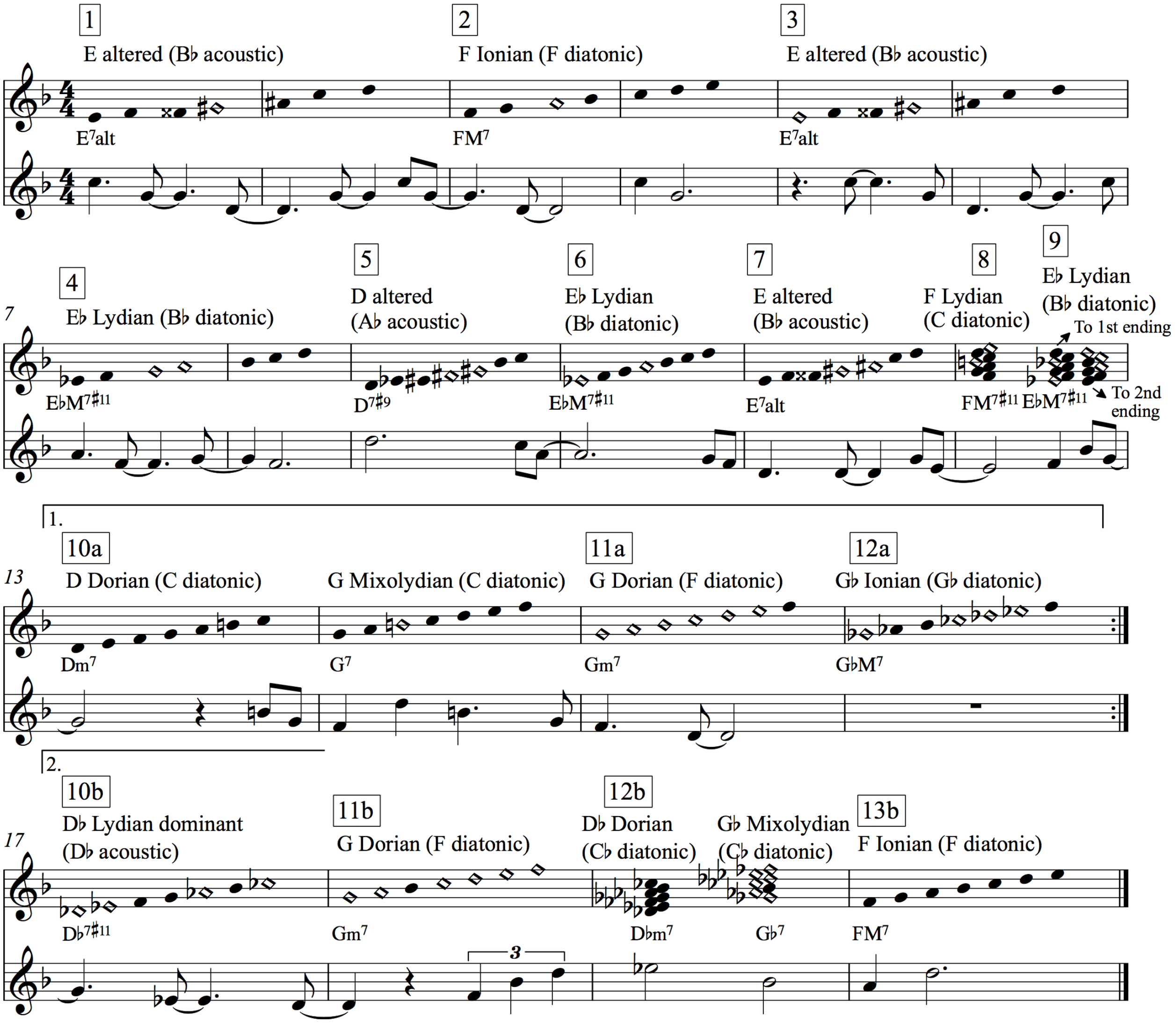
INTRODUCTION TO THE CHORD-SCALE-NETWORK ANALYSES

With the foregoing theoretical model in place, we now turn to three of Wayne Shorter's tunes (with solo improvisations) from the mid-1960s. "E.S.P.," "Juju," and "Iris" were all recorded within six months of each other: "Juju" in August of 1964, and "E.S.P." and "Iris" in January of 1965. Despite this temporal proximity, they all exhibit markedly different chord-scale motions. As alluded to in the introduction, "E.S.P." straddles two musical languages, that of bebop and post-bop. The tune can be heard to engender a sense of tonal centricity, but the chord-scale network suggests greater ambiguity. In his improvisation, however, Shorter often departs from the chord scales expressed by the tune due to his use of more chord-centric bebop language at times and his clever and often thematic replacement of certain chord scales at others. In "Juju," Shorter uses the whole-tone scale extensively and juxtaposes maximally different chord scales. While Shorter's improvisation largely corresponds to the chord scales expressed by the tune, he notably deviates from them at particular moments by performing a pentatonic scale that helps bridge the gap between some of the tune's distinct chord-scale regions. Finally, "Iris" has the most complex and ambiguous chord-scale network of the three. Despite his use of a wide variety of chord scales, and particularly his notable use of the hexatonic, a reduced network that exposes a simpler structure lies below the complex surface. At first glance, Shorter's improvisation seems more focused on developing rhythmic and melodic motives that conflict with the tune's chord scales, but on closer inspection his pathway through the network follows almost exactly the reduced network. In all three tunes, Shorter finds a way to marry complex and ambiguous post-bop harmonies with simple, tuneful melodies, a hallmark of his compositional and improvisational style.

"*E.S.P.*"

Returning now to "E.S.P.," Example 2 gives a lead-sheet representation of the tune distilled from four written sources (Shorter 1985, 9; *The Real Book* 1988, 141; Sher 1988, 90; and Waters 2011, 110) and the original Miles Davis Quintet recording (1965). In the example, the upper staff notates each of the chord scales. Information above the staff identifies specific modes and general scales. These modes and scales are interpreted from the lead sheet's melody shown in the lower staff and chord symbols above the lower staff. Diamond-shaped noteheads indicate pitch classes that shift in the following chord scale, providing concise information about the distance moved from one chord scale to the next. Figure 6 gives a chord-scale network for "E.S.P." This network consists of the maximally intersecting diatonic chord scales stretching from C to C♭ along with a few acoustic chord scales that branch off to the left. The tune's traversal of this network is indicated by numbers, which index to the numbered chord scales in the lead sheet, and dotted arrows, which highlight the succession.[20] Chord scales shown in dotted hexagons do not appear in the tune. The branches of the first and second endings are shown with "a"- and "b"-appended chord-scale numbers for the first and second endings respectively.

EXAMPLE 2: "E.S.P." lead sheet with chord scales


1
E altered (B♭ acoustic)
E7alt
2
F Ionian (F diatonic)
FM7
3
E altered (B♭ acoustic)
E7alt
7
4
E♭ Lydian (B♭ diatonic)
E♭M7♯11
5
D altered
(A♭ acoustic)
D7♯9
6
E♭ Lydian
(B♭ diatonic)
E♭M7♯11
7
E altered
(B♭ acoustic)
E7alt
8
F Lydian
(C diatonic)
FM7♯11
9
E♭ Lydian
(B♭ diatonic)
E♭M7♯11
To 1st ending
To 2nd ending
1.
13
10a
D Dorian (C diatonic)
Dm7
G Mixolydian (C diatonic)
G7
11a
G Dorian (F diatonic)
Gm7
12a
G♭ Ionian (G♭ diatonic)
G♭M7
2.
17
10b
D♭ Lydian dominant
(D♭ acoustic)
D♭7♯11
11b
G Dorian (F diatonic)
Gm7
3
12b
D♭ Dorian
(C♭ diatonic)
D♭m7
G♭ Mixolydian
(C♭ diatonic)
G♭7
13b
F Ionian (F diatonic)
FM7

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[20] Note that chord successions that fall within the same parent chord scale (i.e., they project different modal orderings of the same chord scale) do not receive new index numbers. Only parent chord-scales receive index numbers.

The tune begins with an E7alt chord with prominent altered extensions C_5(♭13) and G_4 (enharmonically, ♯9) in the melody, thereby expressing the E altered chord scale, a member of the B♭ acoustic scale (chord-scale #1 on Figure 6).[21] Next, it shifts to an FM7 chord that expresses F Ionian (F diatonic, #2).[22] This two-chord succession, which Waters describes as a "lower chromatic neighboring chord (resolving to F)" (2011, 110), produces a similar neighboring connection between the B♭ acoustic (#1) and F diatonic (#2) chord scales. Indeed, the melody's repeating C, G, and D across this succession highlights their common tones and also underscores the centrality of those pitches to their supporting chords. Following F diatonic (#2), B♭ acoustic (#3) returns with E7alt in m. 5, before concluding the tune's opening eight-bar section on E♭M7$^{\sharp 11}$ two bars later.[23] This chord expresses E♭ Lydian (B♭ diatonic, #4), resulting in the tune's first two-node shift on the chord-scale network, which is accompanied by a contraction of the melody's opening fourths to an A_4-F_4 major third. With the appearance of B♭ diatonic (#3), F diatonic (#2) is now surrounded by two of its closest neighbors on the network, creating a dense center of activity. Moving from m. 8 to m. 9, the tune makes another two-node move with the arrival of D7$^{\sharp 9}$, expressing D altered (A♭ acoustic, #5) and breaking out of the confined ambitus of the first eight bars. While the chordal roots in mm. 9–11 ascend by half step from D to E♭ to E, the chord-scale succession remains narrowly focused on the same small set of chord scales: A♭ acoustic (#5), B♭ diatonic (#6), and B♭ acoustic (#7).[24] The tune achieves this repetition by not featuring parallel dominant-seventh-♯9 chords, instead returning in m. 10 to the same E♭M7$^{\sharp 11}$ chord used in mm. 7–8.[25] Despite the chromatic half-step root motions in mm. 9–11, the melody notably contains pitches congruent with all three chords and with F diatonic, a feature Shorter emphasizes in his solo improvisation.

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[21] Most lead-sheet sources label this chord E7alt (*The Real Book* 1988, Sher 1988, Waters 2011), but Shorter 1985 (ed. Aebersold) prefers the more literal "E^{7+9+5}" (using the "+" symbol in place of the conventional sharp sign). Waters notes that Shorter's original lead sheet gave the chord as "E+9$^{\flat 5}$" (2011, 110).

[22] All four lead-sheet sources do not specify a ♯11 addition to the chord and so, despite no clarifying B♭ in the melody, this chord expresses F Ionian (F diatonic).

[23] The ♯11 addition to E♭M7 appears in the Sher 1988 and Shorter 1985 sources, but not the others. Due to the melody's strongly emphasized A-natural and audible inclusion in pianist Herbie Hancock's voicing during the initial melody statement, the tune expresses E♭ Lydian here despite Shorter's emphasis on E♭ Ionian in his solo to be discussed.

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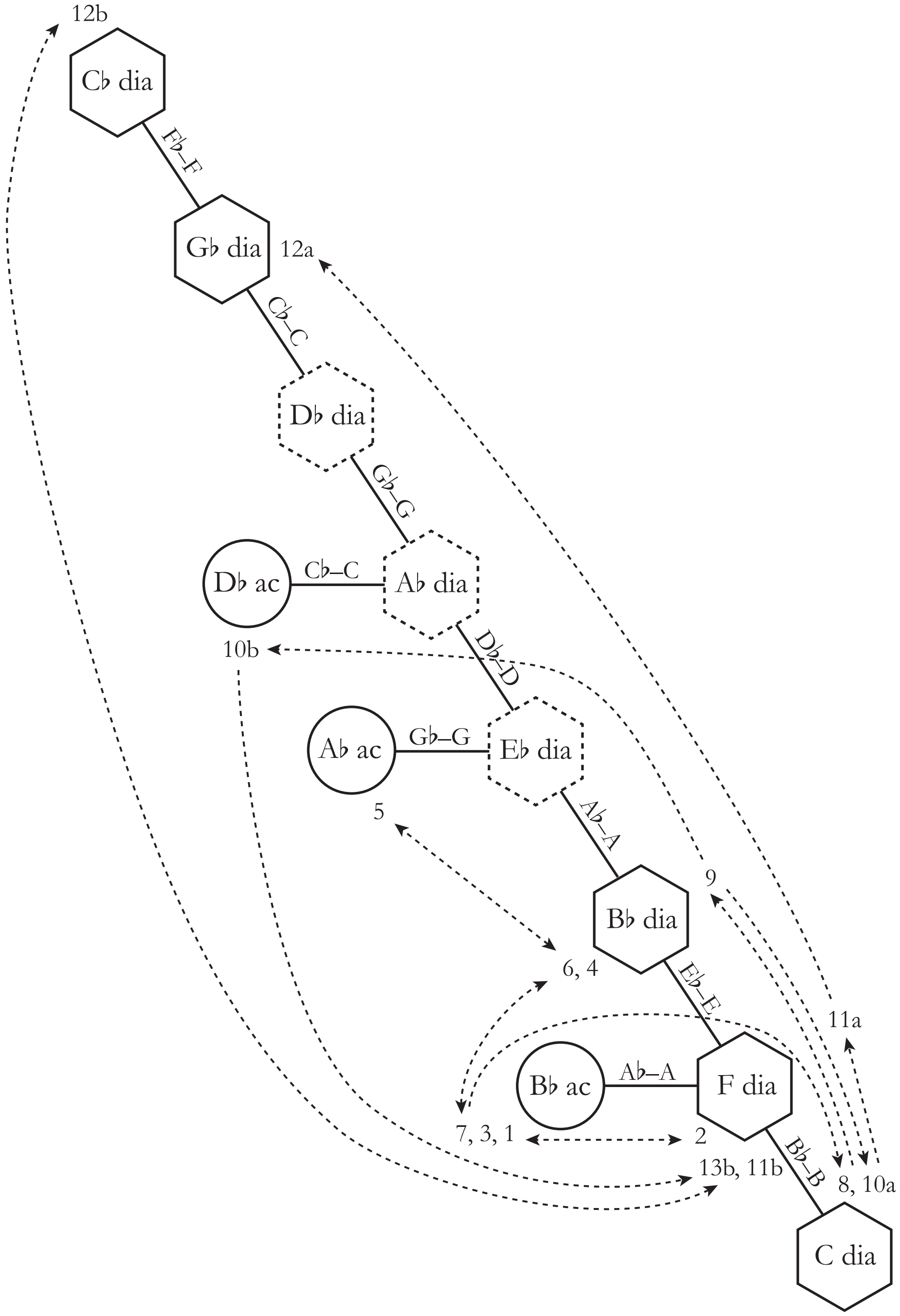
[24] It is worth noting that the chords in mm. 9 and 11 are dominant-seventh-♯9 chords, not fully altered chords like the opening E7alt. Another common chord scale used to express dominant-♯9 chords is octatonic, which differs from altered in its lacking the ♭13 alteration. Due to the tune's prominent emphasis on E7alt in its first six bars, these chords may be heard to express acoustic-derived altered chord scales instead of octatonic ones. The altered and octatonic scales do maximally intersect with each other, so the distances on the network increase by only one step when choosing octatonic over altered. It is also worth noting that Hancock uses the octatonic scale over many of these chords, even including E7alt (see Waters 2011, 212–219 for a transcription and discussion of Hancock's solo improvisation).

[25] The quality of the E♭ chord in m. 10 varies among the lead-sheet sources and in the 1965 recording itself, perhaps due to the fact that Hancock lays out in these measures during the head statements. Strunk identifies the chord as E♭M7 (2005, 307), which fits with the E♭M7$^{\sharp 11}$ chord shown in fake-book versions by Jamey Aebersold (Shorter 1985, 9) and Chuck Sher (1988, 90). Waters, however, notates E♭7$^{\sharp 9}$ (2011, 110), perhaps due to the fact that Hancock frequently plays that chord in that bar of the form during the improvisations. It is possible that, due to the fast tempo taken on the recording, Hancock often chose to voice three parallel dominant-seventh-♯9 chords rather than change his hand position for the E♭ chord. Indeed, at 4:33–4:36 during his solo, he continues the pattern of parallel dominant-seventh-♯9 chords even onto the FM7$^{\sharp 11}$ chord in m. 12. Hancock does not consistently play E♭7$^{\sharp 9}$ in this spot, however, instead performing E♭ major at 1:30, 2:50, and 3:16. Due to the agreement among Strunk, Aebersold, and Sher, it is likely Shorter notated E♭M7$^{\sharp 11}$ here and that E♭7$^{\sharp 9}$ was a reharmonization made by Hancock.

FIGURE 6: "E.S.P." chord-scale network


12b
C♭ dia
F♭–F
G♭ dia
12a
C♭–C
D♭ dia
G♭–G
D♭ ac
C♭–C
A♭ dia
10b
D♭–D
A♭ ac
G♭–G
E♭ dia
5
A♭–A
9
B♭ dia
6, 4
E♭–E
11a
B♭ ac
A♭–A
F dia
7, 3, 1
2
B♭–B
13b, 11b
8, 10a
C dia

Once back on E altered (B♭ acoustic, #7) in m. 11, the pianist on the recording (Herbie Hancock) performs chords in m. 12 that unexpectedly deviate from those given in all of the lead-sheet sources. While the sources list the two chords in bar 12 as FM7–E♭M7, Hancock actually performs FM7$^{\sharp 11}$–E♭M7$^{\sharp 11}$. By expressing F Lydian (C diatonic, #8) instead of F Ionian (F diatonic), Hancock's FM7$^{\sharp 11}$ chord denies the closely-neighboring shift from B♭ acoustic to F diatonic that might have occurred. It should be noted that substituting a M7$^{\sharp 11}$, Lydian-expressing chord for a M7, Ionian-expressing one was an extremely common practice in post-bop jazz and even in earlier styles. The distinction here is that for the first FM7 chord in mm. 3–4, Hancock performs a different chord voicing that emphasizes the pitches it has in common with the preceding E7alt, and that requires an omission of the ♯11 extension. He could easily have used this or a similar voicing in m. 12, but he does not. Instead, he includes a ♯11 on it and the next chord each time the head recurs. As a result, throughout these opening twelve bars, the chords express F diatonic only once, in mm. 3–4, while they express B♭ acoustic three times. Thus, B♭ acoustic receives special emphasis, both through the amount of time it is heard and its prominent appearance at the start of the tune. While the first and second endings (discussed below) feature functional progressions directed towards F major, it is worth noting that, after their final head statement at the end of the recording, the musicians conclude "E.S.P." on E7alt, not FM7. As a result, this repeated focus on E altered (B♭ acoustic) calls into question the primacy of F Ionian (F diatonic) and F major that Strunk (2005, 306) and Waters (2011, 110) take as implicit.

Heading into the first ending, the tune features two beats of E♭M7$^{\sharp 11}$ in m. 12 that lead to Dm7 in m. 13. This succession results in a return to two chord-scale regions visited recently: E♭ Lydian (B♭ diatonic, #9) and D Dorian (C diatonic, #10a). The tune's first ending brings about a shift from the opening's nonfunctional, post-bop language to a more functional, bebop one. It suggests turnaround chord changes—a ii7–V7 in C major, expressed by C diatonic (#10a), followed by a ii7–V7 in F, expressed by F diatonic (#11a)—but the G♭M7 chord in m. 16 departs from this pattern, resulting in a large shift in the network to G♭ diatonic (#12a). While the ♭2 bass pitch of this chord outwardly suggests a tritone substitution, its M7 quality calls this into question by overwriting the enharmonically equivalent tritone between third and seventh so integral to the ♭II7/V7 functional equivalence.[26] This chord sticks out in the midst of the turnaround changes much like the G♭ diatonic chord scale (#12a) stands apart from the main locus of chord-scale activity heard earlier.

After a repetition of the opening twelve bars, bebop-derived functional progressions and substitutional processes occur in the second ending resulting in a patterned chord-scale succession that is similar to the first ending, though concluding on FM7 instead of G♭M7. The D♭7$^{\sharp 11}$ chord in m. 17 functions in two ways. First, it continues the pattern of whole-step root descent that begins in m. 12 (F–E♭–D♭), creating a variation of the earlier descent from F to E♭ to D that leads into the first ending. Second, it creates a tritone-substitution variant of the C-diatonic ii7–V7 heard at the start of the first ending. By retaining the same melodic pitch G at the start of both the first and second endings, the tune adds a ♯11 to the D♭7 chord, expressing a chord scale of D♭ acoustic (#10b) rather than the expected G♭ diatonic.[27] Additionally, this single measure of D♭7$^{\sharp 11}$ stands in for the two-bar ii7–V7 progression in C major heard in mm. 13–14, allowing the tune to arrive on F major in its final bar. The Gm7 (ii7) chord follows in m. 18, expressing G Dorian (F diatonic, #11b), but does not proceed to its dominant. Instead, the tune employs tritone substitutes, D♭m7 and G♭7, for both the diatonic ii7 and V7 chords, thereby expressing the C♭ diatonic chord scale (#12b) for the final cadence in m. 19. This final, unambiguous tritone substitution reveals a different way of approaching the FM7 chord and F diatonic chord scale (#13b). Rather than using the closely neighboring E7alt chord, the tune moves between the most distant, tritone-related chords and their expressed chord scales. This is yet another feature of the tune that Shorter draws out in his solo, to which we now turn.

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[26] Tritone substitutions are ii7–V7–I7 progressions in which the dominant chord, and less often the ii7 chord as well, are substituted by chords a tritone away, often of the same type or quality. When substituting ♭II7 for V7, this produces a chromatic 2–♭2–1 bass line while preserving the two chord's enharmonically equivalent thirds and sevenths. For more on the tritone substitution, see Martin 1988, Biamonte 2008, and Tymoczko 2011, 360–365.

It is also worth noting that *The Real Book* (5th ed., 1988) lists the unmodified tritone substitute (G♭7) in m. 17 of the tune and Sher 1988 gives G♭7 as a parenthetical option. Enough of the other sources use G♭M7 and, given Shorter's predilection for replacing dominant chords with major sevenths (noted in Julien 2001, 53 and Strunk 2005, 303–304) and his performance of a G♭-major-seventh arpeggio in his solo improvisation, it seems likely he intended it here.

Shorter takes the first solo after the initial presentation of the tune's head and he plays for two choruses, transcribed in Example 3.[28] The example identifies prominent scales Shorter uses above the staff. The network of the scales used in his improvisation, shown in Figure 7, highlights a subset of the scales he performs, to be discussed in more detail below. Strikingly, Shorter's first utterance ascends through E Lydian (B diatonic) in stark contrast to E altered (B♭ diatonic) expressed by the tune's lead sheet. This is a fascinating and unexpected choice for numerous reasons. E Lydian includes none of the tune's melodic pitches heard over this chord (C, G, and D), which nonetheless sound in Hancock's favored E7alt voicing just prior to

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[27] An interesting chord-scale connection emerges when using dominant chords with chromatic alterations in tritone substitutions. G7alt and D♭7$^{\sharp 11}$, chords a tritone apart with different chromatic alterations, are both represented by modes of the D♭ acoustic chord scale. This relationship is similar to the enharmonically equivalent third and seventh of two tritone-related dominant-seventh chords mentioned above. It also gives further evidence to the claim that D♭ acoustic acts as a modified tritone substitution for C diatonic here, since G7alt would be an altered version of the dominant chord derived from C diatonic.

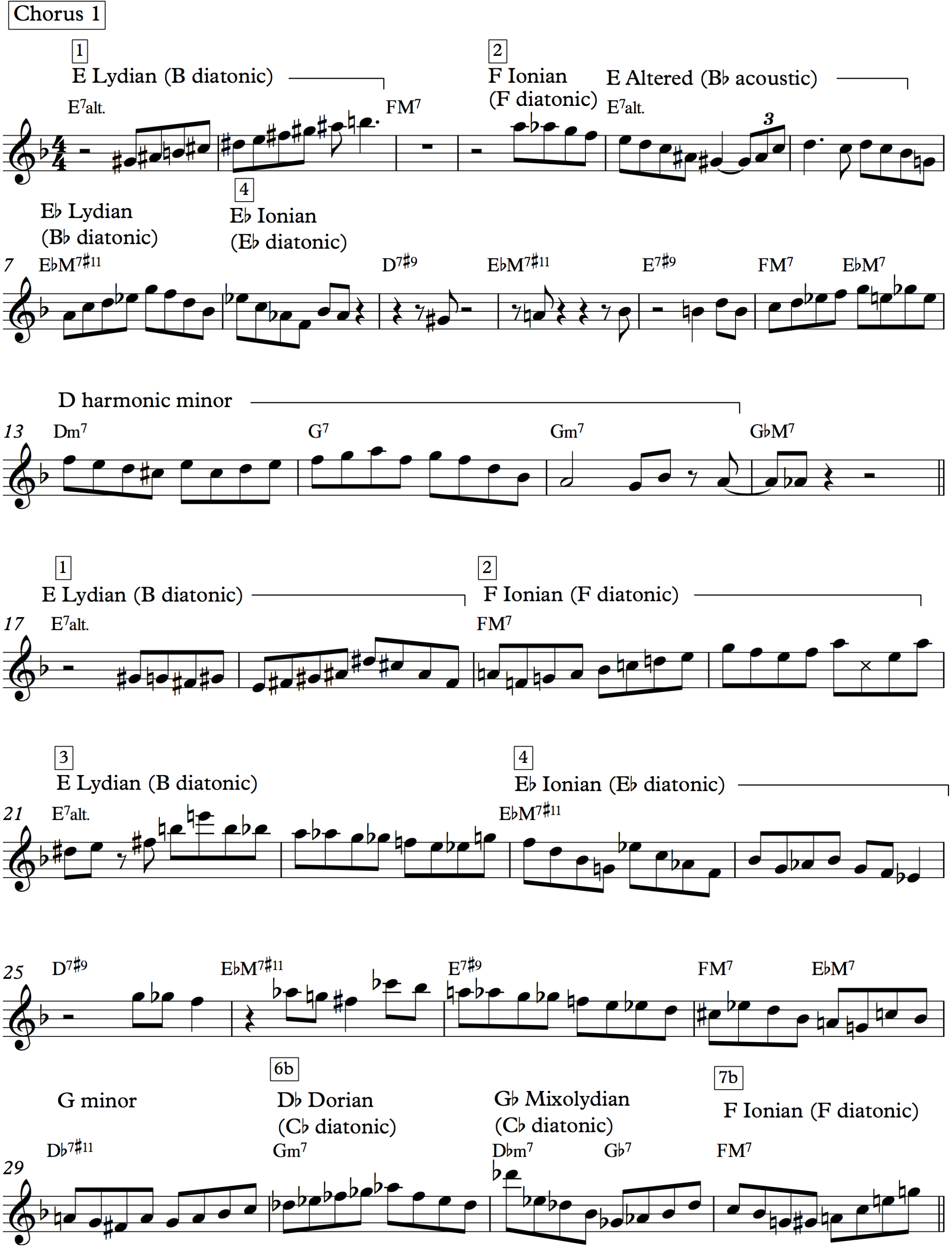
[28] The transcription given here is adapted from Shorter 1995, 28–30. Errors in the source transcription have been corrected and some pitches respelled to clarify the harmonic and melodic relationships.

Shorter's entrance. E Lydian does not even include the D♮ congruent with that chord's dominant seventh. Moreover, his choice appears numerous times throughout the solo; Shorter unambiguously uses E Lydian again in mm. 17–18, suggests it in m. 21 by emphasizing pitches that conflict with E altered (D♯$_5$, F♯$_5$, and B$_5$), states its essential A♯$_5$ in m. 33, and works through a chromatic amalgamation of E Lydian and E altered in mm. 37–38. What Shorter may be doing in these bars is drawing on the alternate FM7 approach in the tune's final two bars, discussed above. Instead of emphasizing the neighboring E altered (B♭ acoustic)–F Ionian (F diatonic) chord-scale relationship, he employs the maximally distant E Lydian (B diatonic)–F Ionian (F diatonic) connection from the tritone substituted ii7–V7 chords in the penultimate bar of the tune. The difference between his scale choice in his solo and the chord scale expressed by the tune is extreme; instead of using one of the scales that maximally intersects with F diatonic, he uses one of the most distant ones.

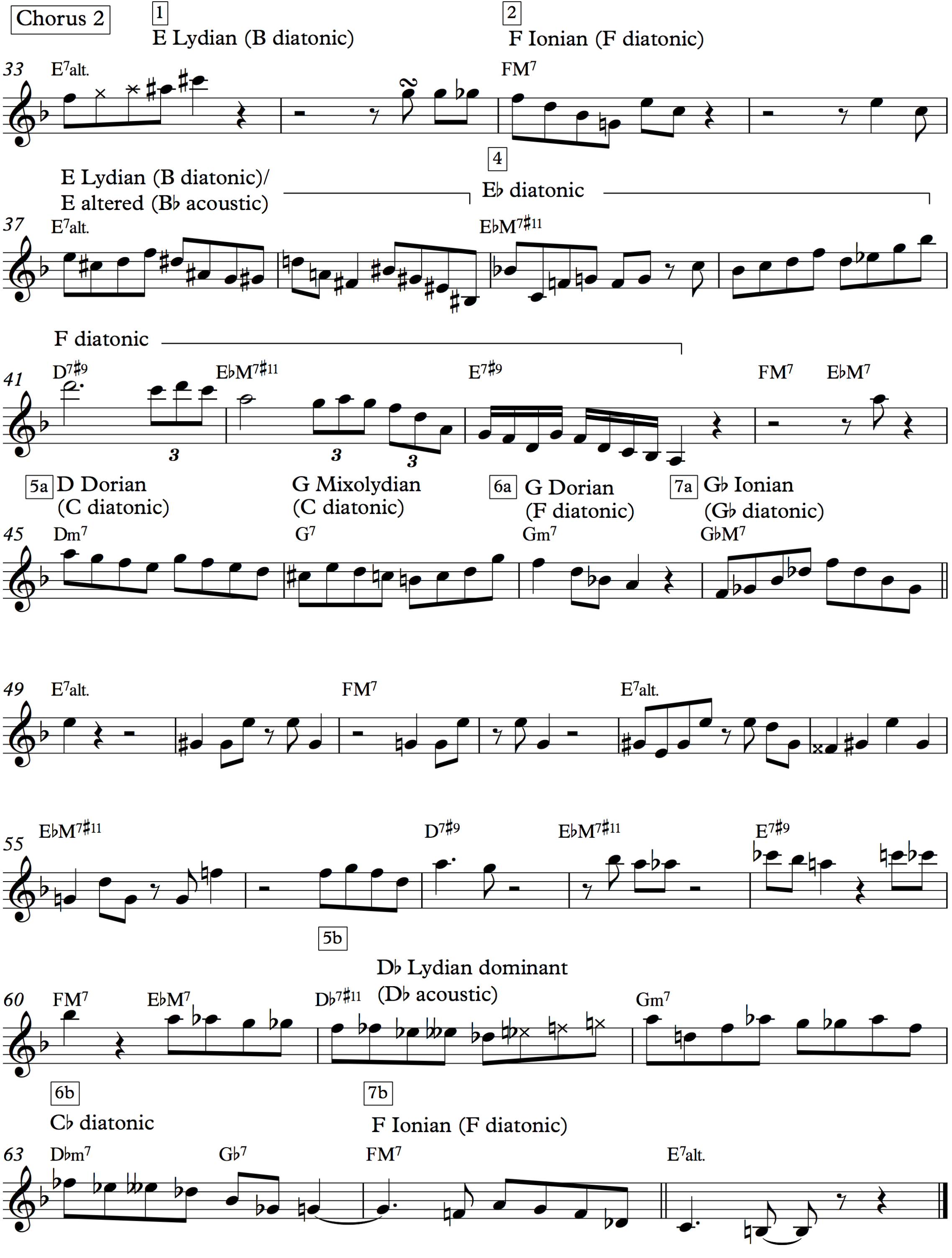
After the arrival of FM7 in m. 3, Shorter performs a brief scalar snippet in the next bar that—barring the A♭$_5$ chromatic passing tone—fits with F Ionian (F diatonic). The first two times m. 3 of the tune returns (mm. 19–20 and 35–6), he clearly uses F Ionian. When E7alt appears in m. 5, Shorter, performs pitches that fit with the E altered (B♭ acoustic) chord scale expressed by the lead sheet. Notably, this is the only time he unambiguously uses the E altered scale that the tune implies so strongly. At first, he converges with the tune's E♭ Lydian (B♭ diatonic) chord scale on the downbeat of m. 7 with A♮$_4$, but in the following measure he overwrites this with E♭ Ionian (E♭ diatonic), with A♭$_4$ sounding twice. In fact, he also uses E♭ Ionian (E♭ diatonic) the second time through this section in mm. 23–24 and avoids A♮'s or A♭'s altogether in this spot in his second chorus (mm. 37–8 and 55–6). Given the interchangeable way musicians tend to treat

Ionian and Lydian scales over major chords, it is not surprising that Shorter did not consider the ♯11 to be an essential chromatic alteration, despite his melody's emphasis on A♮.

EXAMPLE 3 (two pages): Shorter's solo on "E.S.P.," with implied scales indicated


Chorus 1
1
E Lydian (B diatonic)
E7alt.
FM7
2
F Ionian (F diatonic)
E Altered (B♭ acoustic)
E7alt.
3
E♭ Lydian (B♭ diatonic)
4
E♭ Ionian (E♭ diatonic)
7
E♭M7♯11
D7♯9
E♭M7♯11
E7♯9
FM7
E♭M7
D harmonic minor
13
Dm7
G7
Gm7
G♭M7
1
E Lydian (B diatonic)
2
F Ionian (F diatonic)
17
E7alt.
FM7
3
E Lydian (B diatonic)
4
E♭ Ionian (E♭ diatonic)
21
E7alt.
E♭M7♯11
25
D7♯9
E♭M7♯11
E7♯9
FM7
E♭M7
G minor
6b
D♭ Dorian (C♭ diatonic)
G♭ Mixolydian (C♭ diatonic)
7b
F Ionian (F diatonic)
29
D♭7♯11
Gm7
D♭m7
G♭7
FM7

EXAMPLE 3, cont.


Chorus 2
1
E Lydian (B diatonic)
2
F Ionian (F diatonic)
33
E7alt.
FM7
4
E Lydian (B diatonic)/
E altered (B♭ acoustic)
E♭ diatonic
37
E7alt.
E♭M7♯11
F diatonic
41
D7♯9
E♭M7♯11
E7♯9
FM7
E♭M7
3
3
3
5a D Dorian
(C diatonic)
G Mixolydian
(C diatonic)
6a G Dorian
(F diatonic)
7a G♭ Ionian
(G♭ diatonic)
45
Dm7
G7
Gm7
G♭M7
49
E7alt.
FM7
E7alt.
55
E♭M7♯11
D7♯9
E♭M7♯11
E7♯9
5b
D♭ Lydian dominant
(D♭ acoustic)
60
FM7
E♭M7
D♭7♯11
Gm7
6b
C♭ diatonic
7b
F Ionian (F diatonic)
63
D♭m7
G♭7
FM7
E7alt.

Almost every time Shorter moves through the next four bars of the tune's form, he relies on chromaticism and half-step motivic transposition instead of scalar content. In mm. 8–10, he performs a rhythmically unpredictable chromatic ascent that arrives on C_5 with FM7 in m. 12. Given that m. 12 contains two chords, there is not much time for Shorter to express any particular scales, and he tends to continue his general chromatic focus in this bar each time it returns. His second pass through this section (mm. 25–28) features a similar strategy, this time with a three-note chromatic descent that he transposes up by half step twice before abandoning it to pure chromaticism at the end of m. 26. Similarly, his fourth pass (mm. 57–60) features a transposed three-note motive and descending chromatic scale. Across mm. 41–44 (Shorter's third pass through this section), Shorter elects to quote the tune's melody, performing pitches belonging to F diatonic across all four bars and outlining a D-minor pentatonic scale. Overall, Shorter's utterances in his four passes are drawn from other features of the tune such as the chromatically ascending chord roots and the pentatonic melody, rather than any of the chord scales that his chord symbols and melody express.

Shorter approaches the four-bar turnaround of the tune's first ending in similar ways in his two choruses. Beginning with the second chorus (mm. 45–48), Shorter draws on conventional bebop idioms to create a melodic line less focused on scales than on chromatic motions around chord tones. This choice aligns nicely with the functional nature of the chord progression in these measures. Despite Shorter's adoption of bebop style in these measures, his utterances can still be heard to imply chord scales convergent with those expressed by the tune. Measures 45–46 largely contain C diatonic pitches, with a momentary $C\sharp_5$ moving to $C\natural_5$ four pitches later. On the following Gm7 chord, he includes $B\flat_4$, thereby hinting at G Dorian (F diatonic), even if only four of its pitches are stated. The final bar features a G♭M7 arpeggiation, converging with the tune's expression of a G♭ Ionian (G♭ diatonic) chord scale. Shifting back to his first time though this turnaround in mm. 13–16, Shorter performs a similarly bebop-focused line. C♯$_5$ appears again, this time over Dm7 harmony, but is never lowered to C$_5$ as it was in m. 46. Shorter also diverges from the G7 chord in the next bar by stating B♭$_4$ against the chord's B♮. Taken together, he performs all the pitches of a D harmonic minor scale over mm. 13–15. Figure 7 shows where D harmonic minor fits into the chord-scale network, intersecting with B♭ diatonic. Despite his literal statement of D harmonic minor, it is possible to hear similarities with his bebop chromaticism and scale suggestions in the second chorus. The C♯$_5$ can be heard as a chromatic lower neighbor to D and the B♭$_4$ as an anticipation of Gm7 to come in bar 15. Even the final A♭$_4$ in m. 16 hints at the change to G♭ Ionian (G♭ diatonic) more fully stated later. Given the possibility of hearing scales that converge with the chord scales expressed by the tune, Shorter's choices in his second chorus have been indexed on the chord-scale network in Figure 7.

The final missing piece in Shorter's solo is what he plays over the tune's second endings (mm. 29–32 and 61–4).[29] Over the first D♭7$^{\sharp 11}$ chord in m. 29, Shorter diverges significantly from a typical chord-scale expression. While he does emphasize the tune's melodic pitch G$_4$ with surrounding pitches F♯$_4$ and A$_4$, his scalar motive here creates a parallelism with what he played over the Dm7 chord in m. 13, the initial bar of the tune's first ending. His choice of G minor here anticipates the Gm7 chord in the following measure instead of expressing D♭7$^{\sharp 11}$ harmony. Indeed, this harmonic anticipation continues in the next bar when Gm7 arrives. Again, he jumps forward to the next chord, expressing D♭ Dorian (C♭ diatonic) a bar early, then continues with G♭ Mixolydian before resolving the tritone-substituted cadence to F Ionian (F diatonic) in the tune's

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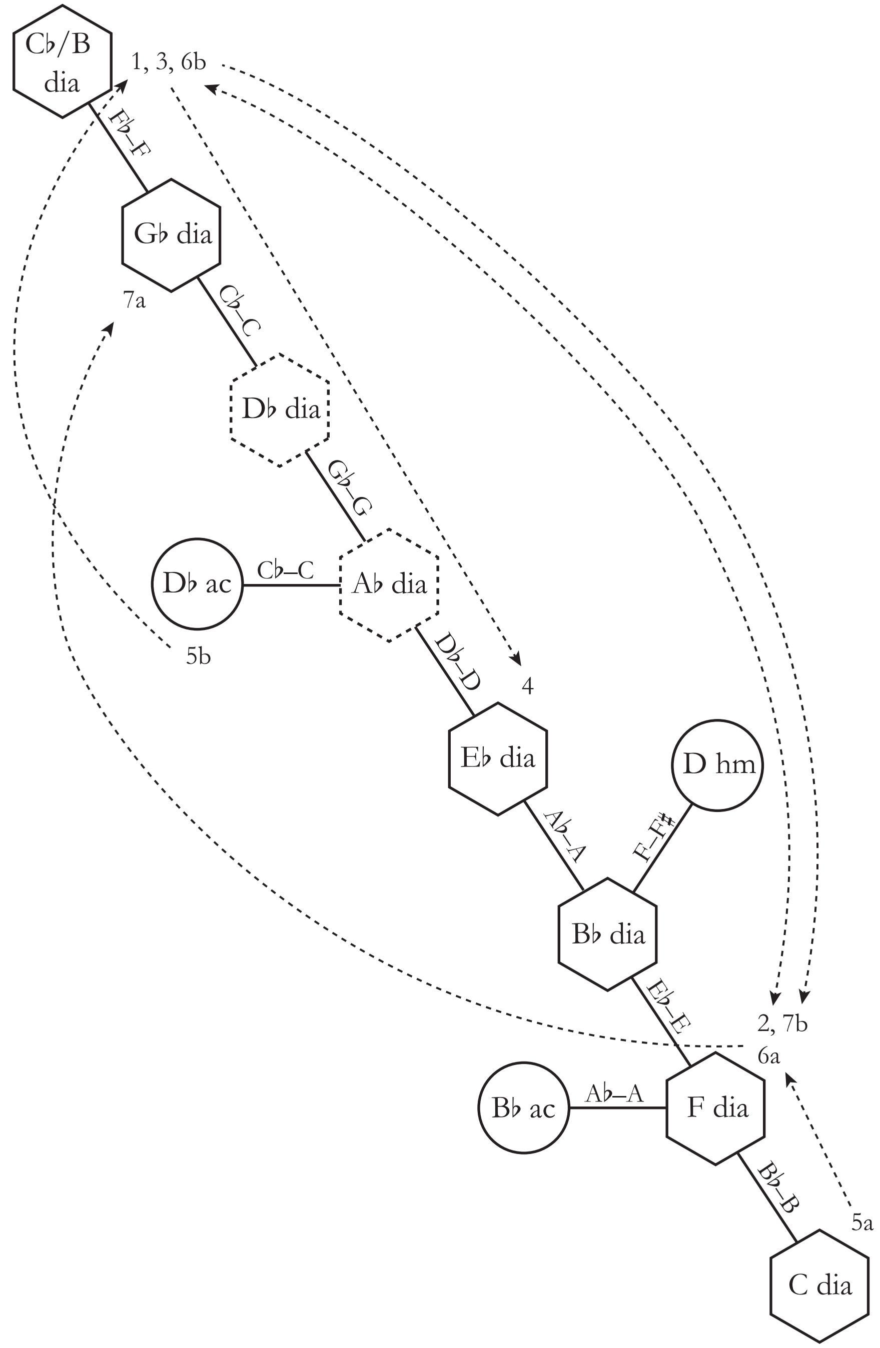
[29] Shorter does not articulate enough pitch classes in mm. 49–56 to make any clear determinations about his scale choices in these bars, so they have been left out of the discussion. Still, most everything he plays does fit with the primary chord scales shown in the network.

FIGURE 7: Scale network for Shorter's solo on "E.S.P."


C♭/B dia
1, 3, 6b
F♭–F
G♭ dia
7a
C♭–C
D♭ dia
G♭–G
D♭ ac
C♭–C
A♭ dia
5b
D♭–D
4
E♭ dia
D hm
A♭–A
F–F♯
B♭ dia
E♭–E
2, 7b
6a
B♭ ac
A♭–A
F dia
B♭–B
5a
C dia

final bar.[30] In m. 61 (the start of Shorter's final pass through the tune's second ending), Shorter performs a line more convergent with the D♭7$^{\sharp 11}$ harmony, though with added chromaticism and imprecisely articulated pitches (notated with "x"-shaped noteheads). Chromaticism dominates the next two measures, but he hints at C♭ diatonic in m. 63. Shorter suggests F Ionian (F diatonic) again in the tune's final bar before spilling over briefly into Davis's following chorus. In his utterances in both of the second endings, Shorter exploits the C♭ diatonic tritone substitute before resolving it to F major. As he does in the first endings, his improvised melody has much more of a bebop sensibility, which corresponds with the functional progressions in these measures. He thus shifts fluidly between bebop and post-bebop styles in correspondence with the functional or nonfunctional nature of the chord progression over which he is improvising.

Focusing now on the scale network, Figure 7 distills Shorter's scale choices to those he uses most consistently. His pathway through the network is marked with numbers that index to the scales indicated on the transcription in Example 3. As mentioned previously, Shorter does not begin with the F diatonic scale's close neighbor B♭ acoustic, but with the maximally distant B diatonic (#1 on Figure 7), which moves to F diatonic (#2) and back (#3). The opening section of his improvisation concludes on E♭ diatonic (#4), a scale that falls between the two and that is notably not the B♭-diatonic chord scale expressed by the tune. Since Shorter mainly relies on motivic processes and chromatic motions instead of scales over mm. 9–12 of the tune, the network breaks off at this point, beginning again with the "a"- and "b"-appended numbers to reflect his scale choices in the first and second endings respectively. Shorter's pathways in the first and second endings more closely follow the tune, with the "a"-appended numbers repeating the journey shown in the tune's network in Figure 6, while the "b"-appended numbers reflect

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[30] Waters notices that Hancock makes a similar harmonic anticipation in his solo improvisation on "E.S.P." (2011, 118).

Shorter's avoidance of F diatonic (#7b) until after he has performed C♭ diatonic (#6b) pitches. Comparing Shorter's solo network (Figure 7) to the network expressed by the tune (Figure 6), it is striking how Shorter assiduously avoids maximally intersecting scales. He returns to F diatonic even more regularly than the tune itself does, but sets C♭/B diatonic against F diatonic through his use of E Lydian (B diatonic) on the E7alt chords and tritone-substituted C♭ diatonic for the final cadence. Instead of emphasizing similarities between chords with roots one half step apart, Shorter focuses on differences, resulting in a remarkably different traversal of the chord-scale network.

"Juju"

The next example, "Juju," shown in Example 4, features harmonies derived from the whole-tone scale. At the center of the chord-scale network shown in Figure 8 lies a circle-of-fifths diatonic zigzag, which is highlighted with thicker lines.[31] In addition to two other diatonic chord scales, each diatonic also intersects with two acoustic scales.[32] (So, for instance, the C diatonic chord scale, which intersects with F and G diatonic, also intersects with F and G acoustic.) This produces an interesting interlocking arrangement such that one may move between C and D diatonic—which are separated by two shifts on the network—through either the G diatonic or G acoustic chord scales. None of the tune's chords actually express any of the acoustic chord scales, however, and therefore Figure 8 shows them in dashed circles, along with unexpressed diatonic chord scales. While Figure 8 displays a two-dimensional subset of the full space, the diatonic chord scales that intersect with each other in the center of the network eventually wrap around, creating a closed, cyclic space. On either side of this central diatonic belt lie six acoustic chord scales whose index pitch classes form a whole-tone scale. The two whole-tone chord scales sit at the top and bottom of the network, and each of those intersects with the six acoustic chord scales on either side of the central diatonic belt.[33]

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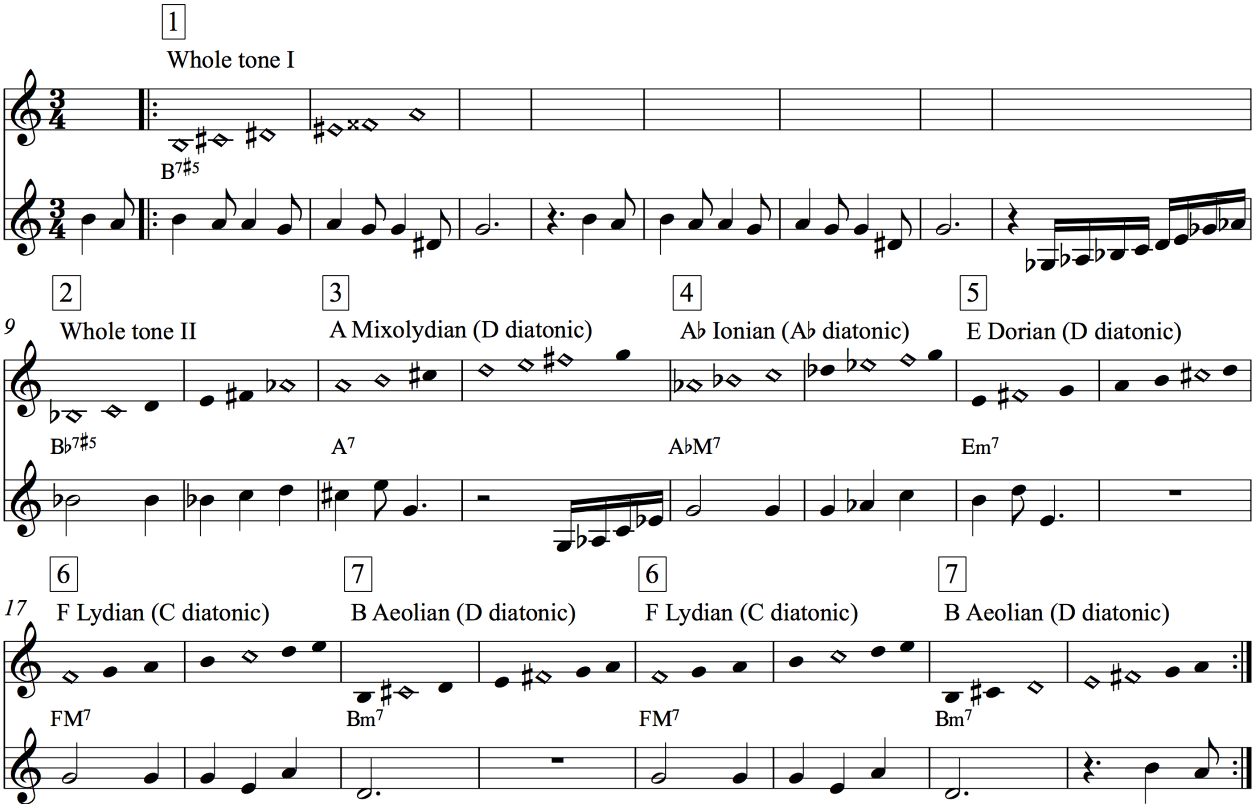
[31] Each diatonic chord scale maximally intersects with four other chord scales, two acoustic and two diatonic. As a result, surrounding hexagons are not used as they were for "E.S.P.", which show the six intersecting chord scales, and instead, circles are used here.

[32] Waters 2005 discusses similar networks involving diatonic and acoustic collections in the music of Herbie Hancock.

EXAMPLE 4: "Juju" lead sheet and chord scales


1
Whole tone I
B7♯5
9
2
Whole tone II
B♭7♯5
3
A Mixolydian (D diatonic)
A7
4
A♭ Ionian (A♭ diatonic)
A♭M7
5
E Dorian (D diatonic)
Em7
17
6
F Lydian (C diatonic)
FM7
7
B Aeolian (D diatonic)
Bm7
6
F Lydian (C diatonic)
FM7
7
B Aeolian (D diatonic)
Bm7

---

[33] Tymoczko uses a similar space in his analysis of Debussy's "Cloches à travers les feuilles" (2004, 269).

"Juju" begins on B7$^{\sharp 5}$, which expresses whole-tone chord scale I (#1 on Figure 8), and sustains it for eight bars.[34] In mm. 9–10, this chord slides down a half step to B♭7$^{\sharp 5}$, thereby shifting to whole-tone chord scale II (#2) at the opposite end of the network. The next chord continues the chromatic root descent with two bars of A7 harmony, creating a three-node move to the chord scale A Mixolydian (D diatonic, #3). One more chromatic slide in the bass brings the harmony to A♭M7 in mm. 13–14, which expresses A♭ Ionian (A♭ diatonic, #4). This two-chord succession, A7–A♭M7, forms a tritone-substituted V7–I7 progression (with A7 substituting for E♭7), and their expressed diatonic chord scales are thus maximally different from one another as discussed above with the tritone substitutions in "E.S.P." In "Juju," this juxtaposition is also thematic in that it parallels the shift between the two maximally dissimilar whole-tone chord scales heard in the tune's opening ten bars. While whole-tone I and II share no pitch classes, D and A♭ diatonic do share G and C♯/D♭, a connection emphasized by the Gs in the melody in mm. 11–14.

The tune breaks the pattern of half-step root descents established thus far by shifting to an Em7 chord in m. 15. E Dorian (D diatonic, #5) is a common chord-scale expression of this chord, which the pianist on the recording, McCoy Tyner, confirms by including F♯s and C♯s in his voicings during the head (hear at 0:26, 0:51, 6:34, and 6:58). This effects a return to D diatonic (#5) following A♭ diatonic (#4), but notably expressed by a different chord from the A7 chord used in mm. 11–12. In so doing, the tune reiterates the importance of D diatonic and reduces the slightly cadential effect of the A7–A♭M7 progression that leads into it.

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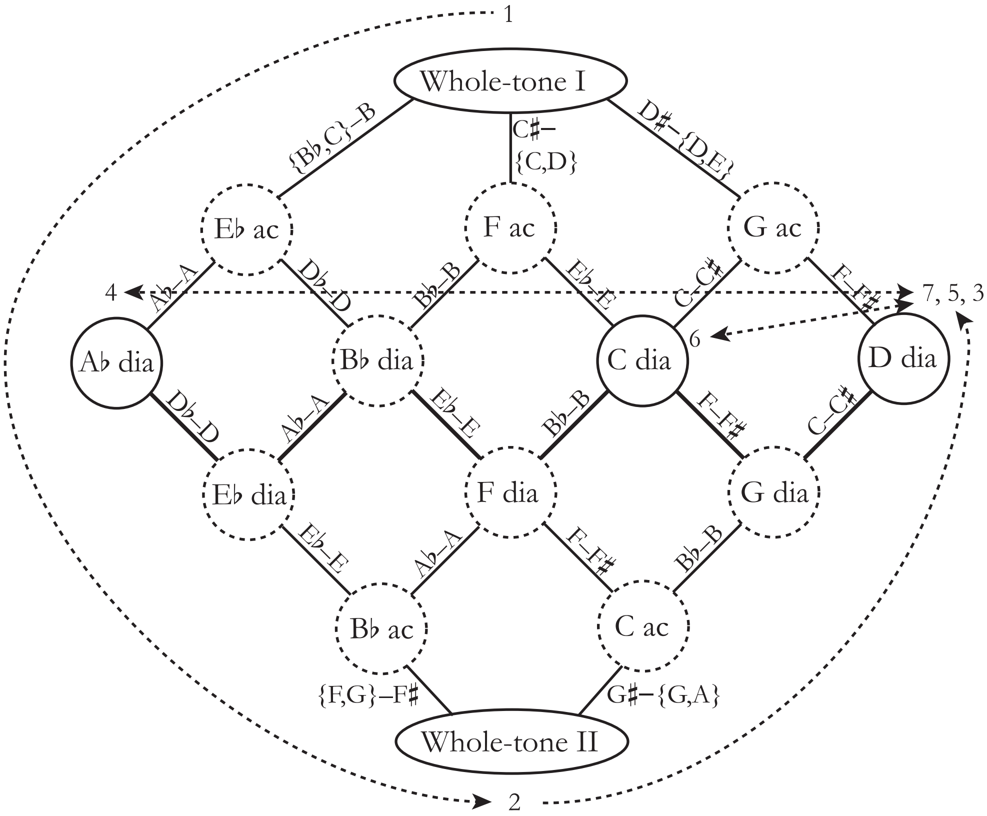
[34] As explained in footnote 18, whole-tone I is the collection that includes the pitch class C♯/D♭ (pitch-class integer 1), while whole-tone II is the collection that includes D (pitch-class integer 2), following Tymoczko (2004, 283–84).

FIGURE 8: “Juju” chord-scale network


1
Whole-tone I
{B♭,C}–B
C♯–{C,D}
D♯–{D,E}
E♭ ac
F ac
G ac
4
A♭–A
D♭–D
B♭–B
E♭–E
C–C♯
F–F♯
7, 5, 3
6
A♭ dia
B♭ dia
C dia
D dia
D♭–D
A♭–A
E♭–E
B♭–B
F–F♯
C–C♯
E♭ dia
F dia
G dia
E♭–E
A♭–A
F–F♯
B♭–B
B♭ ac
C ac
{F,G}–F♯
G♯–{G,A}
Whole-tone II
2

The final eight bars of the tune feature a repeated alternation of two chords, FM7 and Bm7, along with a melody emphasizing pitches from the E minor pentatonic scale. All of the lead-sheet sources for “Juju” (Shorter 1985, 19; Shorter 1995, 58; Strunk 2005, 319) do not indicate any chromatic alteration of the upper extensions for these chords, which would suggest chord-scale expressions of F Ionian (F diatonic) and B Dorian (A diatonic). Both of these expressions are brought into question by the pitches the musicians frequently play, however. In his solo, Shorter almost always performs B♮s over FM7, adding a ♯11 not included in the lead sheet and suggesting F Lydian (C diatonic) instead of F diatonic. Tyner, however, does not perform any prominent B♮s during his four passes through this spot in his solo at 1:16, 1:41, 2:06, and 2:30, instead preferring chords and solo lines emphasizing an A–D–E trichord. Over the Bm7 chord, Shorter and Tyner again diverge. Shorter consistently performs G♮s over the chord, thus projecting B Aeolian (D diatonic) instead of B Dorian (A diatonic). Tyner, however, often includes G♯s in his chord voicings during the solo sections, though not during the head, suggesting B Dorian. Due to these discrepancies between Shorter's and Tyner's utterances, it is likely that the lead sheet from which Tyner learned the tune gave these chords as simply FM7 and Bm7, and Tyner therefore chose F Ionian and B Dorian, the most common choices for those chord symbols absent further clarifying information. It is also likely that Shorter did not mind this variable chord-scale treatment of major- and minor-seventh chords, as musicians commonly use Ionian or Lydian interchangeably for major-seventh chords and Dorian and Aeolian for minor-seventh chords.

It is also clear, though, that Shorter had something specific in mind. Given his consistency in performing B♮s over FM7 and G♮s over Bm7, the chord-scale network in Figure 8 indexes these chords to F Lydian (C diatonic, #6) and B Aeolian (D diatonic, #7). This interpretation privileges his status as the tune's composer even though it is possible that these chord-scale expressions are less likely to be chosen by other musicians (such as Tyner) without specifying certain chromatically altered upper extensions prior to performing. When the chord scale changes from E Dorian (D diatonic, #5) to F Lydian (C diatonic, #6), we find ourselves in a space that lies in between the two chord scales that sounded previously (D diatonic and A♭ diatonic). C diatonic therefore acts as a kind of counterbalance to the extreme juxtapositions heard thus far in the tune: whole-tone I vs. whole-tone II, and D diatonic vs. A♭ diatonic. When the Bm7 chord follows FM7, the tune yet again returns to the D diatonic chord scale (#7), this time expressed by B Aeolian. D diatonic emerges as a central point of emphasis, appearing with the A7, Em7, and Bm7 chords. In total, it appears during eight bars of the tune, equaling the duration of whole tone I at its start, and is also the final chord scale heard before the form repeats. In summary, the tune juxtaposes whole tone I and D diatonic, the two chord scales emphasized through duration and their positions within the tune's form, against their maximally different counterparts whole tone II and A♭ diatonic. The C diatonic chord scale, falling near the middle of the network as whole, helps to bridge the gap between these extremes.

Shorter's scale choices in his solo largely confirm the tune's chord-scale network, with one important difference (Example 5).[35] He performs the relevant whole-tone scales over the B7$^{\sharp 5}$ and B♭7$^{\sharp 5}$ chords in each of his seven choruses, with occasional flurries of chromaticism.[36] His utterances over the succeeding A7 and A♭M7 chords do not fully articulate a complete scale at any given point, but taken together they support the A Mixolydian (D diatonic) and A♭ Ionian (A♭ diatonic) chord scales expressed by the tune. It is with the final chord sequence, Em7–FM7–Bm7–FM7–Bm7, that Shorter often diverges. During his seven passes through the tune's final ten bars, Shorter's improvisation reveals two options. In the first option, heard in mm. 15–24, 39–48, 89–96, and 135–44, Shorter largely converges with the chord scales expressed by the tune: E Dorian (D diatonic), F Lydian (C diatonic), and B Aeolian (D diatonic).[37] In the second option, which appears unambiguously in mm. 63–72, 111–20, and 159–68, Shorter draws on the tune's melody over these bars and uses an E minor pentatonic scale. Shorter clearly expresses the first option only during mm. 39–48, however, with aspects of the second option blending with the first during the other passages. Shorter thus seems to prefer option two to the more chord-scale convergent option one.

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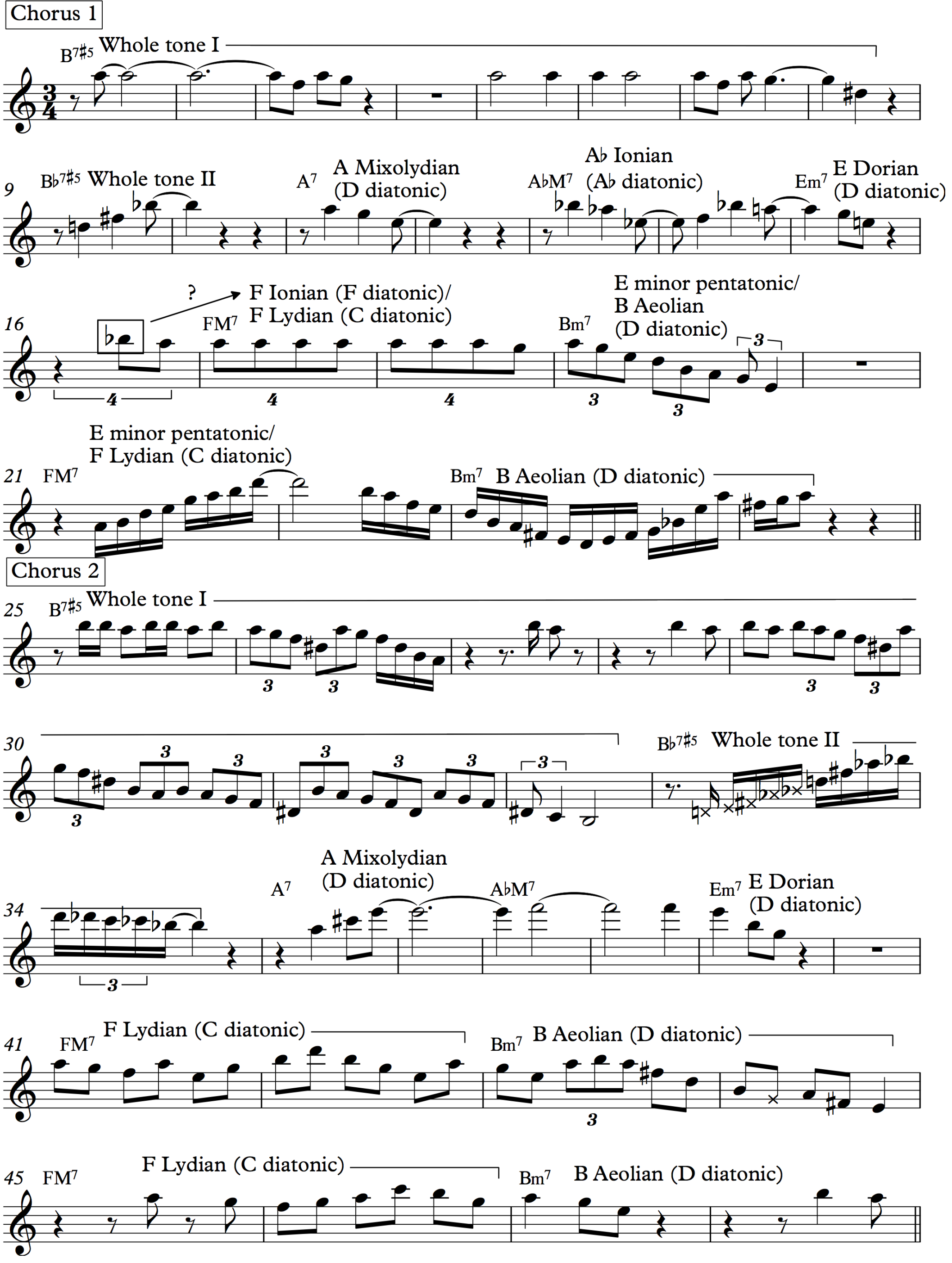
[35] The transcription is roughly adapted from Shorter 1995, 58–62.

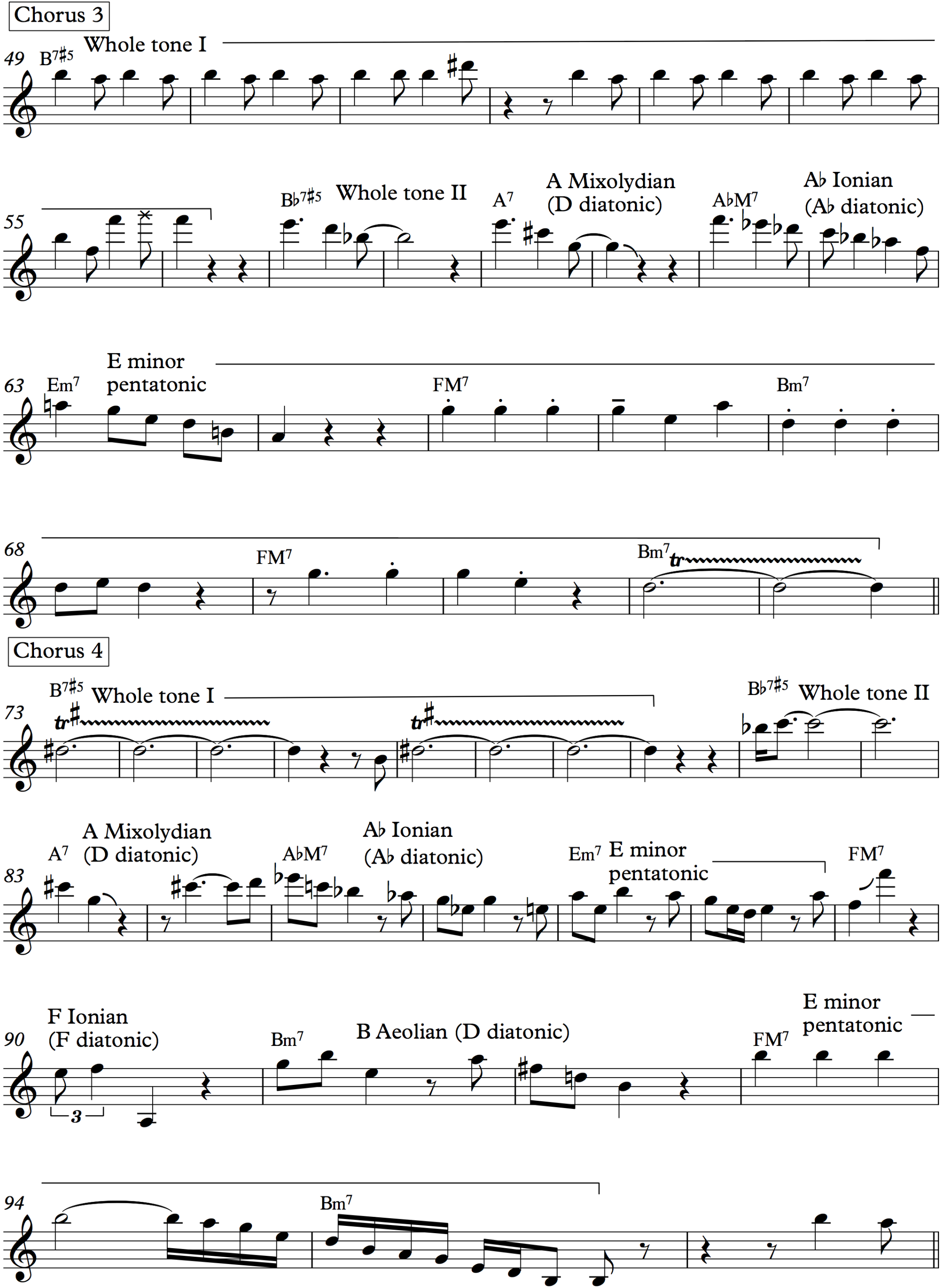
[36] One repetition of the 24-bar tune is equivalent to one chorus. While the musicians perform the melody twice during the initial performance of the tune's head, there are no substantial differences between the two statements that might suggest a 48-bar overall form. Shorter also performs an odd number, seven, of 24-bar choruses, which suggests that the primary formal unit for the tune is 24 bars, not 48.

[37] It is worth noting a couple conflicting pitches Shorter performs in mm. 15–24. In m. 16, he performs a B♭$_5$ over the Em7 chord, perhaps as an anticipation of FM7 to come in the next bar or as a chromatic passing tone. For this reason, both F Ionian and F Lydian are listed as possibilities for mm. 17–18, which on their own only contain the pitches A$_5$ and G$_5$. Additionally, in the midst of a fast run in m. 23 Shorter performs a momentary B♭$_4$ in contradiction of the B Aeolian scale he uses in mm. 23–24.

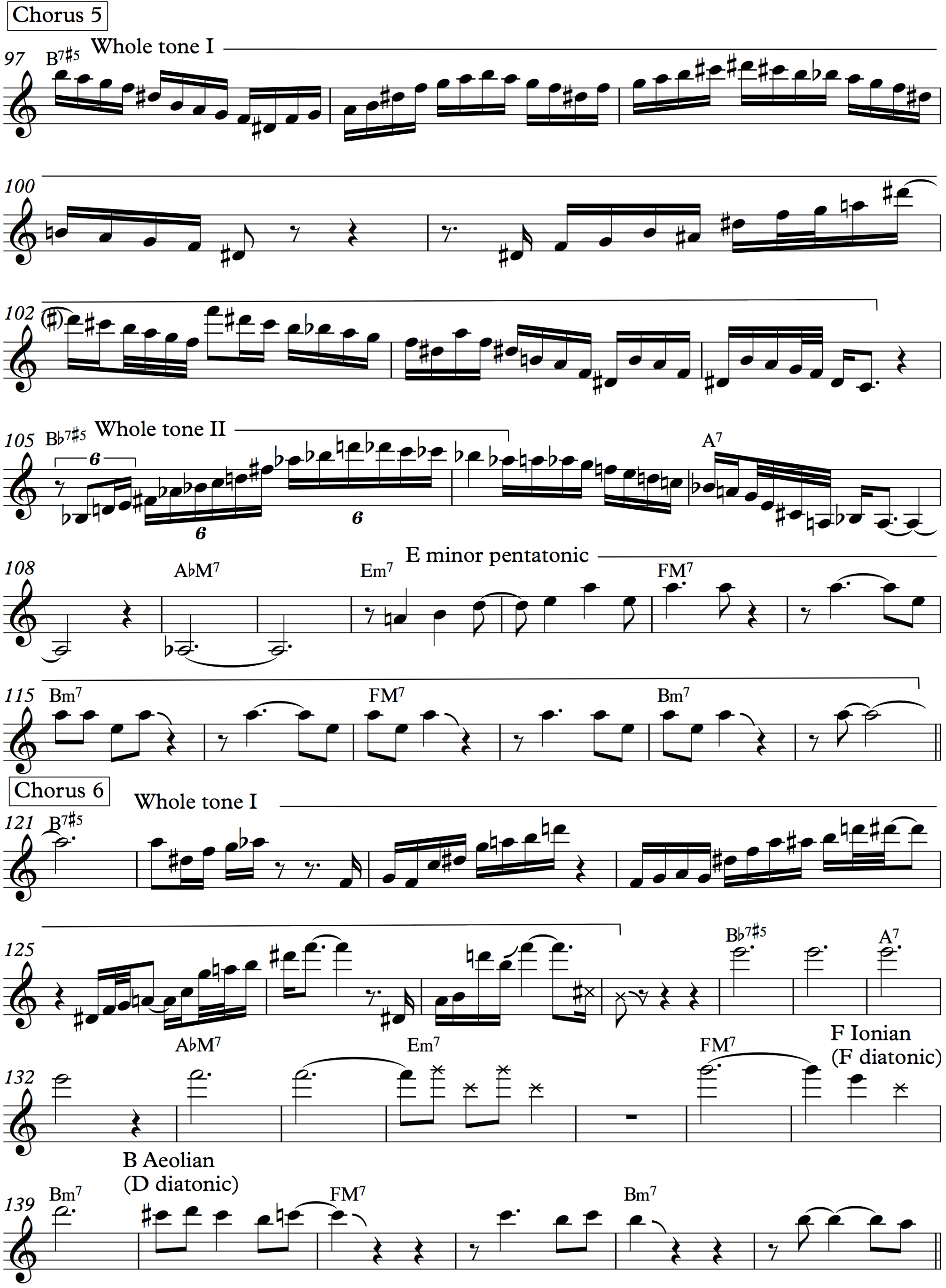
EXAMPLE 5 (four pages): Shorter's solo on "Juju," with implied scales indicated


Chorus 1
B7♯5
Whole tone I
9
B♭7♯5
Whole tone II
A7
A Mixolydian (D diatonic)
A♭M7
A♭ Ionian (A♭ diatonic)
Em7
E Dorian (D diatonic)
16
?
F Ionian (F diatonic)/ F Lydian (C diatonic)
FM7
Bm7
E minor pentatonic/ B Aeolian (D diatonic)
21
FM7
E minor pentatonic/ F Lydian (C diatonic)
Bm7
B Aeolian (D diatonic)
Chorus 2
25
B7♯5
Whole tone I
30
B♭7♯5
Whole tone II
34
A7
A Mixolydian (D diatonic)
A♭M7
Em7
E Dorian (D diatonic)
41
FM7
F Lydian (C diatonic)
Bm7
B Aeolian (D diatonic)
45
FM7
F Lydian (C diatonic)
Bm7
B Aeolian (D diatonic)

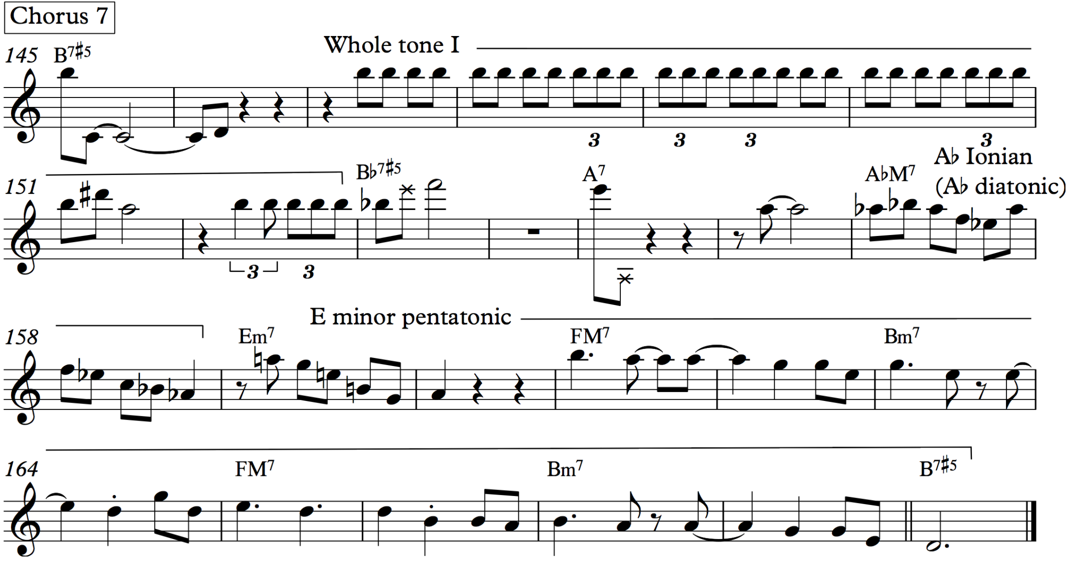
EXAMPLE 5, cont.


Chorus 3
49
B7♯5
Whole tone I
55
B♭7♯5
Whole tone II
A7
A Mixolydian
(D diatonic)
A♭M7
A♭ Ionian
(A♭ diatonic)
63
Em7
E minor
pentatonic
FM7
Bm7
68
FM7
Bm7
tr
Chorus 4
73
B7♯5
Whole tone I
tr♯
tr♯
B♭7♯5
Whole tone II
83
A7
A Mixolydian
(D diatonic)
A♭M7
A♭ Ionian
(A♭ diatonic)
Em7
E minor
pentatonic
FM7
90
F Ionian
(F diatonic)
3
Bm7
B Aeolian (D diatonic)
FM7
E minor
pentatonic
94
Bm7

EXAMPLE 5, cont.

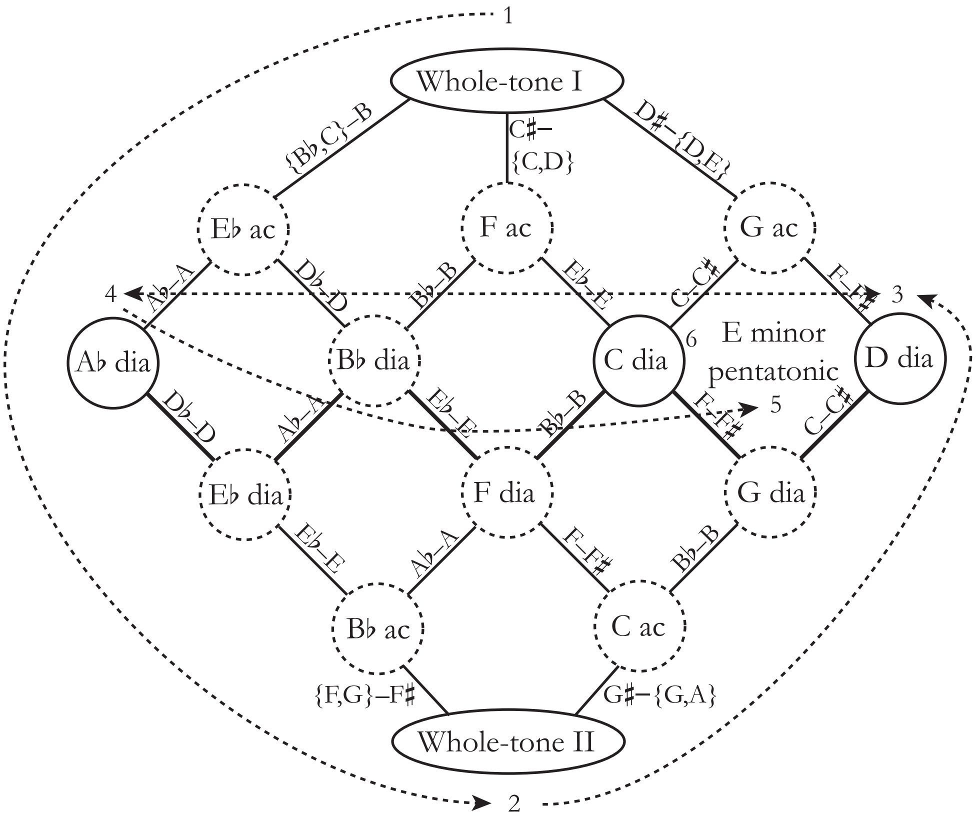

Chorus 5
97
B7♯5
Whole tone I
100
102
105
B♭7♯5
Whole tone II
6
6
6
A7
108
A♭M7
Em7
E minor pentatonic
FM7
115
Bm7
FM7
Bm7
Chorus 6
121
B7♯5
Whole tone I
125
B♭7♯5
A7
132
A♭M7
Em7
FM7
F Ionian
(F diatonic)
139
Bm7
B Aeolian
(D diatonic)
FM7
Bm7

EXAMPLE 5, cont.


Chorus 7
145
B7♯5
Whole tone I
151
B♭7♯5
A7
A♭M7
A♭ Ionian
(A♭ diatonic)
158
Em7
E minor pentatonic
FM7
Bm7
164
FM7
Bm7
B7♯5

Shorter's use of E minor pentatonic is notable beyond its convergence with the tune's melody. The five pitch classes of E minor pentatonic, E-G-A-B-D, are the five pitch classes shared in common by the quartet of intersecting chord scales on the right side of the network. Figure 9 provides a modified pathway through the chord-scale network, with E minor pentatonic appearing in the middle of the far-right diamond—the very path that Shorter takes when he selects option two. By frequently taking this path, Shorter not only references the tune's melody but also bridges the gap between D and C diatonic. In so doing, he finds a way to emphasize similarity in a tune focused on the juxtaposition of maximally different chord scales.

FIGURE 9: Scale network for Shorter's solo on "Juju"


1
Whole-tone I
{B♭,C}–B
C♯–{C,D}
D♯–{D,E}
E♭ ac
F ac
G ac
A♭–A
D♭–D
B♭–B
E♭–E
C–C♯
F–F♯
4
3
A♭ dia
B♭ dia
C dia
6
E minor pentatonic
D dia
D♭–D
A♭–A
E♭–E
B♭–B
F–F♯
5
C–C♯
E♭ dia
F dia
G dia
E♭–E
A♭–A
F–F♯
B♭–B
B♭ ac
C ac
{F,G}–F♯
G♯–{G,A}
Whole-tone II
2

"Iris"

The final Shorter tune this article examines is "Iris." The version of the tune presented in Example 6 is from the Miles Davis Quintet's 1965 album, *E.S.P.* As Keith Waters discusses, the musicians altered "Iris" significantly from Shorter's original copyright deposit during the process of recording (2011, 84–89).[38] While the original version had a 4/4 meter with five-bar phrases, the quintet changed the recorded version's meter to 3/4 and normalized its phrase lengths to four bars. The tune's harmony was also changed significantly, a product of what Waters calls "a calculated effort to suppress the functional harmonic progressions from Shorter's lead sheet" (2011, 87).[39] As a result, "Iris" contains the greatest variety of chord scales and the most ambiguous sense of tonal centricity of the three tunes discussed here.

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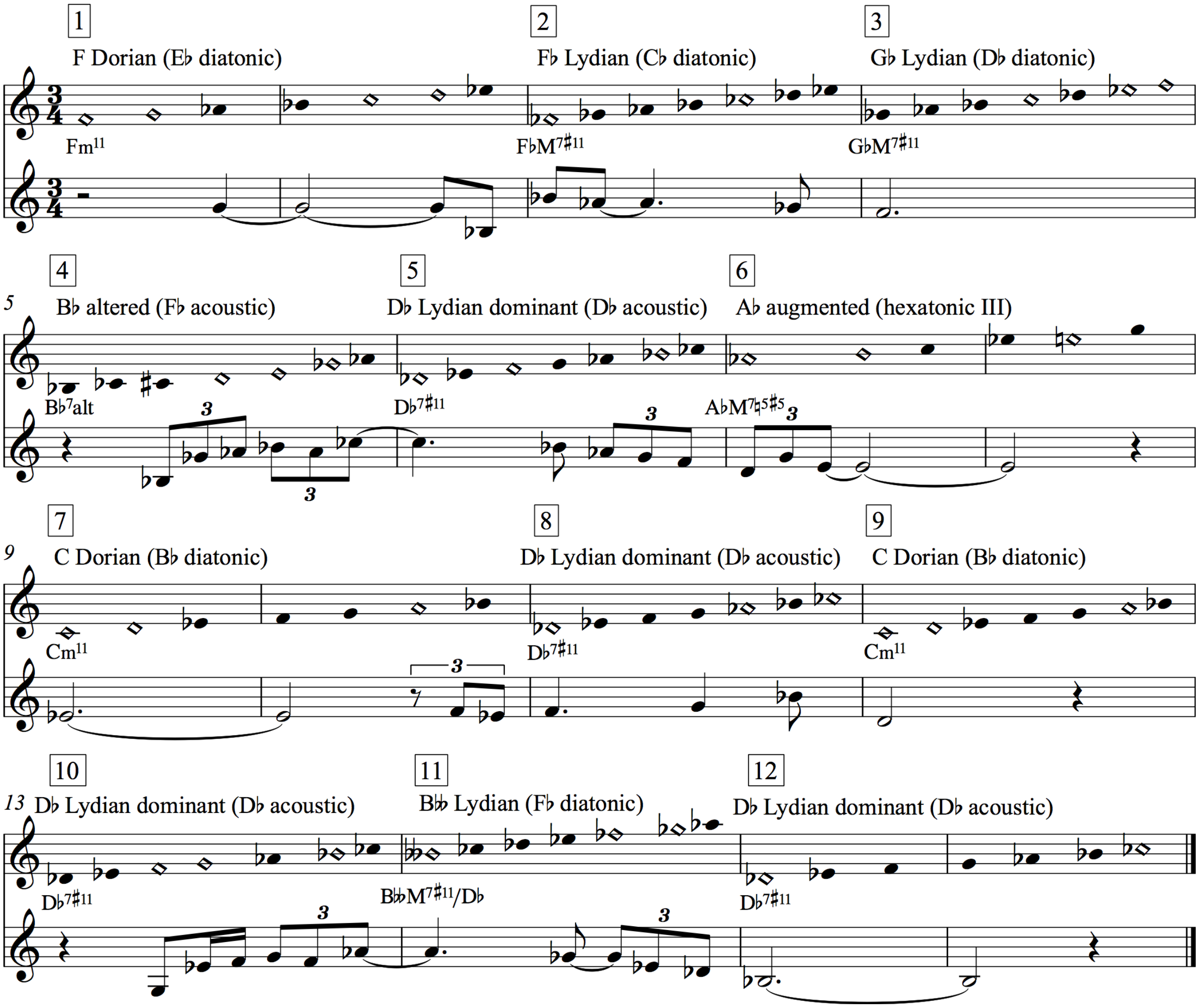
[38] The lead sheet for "Iris" is adapted from Waters 2011, 85. Beyond a handful of enharmonic respellings, the chord symbol in m. 14 has been changed from B♭♭M7/D♭ to B♭♭M7$^{\sharp 11}$/D♭. This change retains E♭ across mm. 13–16 and accounts for that pitch's inclusion in the melody in m. 14. In Shorter's solo to be discussed, he consistently performs E♭s, and never E♭♭s, in this bar, though also with B♭ instead of B♭♭. *The Real Book* 1988, 236 lists D♭m$^{\flat 6}$ as the chord in this bar, an alternate method of notating the same inverted B♭♭M7/D♭ that more strongly implies E♭ in its expressed chord scale.

EXAMPLE 6: "Iris" lead sheet and chord scales


1
F Dorian (E♭ diatonic)
2
F♭ Lydian (C♭ diatonic)
3
G♭ Lydian (D♭ diatonic)
Fm11
F♭M7♯11
G♭M7♯11
4
5
B♭ altered (F♭ acoustic)
5
D♭ Lydian dominant (D♭ acoustic)
6
A♭ augmented (hexatonic III)
B♭7alt
D♭7♯11
A♭M7♮5♯5
7
9
C Dorian (B♭ diatonic)
8
D♭ Lydian dominant (D♭ acoustic)
9
C Dorian (B♭ diatonic)
Cm11
D♭7♯11
Cm11
10
13
D♭ Lydian dominant (D♭ acoustic)
11
B♭♭ Lydian (F♭ diatonic)
12
D♭ Lydian dominant (D♭ acoustic)
D♭7♯11
B♭♭M7♯11/D♭
D♭7♯11

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[39] Henry Martin uses a Schenkerian approach to show how the version of "Iris" from Shorter's copyright deposit more clearly articulates a key than the Miles Davis Quintet's recorded version (forthcoming).

The chord-scale network for “Iris,” shown in Figure 10, is by far the most complex yet. The figure shows a circle-of-fifths spine of diatonic chord scales stretching from B♭ to F♭ diatonic. A few acoustic, harmonic minor (abbreviated as “hm”), and harmonic major (“HM”) chord scales connect to these diatonic ones. As before, chord scales surrounded by dotted circles or hexagons do not appear in the tune, but are included in order to make connections to others that do. In contrast to the “Juju” network just discussed, the network in Figure 10 is built around a chain of diatonic chord scales like the “E.S.P.” network given in Figure 6 and Tymoczko’s network from Figure 3. As a result of the network’s construction, some of the included chord scales appear twice; D♭ acoustic, for instance, connects to both A♭ and G♭ diatonic. Any chord scales that appear twice on the network are given light gray surrounding circles and act like “wormholes” in the network. Follow, for example, the chord-scale succession indicated by the numbers and arrows. Once the tune reaches D♭ acoustic (#10) to the left of A♭ diatonic, the succession picks up to the right of G♭ diatonic to illustrate the closest distance traveled to F♭ diatonic in chord scale 11. This occurs three times, at chord scales 5, 6, and 10. The network also includes a chord scale not yet encountered: A♭ augmented (hexatonic scale III). This chord scale maximally intersects with C, F♭, and A♭ harmonic major and harmonic minor. Only four of these chord scales appear in this region of the overall space, and they are shown connecting to hexatonic III on the right and left sides of the network.

Formally, the tune unfolds in two halves, each of which splits into two four-bar units. Each four-bar unit contains three chords that unfold with a palindromic harmonic rhythm: 2-1-1 1-1-2 (in terms of bars per chord) when paired with its successor (Waters 2011, 89). While the root pitches of the first three chords, Fm^{11}–F♭M7$^{\sharp 11}$–G♭M7$^{\sharp 11}$, chromatically surround F, these chords’ chord-scale representations work through a gap-fill process on the network depicted in

FIGURE 10: “Iris” chord-scale network

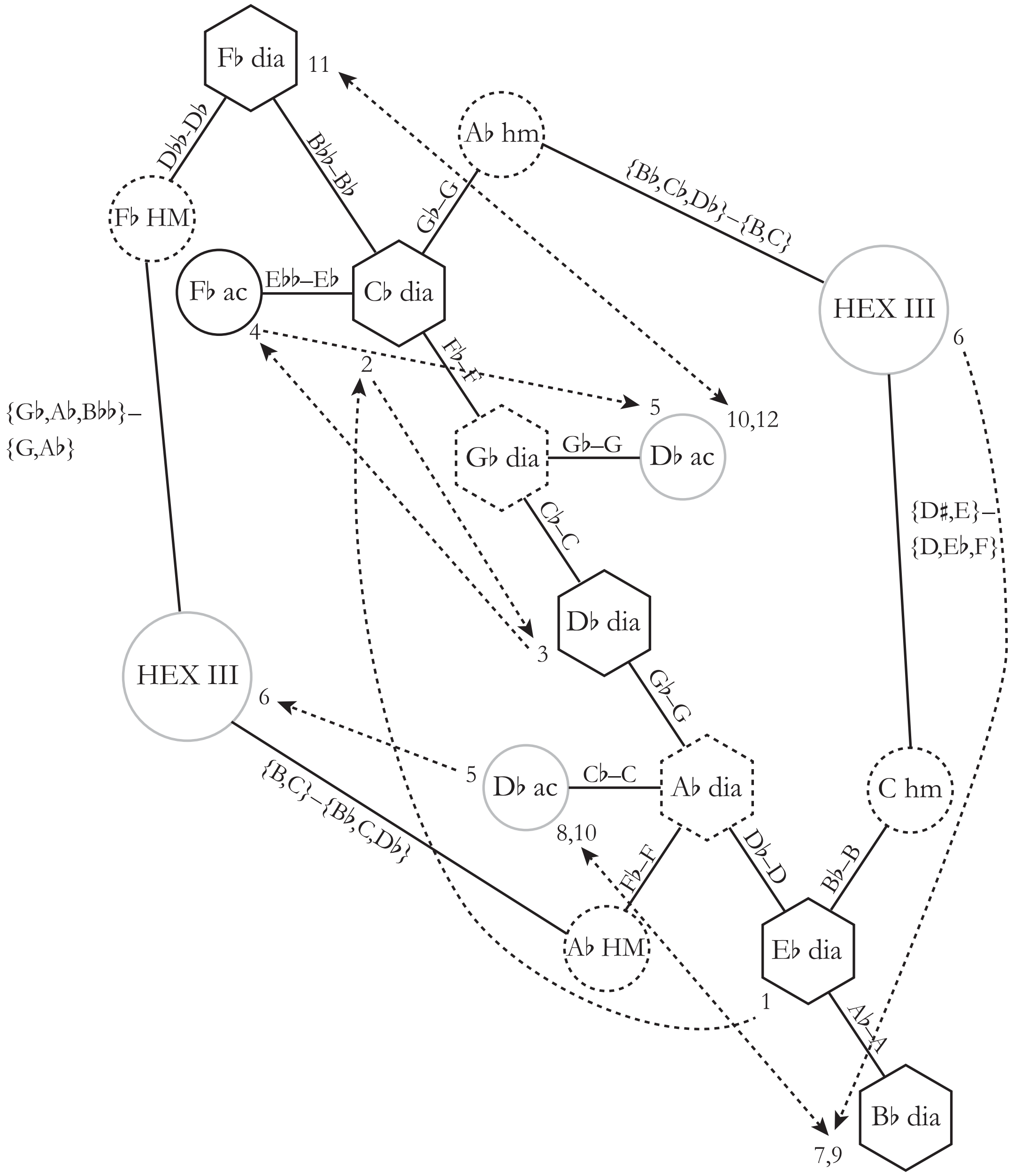
F♭ dia
11
A♭ hm
D♭♭–D♭
B♭♭–B♭
G♭–G
{B♭,C♭,D♭}–{B,C}
F♭ HM
F♭ ac
E♭♭–E♭
C♭ dia
HEX III
6
4
2
F♭–F
5
10,12
{G♭,A♭,B♭♭}–
{G,A♭}
G♭ dia
G♭–G
D♭ ac
C♭–C
{D♯,E}–
{D,E♭,F}
D♭ dia
3
HEX III
6
G♭–G
5
D♭ ac
C♭–C
A♭ dia
C hm
{B,C}–{B♭,C,D♭}
8,10
F♭–F
D♭–D
B♭–B
A♭ HM
E♭ dia
1
A♭–A
B♭ dia
7,9

Figure 10. Following F Dorian (E♭ diatonic, #1 on Figure 10), the tune leaps to distant F♭ Lydian (C♭ diatonic, #2), which is then balanced by the chord scale that falls exactly in between these two, G♭ Lydian (D♭ diatonic, #3). The next four-bar unit moves from B♭7alt to D♭7$^{\sharp 11}$ and then arrives on A♭M7$^{\natural 5\sharp 5}$.[40] The pianist on the recording, Herbie Hancock, plays this chord with the very specific voicing and motivic pattern shown in Example 7 during the opening statement of the tune's melody and often during the solo improvisations. Waters and Williams identify this harmony, along with a few other examples from the 1960s and 1970s, as being based on the hexatonic scale (2010, 2.2), which jazz musicians would refer to in this context as the A♭ augmented scale (Haerle 1980, 35–36).[41] The A♭ augmented chord scale accounts for every pitch in Hancock's voicing, with only B♮ not heard in the chord.[42] Shorter and the other musicians on the record tend to treat this chord quite flexibly in their solo improvisations, but Shorter does use A♭ augmented (hexatonic III) during his solo. In contrast to the focus on diatonic chord scales in the tune's first four bars, the tune shifts in mm. 5–8 between offshoots of the network's central

diatonic trunk: F♭ acoustic (#4), D♭ acoustic (#5), and eventually the region furthest from that trunk, hexatonic III (#6).[43]

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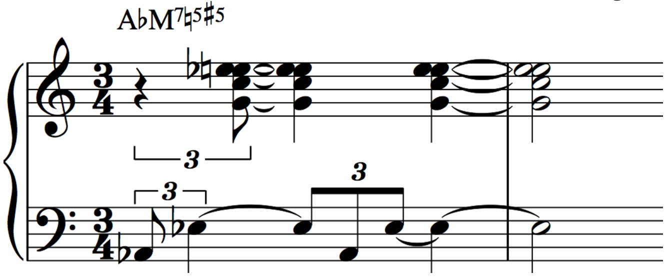
[40] A more conventional way to notate this chord would be A♭M7$^{\flat 6}$. This chord symbol, however, would appear to imply a chord scale of A♭ harmonic major, given that this scale is created by lowering the sixth of a major scale. Perhaps one of the reasons lead-sheet authors (e.g., *The Real Book* 1988, 236 and Waters 2011, 85) tend to use something like A♭M7$^{\natural 5\sharp 5}$ is that by giving the chord an unusual dual-identity fifth, the chord symbol is marked in a way that implies an A♭ augmented (hexatonic III) chord scale more strongly than A♭ harmonic major.

[41] Hexatonic III contains the pitch classes A♭, B, C, E♭, E, and G.

[42] It is also worth noting that the pitch D in the tune's melody that appears at the start of m. 7 contradicts hexatonic scale III. Despite this conflict, the harmony may be construed as expressing hexatonic III for two reasons: First, the D heard at the start of the measure is brief and quickly resolves to E, the more emphasized pitch. Second, Waters's recreation of Shorter's original lead sheet for "Iris" reveals that this segment of the melody remained unchanged through the ensemble's revisions during recording (2011, 85). In Shorter's original, the melody D-G-E in m. 7 was accompanied by a CM7 chord. The change to A♭M7$^{\natural 5\sharp 5}$ was likely instigated by Hancock, whom Waters notes played this chord in the Miles Davis Quintet's well-known 1964 live recording of "My Funny Valentine" (2011, 87).

EXAMPLE 7: Hancock's hexatonic chord voicing in "Iris"



In comparison with the first half, the second half of the tune contains fewer harmonic and chord-scale materials. Cm^{11} begins the third four-bar unit in m. 9, leading to D♭7$^{\sharp 11}$ next in m. 11 as a neighboring chord that returns to Cm^{11} in the following bar. In chord-scale space, this results in C Dorian (B♭ diatonic, #7) shifting to D♭ Lydian dominant (D♭ acoustic, #8) and back (#9). These chord scales return to the lower right side of the network following the movement to the upper left side in the four-bar unit just prior. The final four bars emphasize D♭ by returning to D♭7$^{\sharp 11}$ in m. 13, shifting to B♭♭M7$^{\sharp 11}$ over a D♭ bass pedal, and then returning to D♭7$^{\sharp 11}$. On the network, D♭ Lydian dominant (D♭ acoustic, #10) moves to B♭♭ Lydian (F♭ diatonic, #11) and back (#12). As a result, an analogous relationship between the tune's two halves emerges. Relative to mm. 5–8, mm. 1–4 occupy more of the lower right portion of the network, particularly when considering the two-measures spent on E♭ diatonic. The chord scales in mm. 5–8 (#s 4, 5, and 6) occupy a region of the space near C♭ diatonic, the chord scale furthest from the starting point of E♭ diatonic (#1). The pattern across the second half of "Iris" can be understood analogously—but with exaggeration: the chord scales in mm. 9–12 overshoot E♭ diatonic and reside mostly on the network's lower-right terminus, while the chord scales in mm. 13–16 shift from near the network's midpoint to its upper-left terminus.

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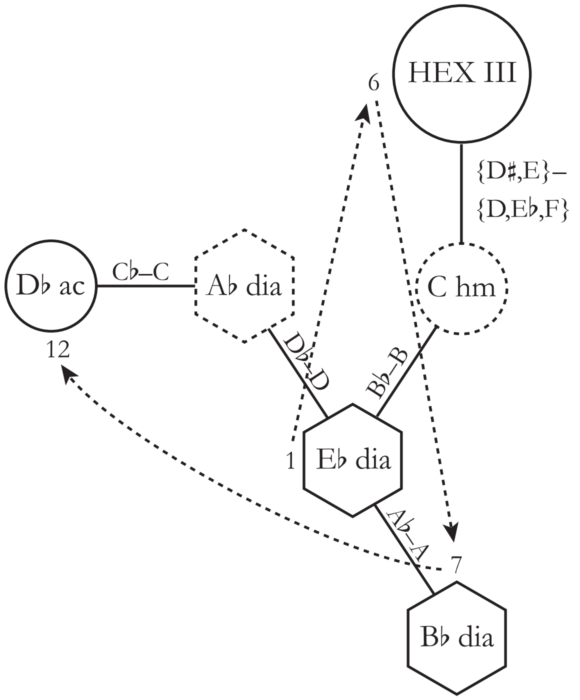
[43] D♭ acoustic and hexatonic III, the two relevant "wormhole" chord scales mentioned earlier, are involved in some intricate network motions during mm. 5–8. Once the tune reaches D♭ acoustic as chord scale #5 to the right of G♭ diatonic, the quickest route to hexatonic III (#6) is actually from its other location in the network, to the left of A♭ diatonic (three nodes vs. four). From hexatonic III (#6) to the first chord scale in m. 9, B♭ diatonic (#7), the quickest path is now from the hexatonic III on the right side of the network, and thus the chord scale numbers leap back and forth across the network in this passage. It is important to note that this results from the two-dimensional rendering of this network given in Figure 10. Higher dimensional representations, such as those presented in Tymoczko 2011, eliminate this wormhole effect.

Scholars have differed regarding the 'key' of "Iris," with Strunk suggesting F minor (2005), Lex Giel advocating E♭ major (2003), and Henry Martin proposing C minor (forthcoming) while Waters maintains that ambiguity reigns (2011). The tune never states any clear ii7–V7–I7 progressions and consistently avoids maximally intersecting regions on the chord-scale network. This prevents any centricity from arising through conventional tonal progressions or neighboring relationships. To focus more closely on the issue of chord-scale centricity, Figure 11 gives a reduction of the tune's harmonies to four essential chord scales. The figure keeps the index numbers consistent with the full network shown in Figure 10. These chord scales have the longest durations in the tune at two bars each and frame each of the tune's halves: E♭ diatonic in mm. 1–2 (#1), hexatonic III in mm. 7–8 (#6), B♭ diatonic in mm. 9–10 (#7), and D♭ acoustic in mm. 15–16 (#12). The tune's two eight-bar halves consist of an initial presentation of a diatonic chord scale followed by motion to a non-diatonic region. E♭ diatonic lies in the center of the network and acts as a central hub. As the hypermetrically emphasized chord scales, E♭ and B♭ diatonic are set apart as the two neighboring chord scales, creating an axis set apart from the non-diatonic regions. The differences between key identifications revolves around these two chord scales; Giel hears a highly chromaticized ii7–V7–I7 in E♭ major in the first four bars (2004), while Strunk orients the tune around the opening Fm^{11} chord (2005). These two possibilities both express E♭ diatonic chord scales. Martin provocatively gives precedence to the Cm^{11} chord that begins the tune's second half through the concept of "prolongation by arrival" (forthcoming). Given these three distinct readings, Waters's emphasis on ambiguity is certainly apt (2011). But viewing the tune from the perspective of a chord-scale network reveals a simpler structure. Hearing E♭ diatonic as the center around which the other chord scales revolve ends up encompassing the readings of both Giel and Strunk. As the central chord scale, E♭ diatonic has the capacity to express both the Fm11 chord privileged by Strunk and the imagined E♭M7 chord proposed by Giel. To be sure, key areas and emphasized chord scales are two very different things, but even so the capacity for E♭ diatonic to operate as a background macroharmony goes some way towards unifying the disparate interpretations.

FIGURE 11: "Iris" chord-scale network reduction



In contrast to "E.S.P." and "Juju," the musicians use a different form and harmonic structure for their solo improvisations on "Iris" compared to their head statements. Example 8 gives the chord changes the musicians follow during their solos. The biggest change is that after one largely similar chorus, they cut each chord's duration in half and add one extra bar to produce a nine-bar half chorus.[44] The one additional change is that the musicians add an extra chord, D7$^{\flat 9}$/D♭, to the final bar of each full and half chorus.[45] This very unusual chord symbol is produced by Hancock performing a D major triad with added ♭9 (E♭) while Carter continues the D♭ pedal that spans the last four bars of the tune, producing a markedly chromatic D♭-D-E♭ juxtaposition. During their solos, the musicians either ignore any specific chord-scale expressions of the chord symbol or they base their utterances off of the D7$^{\flat 9}$ portion, such as during Hancock's solo at 5:34 and 6:20. At these locations in particular Hancock reveals the octatonic basis of this chord, which jazz musicians typically refer to as the D diminished half-whole scale (octatonic II). Shorter tends to ignore the chord, either by continuing with utterances based on D♭7$^{\sharp 11}$or by anticipating the following Fm^{11} chord. As a result, no chord-scale representation for this chord symbol appears on the network, given its ambiguity and small overall impact.

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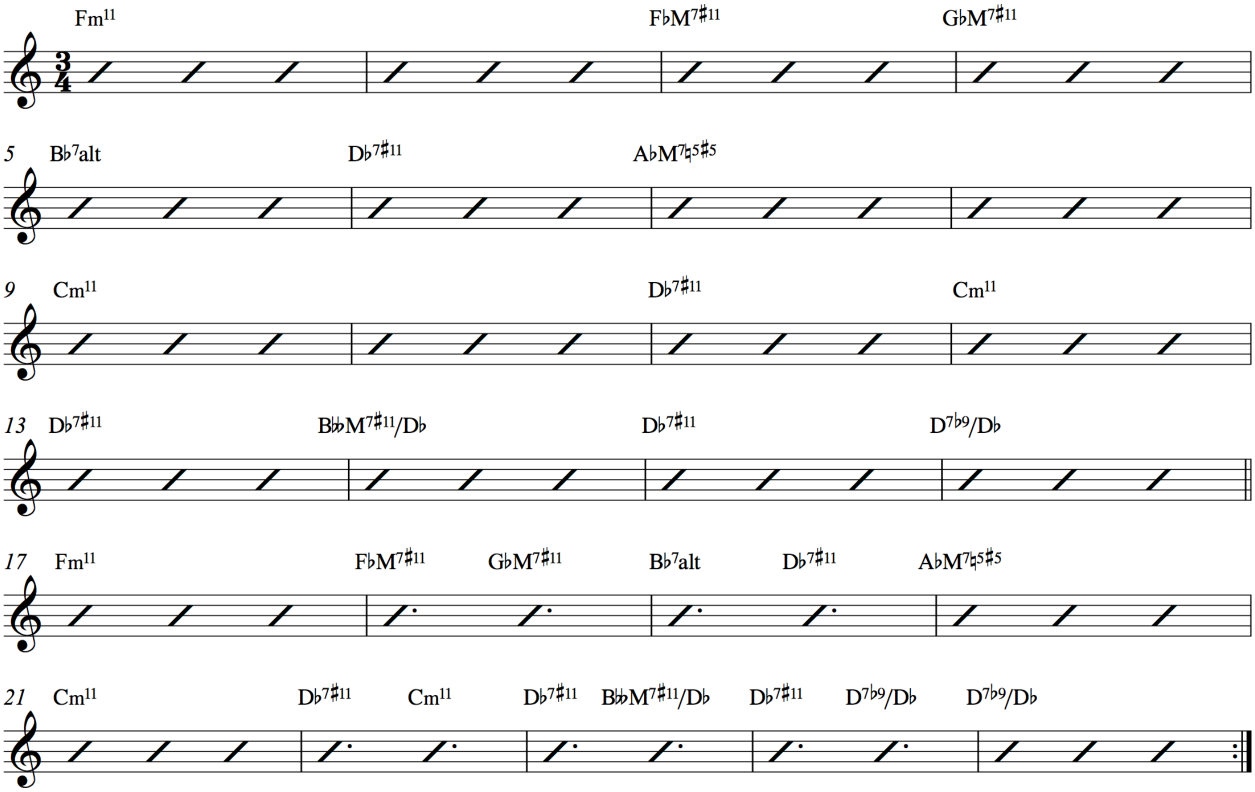
[44] The example is adapted from Waters 2011, 86.

[45] In contrast to Waters 2011, this chord is identified here as D7$^{\flat 9}$/D♭, not D$^{(\flat 9)}$/D♭. This article argues that chord symbols offer musicians a field of possibility when selecting pitches for chords or melodic lines, and it is very likely that, should a musician choose to add a seventh to this chord, he or she would choose a dominant seventh instead of a major seventh. This is the norm when adding ♭9 alterations to chords in order to avoid the consecutive half steps that would result from including a major seventh. Carter's D♭ bass pedal produces these consecutive half steps either way, which suggests that the chord symbol D$^{(\flat 9)}$/D♭ indicates less of a field of possibility than a description of what Hancock performs on the recording. This is likely what Waters intended by his choice of D$^{(\flat 9)}$/D♭.

EXAMPLE 8: Solo form for "Iris"


Fm11
F♭M7♯11
G♭M7♯11
5
B♭7alt
D♭7♯11
A♭M7♮5♯5
9
Cm11
D♭7♯11
Cm11
13
D♭7♯11
B♭♭M7♯11/D♭
D♭7♯11
D7♭9/D♭
17
Fm11
F♭M7♯11
G♭M7♯11
B♭7alt
D♭7♯11
A♭M7♮5♯5
21
Cm11
D♭7♯11
Cm11
D♭7♯11
B♭♭M7♯11/D♭
D♭7♯11
D7♭9/D♭
D7♭9/D♭

Shorter's solo on "Iris," transcribed in Example 9, reveals an elegantly simple path through the more baroque network expressed by the tune's chord symbols.[46] On first glance, Shorter does not seem to construct his solo from scales. Instead, he crafts subtle motivic connections and engages in complex rhythmic and metric interplay, as Waters's analysis reveals (2011, 90–5). When considering his utterances across many chords and measures, however, Shorter smooths over the fine details inscribed in the chord changes and summarizes them concisely. Rather than proceeding from beginning to end, the following analysis connects his pitch choices across choruses in order to reveal a simplified underlying network of scales.

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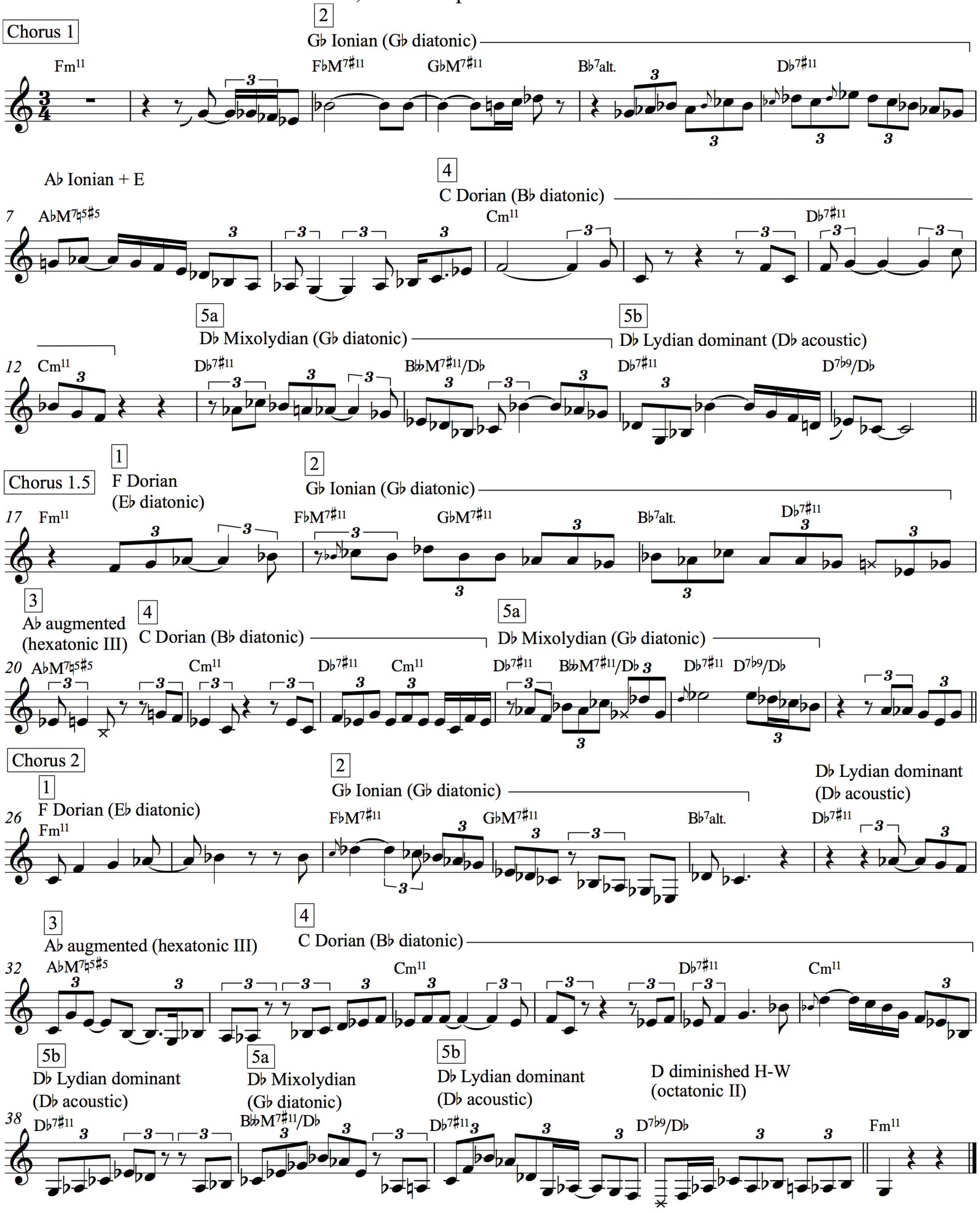
[46] The transcription is adapted from Waters 2011, 90–91.

EXAMPLE 9: Shorter's solo on "Iris," with implied scales indicated


Chorus 1
2
G♭ Ionian (G♭ diatonic)
Fm11
F♭M7♯11
G♭M7♯11
B♭7alt.
D♭7♯11
A♭ Ionian + E
4
C Dorian (B♭ diatonic)
7
A♭M7♮5♯5
Cm11
D♭7♯11
5a
D♭ Mixolydian (G♭ diatonic)
5b
D♭ Lydian dominant (D♭ acoustic)
12
Cm11
D♭7♯11
B♭♭M7♯11/D♭
D♭7♯11
D7♭9/D♭
Chorus 1.5
1
F Dorian
(E♭ diatonic)
2
G♭ Ionian (G♭ diatonic)
17
Fm11
F♭M7♯11
G♭M7♯11
B♭7alt.
D♭7♯11
3
A♭ augmented
(hexatonic III)
4
C Dorian (B♭ diatonic)
5a
D♭ Mixolydian (G♭ diatonic)
20
A♭M7♮5♯5
Cm11
D♭7♯11
Cm11
D♭7♯11
B♭♭M7♯11/D♭
D♭7♯11
D7♭9/D♭
Chorus 2
1
F Dorian (E♭ diatonic)
2
G♭ Ionian (G♭ diatonic)
D♭ Lydian dominant
(D♭ acoustic)
26
Fm11
F♭M7♯11
G♭M7♯11
B♭7alt.
D♭7♯11
3
A♭ augmented (hexatonic III)
4
C Dorian (B♭ diatonic)
32
A♭M7♮5♯5
Cm11
D♭7♯11
Cm11
5b
D♭ Lydian dominant
(D♭ acoustic)
5a
D♭ Mixolydian
(G♭ diatonic)
5b
D♭ Lydian dominant
(D♭ acoustic)
D diminished H-W
(octatonic II)
38
D♭7♯11
B♭♭M7♯11/D♭
D♭7♯11
D7♭9/D♭
Fm11

While he remains silent through most of the Fm^{11} chord in his first chorus, Shorter unequivocally selects pitches in line with F Dorian (E♭ diatonic) over this chord in chorus 1.5 (the half chorus following chorus 1) and chorus 2. For the F♭M7$^{\sharp 11}$–G♭M7$^{\sharp 11}$–B♭7alt–D♭7$^{\sharp 11}$ succession that occurs next, however, Shorter does not follow the chord-scale network's intricate motions. Instead, he performs the pitches of G♭ Ionian (G♭ diatonic), while deftly avoiding the portions of the chord scale that conflict with any particular chord at any time.[47] G♭ diatonic is a remarkable choice because this scale, which is not expressed by any chord symbols in the tune itself, directly neighbors three that do (C♭ diatonic, D♭ diatonic, and D♭ acoustic), and is only two nodes removed from the fourth chord scale expressed in these bars: F♭ acoustic. Shorter thus elegantly abstracts the tune's complexity with this choice, finding the one scale that has the most in common with them all. In his three passes through the A♭M7$^{\natural 5\sharp 5}$ chord, Shorter gradually works his way towards stating nearly the entire A♭ augmented (hexatonic III) scale. In mm. 7–8, he avoids the scale's augmented second and instead performs A♭ Ionian with added raised fifth (E♮$_4$). With the chord's next appearance in m. 20, Shorter performs the chord's quintessential natural and raised fifths (E♭$_4$ and E♮$_4$) before leaping down to B$_3$, the only hexatonic III pitch missing from Hancock's chord voicing (Example 7).[48] It is with his final pass in mm. 32–33 that Shorter presents the A♭ augmented (hexatonic III) scale in a relatively unadulterated fashion.

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[47] Shorter actually never performs an F or F♭ in any of his three passes through mm. 3–6 of the tune's form, making a precise identification of G♭ diatonic versus C♭ diatonic difficult. G♭ diatonic has been selected for three reasons. First, Shorter tends to emphasize members of the G♭-major triad in these bars, thus suggesting G♭ Ionian. Second, G♭ diatonic is an ideal in-between choice for the four chords that appear in these bars, not exactly fitting with any but being one or two pitches off of all. Third, Shorter returns to G♭ diatonic, this time as D♭ Mixolydian, in mm. 13–16 of the tune, and does state a clarifying F$_4$ in m. 23 of his solo. This return to G♭ diatonic is in keeping with his focus on simplifying the tune's pitch materials from its more complex surface.

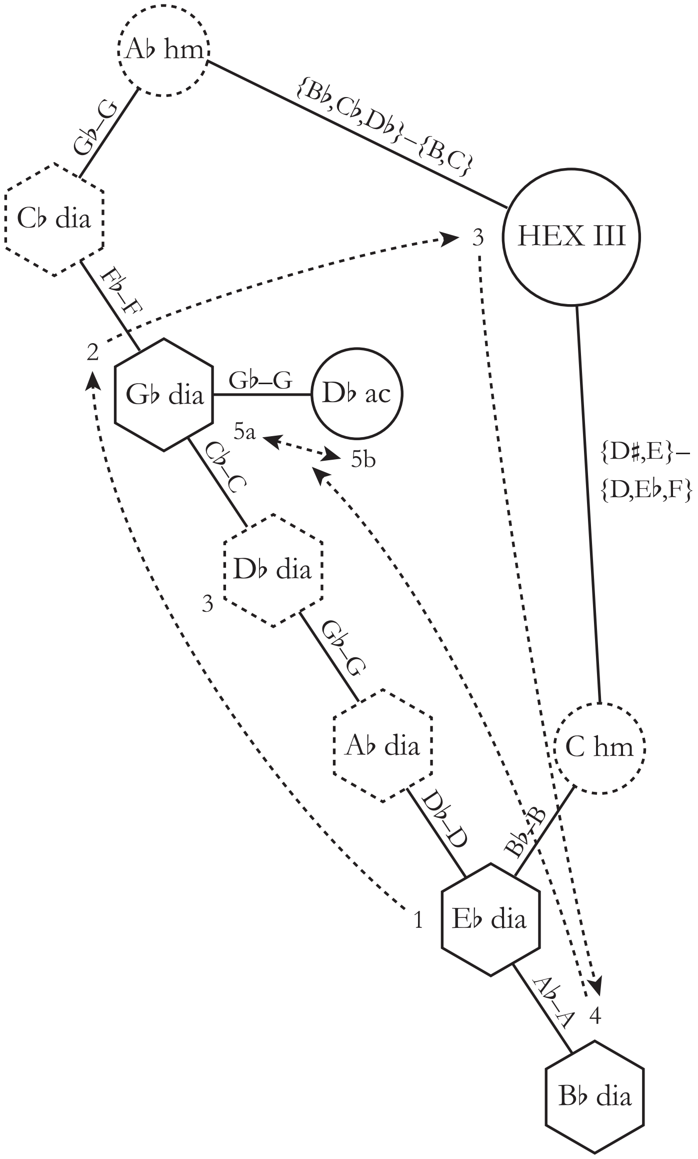
[48] Waters's transcription (2011, 90) gives this pitch as B♭$_3$ with a "+" sign below, indicating its imprecise intonation. The pitch more clearly sounds as a "low" B$_3$ than a "high" B♭$_3$, however.

While Shorter and the other musicians do approach this unusual harmony from other angles, Shorter’s final utterance over it offers strong evidence for the chord’s hexatonic basis.

In the tune’s second half, Shorter continues to find simplified pathways through the chord-scale network. He consistently performs pitches from C Dorian (B♭ diatonic) over the chords in the mm. 9–12 of the tune, Cm^{11}–D♭7$^{\sharp 11}$–Cm^{11}, mostly ignoring the D♭7$^{\sharp 11}$ neighboring chord. For the tune’s final four bars, Shorter shifts between two options (labeled as chord scales 5a and 5b in his solo network, discussed below): D♭ Mixolydian (G♭ diatonic) and D♭ Lydian dominant (D♭ acoustic). His choice of D♭ Mixolydian is particularly noteworthy because it does not contain the signature G♮ of the D♭7$^{\sharp 11}$chord in mm. 13, 15, and 16 of the tune, and it conflicts pointedly with the B♭♭M7$^{\sharp 11}$/D♭ in m. 14. When considering his use of G♭ Ionian (G♭ diatonic) as a summary of neighboring chord scales in mm. 3–6, however, returning to G♭ diatonic, now expressed by the D♭ Mixolydian mode, provides a further distillation and simplification of chord-scale materials. In mm. 13–16 of his solo, Shorter begins with D♭ Mixolydian (G♭ diatonic) over the first two bars, and then shifts to D♭ Lydian dominant (D♭ acoustic) for the second two. Due to the diminution in harmonic rhythm in chorus 1.5, Shorter uses G♭ diatonic pitches across all of these chords in mm. 23–24. In his final pass, Shorter reserves G♭ diatonic for the B♭♭M7$^{\sharp 11}$/D♭ chord and mainly uses D♭ acoustic on the D♭7$^{\sharp 11}$ chords. G♭ diatonic and D♭ acoustic are neighboring chord scales in the network, producing only a minor shift.

Figure 12 summarizes the foregoing discussion with a chord-scale network for Shorter’s solo. This network, clearly much simpler than the one given for the tune in Figure 10, reveals how extensively Shorter reduced the scale materials for his solo. In fact, Shorter’s solo network coincides almost exactly with the network reduction given in Figure 11, with the G♭ diatonic chord scale added as a waypoint en route from hexatonic III to D♭ acoustic. Shorter’s predilection for finding a simpler route through the "Iris" network brings to mind his use of the pentatonic scale as an in-between option in his solo over "Juju." This practice also presents an affinity with Shorter's compositional approach, in which he pairs complex, nonfunctional harmonies with simple, tuneful melodies. The tension between simplicity and complexity is central to his compositions and improvisations, as these chord-scale networks reveal.

FIGURE 12: Scale network for Shorter's solo on "Iris"


A♭ hm
{B♭,C♭,D♭}–{B,C}
G♭–G
C♭ dia
3
HEX III
F♭–F
2
G♭ dia
G♭–G
D♭ ac
5a
5b
{D♯,E}–
{D,E♭,F}
C♭–C
D♭ dia
3
G♭–G
A♭ dia
C hm
D♭–D
B♭–B
1
E♭ dia
A♭–A
4
B♭ dia

CONCLUSION

As jazz musicians and composers moved further and further from functional harmonic tonality that dominated jazz before the 1960s, a number of practical questions arose. If chords no longer progressed in functional ways, how could the *lingua franca* of bebop be applied to it? If the seventh chord was no longer the basis of most harmony, what would take its place? Would post bop continue to be represented by the lead sheet, a notational structure designed around functional tertian harmony, given its inadequacy at representing certain aspects of this music? As a practical solution, chord-scale theory provided answers to these questions: instead of stock bebop licks and phrases, musicians could think in terms of scales; as soon as extensions up to the thirteenth were considered core members of a chord, a scale worked well as an alternate melodic representation; lead sheets could continue to be used as a shorthand for improvisation once more complex ways of inscribing information into them were developed, including intricate associations of chord symbols to scales. While these questions were inchoate at the time Wayne Shorter wrote and recorded the three tunes discussed here, his approach to improvising over them reveals his answers to some of them. In "E.S.P.," he occasionally follows the chord-scale expressions of his detailed chord symbols, but quite often he explores other ways of relating to them, such as with bebop lines or alternative but thematic chord-scale juxtapositions. "Juju" reveals his close adherence to the maximally different chord scales expressed by the tune, except for his attempt to bridge the gap through the use of the pentatonic scale. "Iris" shows most clearly Shorter's predilection for finding simplicity within the complex, by basing his improvisations largely from a background perspective.

When comparing Shorter's solo improvisations to the chord scales expressed by his tunes, a gulf appears at times. While some might consider this evidence of chord-scale theory's inadequacy, these differences can open a space for analysis. As a fundamentally interactional music, jazz of the 1960s was concerned with relationships among musicians, their stylistic *milieux*, and the tunes they performed on.[49] Given the changes musicians were making to their tunes with modal and post-bop styles, new ways of conceptualizing these structures are needed. By setting down the chord scale as the basic unit, the perspective of this study takes into account a dominant strain of pedagogy that initially emerged with George Russell in the 1950s. While Russell's intent was not to bind chords and scales to each other in a one-to-one relationship as much of the pedagogy he inspired does, doing so to establish an abstract structure for musicians to interact with allows for the kinds of interpretations developed here. This article considers chord-scale networks as fixed representations of the tunes not in order to come to final conclusions about the nature of this music, but to offer something with which Shorter's solo improvisations may be heard to be in dialogue. It is contrary to the nature of jazz to suggest that a tune "is" one thing; it is many things performed in many ways by many musicians over many decades. Russell wrote that when relying on his concept, "*you are free to do anything* your taste may dictate, for you can resolve the most 'far out' melody since you always know where home is" (1959, 27; emphasis original).[50] Even within a universe of scale options, there is a "home" that a musician who possesses "taste" knows how and when to return to.

In the final edition of the *Lydian Chromatic Concept*, Russell wrote that "[t]here can be no doubt that the Lydian Concept 'put modes in the air' and was the theoretical foundation for what is commonly referred to as jazz's 'modal era' . . . Modes are woven into the fabric of music. They are intrinsically connected to both chords and scales—an essential part of the nature of music" (2001, 99). Post-bop harmony in the 1960s, which was typified by greater harmonic variety, a departure from fifth-based root motions, consideration of upper extensions as core chord tones, and emphasis on scales as structural elements, may be a direct result of chord-scale thinking. While the use of scales in jazz has been compared with Debussy, chord-scale theory's conflation of the vertical and horizontal dimensions of music brings to mind an affinity with Schoenberg.[51] The harmonic/melodic flexibility and inclusivity the chord-scale tradition affords musicians certainly resonates with Schoenberg's famous proclamation: "THE TWO-OR-MORE DIMENSIONAL SPACE IN WHICH MUSICAL IDEAS ARE PRESENTED IS A UNIT" ([1941] 1975, 220). Nonfunctional harmony has often been considered a core feature of post-bop style, which orients these harmonic practices of the 1960s as an outgrowth of bebop. Given the ways musicians like Shorter's frequent bandmate Herbie Hancock were expanding on Davis's modal music at this time, it seems likely that Shorter was influenced by scale-based modal concepts as well as chord-based bebop ones.[52] Whether or not chord-scale theory brought about such changes in jazz composition, the chord-scale networks identified here in Shorter's tunes and improvisations reveal a different method of musical organization that helps to model the possible ways in which nonfunctional harmony might function.

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[49] See Michaelsen 2013 for more on the domains of musical interaction in 1960s jazz.

[50] Ingrid Monson mentions this quote as well in her examination of Russell, John Coltrane, and the concept of freedom in 1960s jazz (1998). As Monson puts it, "[f]reedom is ultimately what Russell is after, but a freedom with full awareness of all tonal possibilities" (1998, 154).

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[51] See Tymoczko 1997 for an example of a comparison between Debussy and jazz.

[52] See Waters 2005 for an investigation of Hancock's expansion of modality in the 1960s.

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