How Weird Can Things Get? (Maps for Pantonal Improvisation)

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ABSTRACT (ABSTRACT)

Examines the bitonal, polytonal, and pantonal environments in jazz compositions and gives perspective to personal musical experiences. Includes several "maps" for making and understanding planned, limited journeys through such music.

FULL TEXT

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INTRODUCTION

Improvising "outside the changes" whilst other performers continue "within the changes" is a common occurrence in modern jazz -- bitonality and polytonality are part of the sound of the style. Musicians such as John Coltrane often circumnavigate the "home" key using relatively short devices played in other keys, returning to this home key (and their colleagues) relatively swiftly. [1] In a development of this approach, practitioners such as Ornette Coleman incorporate bitonality and polytonality freely, whilst adding pantonality to their palette of improvisation techniques. Here the use of other keys is sufficiently complex and long-term among the whole group to disrupt any sense of the home key. A good understanding of this pantonal approach is not possible using conventional chord-based analysis techniques. The mathematical complexities of 12-note music have been examined in depth with regard to classical music, but these principles are rarely extended to the performance or analysis of jazz music. Most jazz musicians and composers develop a relationship with dissonant sounds through trial and error, incorporating these sounds as they seem appropriate. While the author considers this trial-and-error approach to be essential to the development of any musician, this paper is designed to reveal some truths about exactly how "weird" things can actually get in such bitonal, polytonal, and pantonal environments; with the aim of focusing, and giving perspective to, such personal musical experiments. The author includes several "maps" for making and understanding planned, limited journeys through such music.

[1] For example, the four-note device (F A[flat] F B[flat]) used in *A Love Supreme* (Impulse, 1964).

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TONALITY, BITONALITY, POLYTONALITY, PANTONALITY, AND HARMOLODICSSome definitions

Tonality: This means to be in one key, e.g. C major -- although it is important to remember that music really moves around within a key, and that it takes a gradual revelation of notes in time for a tonality to be defined to an audience.

Bitonality: This means to be in two keys at once. It is

...a way of expanding the tonal system without completely breaking the rules governing tonality, which, on the contrary, are essential to it. Originally developed as a humorous effect in polyphony based on the clash of two different keys (e.g., Mozart's *Ein musikalischer Spass,* K. 522, and Hans Neusidler's *Juden Tantz* (1544), it has since developed a more serious musical status and emotional credence as a sound of its own through the works of composers such as Prokofiev, Shostakovich, Hindemith, Ives, and Les Six (Milhaud in particular). [2]

Polytonality: This means to be in two or more keys at once.

Pantonality: This is a word first used by Rudolph Reft in his book *Tonality, Atonality and Pantonality* (London, 1958), to explain the continued extension of the tonal language of classical music found in the work of Wagner, Debussy, etc. The approach which these composers took is often clearly more than polytonal, but certainly less than atonal. Pantonality is well defined as:

...being characterized by the notion of "movable tonics"; that is, it recognizes and uses tonal relationships in intervals, melodic figures and chord progressions without defining, or even implying, a key centre in any large-scale sense. [3]

Reti applied this description to much of the music of Bartok and Berg, as well as to early Stravinsky and Hindemith (up to about 1920). A vast twentieth-century repertory of "pantonal" music has followed from the developments of these composers.

Shortly after the publication of Reti's book, in 1960, George Russell cowrote an article for *Jazz Review,* which was later added as an appendix to his own book The *Lydian Chromatic Concept of Tonal Organization,* in which he applied the term "pantonal" to the improvisational style

[2] Eric Blom, "Bitonality," in Stanley Sadie, ed., *The New Grove Dictionary of Music and Musicians* (London: Macmillan, 1980), vol.2, p. 747.

[3] William Drabkin, "Pantonality," in ibid., vol. 14, p. 163.

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of Ornette Coleman and other jazz musicians, making the point that this music is often neither polytonal nor atonal in structure. [4]

Harmolodics: Coleman himself has since titled his improvisational method as "harmolodics," i.e., a synthesis of "harmony, movement, and melody." [5]

It is hard to find better quotations on this nebulous subject than those used by John Litweiler in his book, *Ornette Coleman: A Harmolodic Life* . Don Cherry (Coleman's trumpet-playing colleague) once described this harmolodic theory as:

...a profound system based on developing your ear along with technical proficiency on your instrument.... We have to know the chord structure perfectly, all the possible intervals, and then play around with it.... If I play a C and have it in my mind as the tonic, that's what it will become. If I want it to be a minor third or a major seventh that has a tendency to resolve upward, then the quality of the note will change. [6]

Cherry has also said, in a lecture, that:

In the harmolodic concept, you're reaching to the point to make every note sound like the tonic.... [7]

And Charlie Haden, the bassist, described playing with these musicians like this:

Technically speaking, it was a constant modulation in the improvising that was taken from the composition, and from the direction inside the musician, and from listening to each other.... [8]

Clearly, then, we need to include pantonality in any assessment of "Harmolodics," or of Coleman's music per se (and Russell is correct to make the connection). However, although it is true to say that Coleman and his colleagues are melodically driven, often producing heterophonic textures, it should be recognized that these melodic patterns are carefully structured in tonal, bitonal, polytonal, and pantonal ways at various (specifically composed) points within a piece. This variety of textural approach can be heard from Coleman's earliest recordings up to, and including, his recent work with Prime Time -- e.g., "Tone Dialing" (Harmolodic, 1995). For example, while the melody of a particular piece may be tonal in parts, bitonal in others, the improvisations that follow may be polytonal and/or pantonal. The author believes that in a study of Coleman's music the issue of detuned notes is no more an issue than in any

[4] George Russell, *The Lydian Chromatic Concept of Tonal Organization* (New York: Concept, 1959), appendix.

[5] A description of harmolodics by Ronald Shannon Jackson (drummer and composer), in Gary Giddins, "Harmolodic Hoedown," in *Rhythm-a-ning: Jazz Tradition and Innovation in the '80s* (New York: Oxford University Press, 1985) (a collection of previously published articles), pp. 235-49.

[6] Conrad Silvert, "Old and New Dreams," *Down Beat* 47, 6 (June 1980):16-19; quoted by John Litweiler, *Ornette Coleman: a Harmolodic Life* (New York: Morrow, 1992), p. 148.

[7] Don Cherry, in a lecture at Ann Arbor, Michigan, March 28, 1980, quoted in David Wild and Michael Cuscuna, *Ornette Coleman 1958-1979: a Discography* (Ann Arbor: Wildmusic, 1980), p. 76.

[8] Robert Palmer, "Charlie Haden's Creed," *Down Beat,* 39, 13 (July 1972): 16-18; quoted by Litweiler, op. cit., p. 148.

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other music; all music is "out of tune" at various points and to varying degrees. The note you "nearly heard" is just that -- it's the note you nearly heard. LESSONS IN JAZZ

Courses of study in learning to play a musical instrument "in a jazz style" progress in various manners, whether from a book, a teacher or by trial and error. Over time, however, the student is likely to be introduced to the sound of, as well as the techniques for performing, various complex systems characteristic of the style:

- (a) a "Blues" scale (i.e., C E[flat] F F[sharp] G B[flat]) improvisation over a diatonic (often major scale) chord progression with the same tonic (e.g., a simple 12-bar "Blues" using C, F and G major triads, or C / Am / F / G, etc.). This "panacea" scale sounds good in most situations and avoids the "naive" sound of the major scale from which the chords are built. Of course, this is not music constructed from two keys played simultaneously (a traditional definition of bitonality); these are two different scales that share a tonic, and other, note(s)!

- (b) the same "Blues" scale, but played over increasingly complex chord progressions -- at first the chords may be only slightly chromatic, later increasingly chromatic (e.g., at first C / A7 / D7 / G7; later Cmaj7 / A7+-/ D7[flat]9 / G7[flat]9b13; or a 12-bar "Blues" with many "substitutions," etc.). These chord alterations and substitutions are sometimes designed to "fit better" with the Blues scale, but there are often still points of conflict between the chords and the scale (which, ironically, may be deliberately ignored to provide stylistic "color").

- (c) modes and new scales, generally seen as useful as "better fits" for modal and chromatic chords (e.g., C Dorian -- C D E[flat] F G A B[flat] -- for Cm7; C Altered Scale -- C D[flat] F[flat] E G[flat] A[flat] B[flat] -- for C7[flat]9[flat]13, etc.), learned and mastered conventionally, then used more freely to cream new effects; for example: using C Lydian over a Cmaj7 chord, C Phrygian or C Dorian [flat]2 over a Cm7 chord, etc.

- (d) synthesizing new scales, either as a compositional extension of the Blues/diatonic system of (a) above, or, perhaps, in order to deal with potential/actual chromaticisms in other parts of the music (e.g., a complex walking bass line), or to solve metrical problems, such as those of using 7-note scales in duple/quadruple meter.

- (e) "playing outside the changes," i.e., deliberately playing material not in the "key" of the piece (or a part of the piece). Student musicians are often encouraged to improvise in a key "a semitone up" or "a semitone down."

By undergoing such a course, a musician is not only learning how to make "a jazz sound" but is also becoming aurally familiar with music of varying dissonance. From the musician's perspective, they are enlarging (and becoming more fluent with) their "vocabulary of the familiar."

Conventional analysis provides us with an understanding of consonance and dissonance with regard to a tonal gravity, or a tonal center. This is useful for bitonal and polytonal music. In order to assess accurately what happens when musicians in a group deliberately leave a "home" key, each transposing to a key of their choice, and then constantly modulating (see Haden, above) -- i.e., creating "pantonal" music (as Russell defines it), we need to ask an additional question: "How Weird Can Things Get?"

THE 2048 SCALES

There are 2048 different possible scales using 12 semitones, starting from a given note (for example, C):

1 Ã1-note scale	(= C)
11 Ã2-note scales	(from C D[flat] to C B)
5 Ã3-note scales	(from C D[flat] D to C B[flat] B)
165 Ã4-note scales	(from C I), D F4 to C A B[flat] B)
330 Ã5-note scales	(from C D[flat] D E[flat] E to C A[flat] A B[flat] B)
462 Ã6-note scales	(from C D[flat] D E[flat] E F to C G A[flat] A B[flat] B)
462 X 7-note scales	(from C D[flat] D E[flat] E F F[sharp] to C F[sharp] G A[flat] A B[flat] B)
330 Ã8-note scales	(from C D[flat] D E[flat] E F F[sharp] G to C F F[sharp] G A[flat] A B[flat] B)
165 Ã9-note scales	(fromC D[flat] D E[flat] E F F[sharp]G A[flat] to C E F F[sharp] G A[flat] B[flat] B)
55 Ã10-note scales	(fromC D[flat] D E[flat] E F F[sharp]G A[flat] A to C E[flat] E F[sharp] G A[flat] A B[flat] B)
11 Ã11-note scales	(from C D[flat] D E[flat] E F F F[sharp]G Ab A B[flat] to C D E[flat] E F F[sharp] G A[flat] A B[flat] B)
1 Ã12-note scale	(= C D[flat] D E[flat] E F F[sharp] G A[flat] A B[flat] B)

1+11+55+165+330+462+462+330+ 165+55+11+1 = 2048(note the symmetry of this sum) [9]

These scales represent the 2048 different interval patterns that are possible with 12 semitones. These 2048 interval patterns can, of course, be started on any of the 12 notes available on chromatic instruments (C, D[flat],

[9] Note that this list of numbers (1,11,55,165,330,462,462,330,165, 55,11,1) occurs as the 12th "line" of Pascal's Triangle, and, as such, is not a surprising pattern (see note 12 below).

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D, E[flat], E, F, F[sharp], G, A[flat], A, B[flat] or B); making a grand total of 24,576 possible scales! If we number these scales in natural order from 1 to 2048, with scale number 1 being the 1-note scale, and scale number 2048 being the 12-note chromatic scale, we find that commonly used scales occur at the following positions:

No.	Scale
1361	Major (Ionian mode)
1325	Dorian mode
1197	Phrygian mode
1371	Lydian mode
1360	Mixolydian mode
1323	Aeolian mode
1191	Locrian mode
1326	Melodic minor ascending (or "Jazz Melodic")
1199	Dorian [flat]2 (2nd mode of Melodic minor ascending)
1374	Lydian Augmented (3rd mode of Melodic minor ascending)
1370	Lydian [flat]7 (4th mode of Melodic minor ascending)
1358	Mixolydian [flat]6 (5th mode of Melodic minor ascending)
1317	Locrian [sharp]2 (6th mode of Melodic minor ascending)
1171	Super Locrian (7th mode of Melodic minor ascending) -- also known as "Altered Scale"
1324	Harmonic minor
1193	2nd mode of Harmonic minor
1364	3rd mode of Harmonic minor

1335	4th mode of Harmonic minor
1232	5th mode of Harmonic minor
1427	6th mode of Harmonic minor
1170	7th mode of Harmonic minor
936	Blues Scale (= C E[flat] F F[sharp] G B[flat])
785	Major Blues Scale (= C D E[flat] E G A)
393	Pentatonic
465	Minor Pentatonic
1739	Diminished
1636	Auxiliary Diminished

If we sort the above list into numerical order, it is easy to see that many of these commonly used scales are "neighbors," or, at least, "relatively near neighbors":

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No.	Scale
393	Pentatonic
465	Minor Pentatonic
785	Major Blues Scale (= C D E[flat] E G A)
936	Blues Scale (= C E[flat] F F[sharp] G B[flat])
1170	7th mode of Harmonic minor
1171	Super Locrian (7th mode of Melodic minor ascending) -- also known as "Altered Scale"

1191	Locrian mode
1193	2nd mode of Harmonic minor
1197	Phrygian mode
1199	Dorian [flat]2 (2nd mode of Melodic minor ascending)
1232	5th mode of Harmonic minor
1317	Locrian [sharp]2 (6th mode of Melodic minor ascending)
1323	Aeolian mode
1324	Harmonic minor
1325	Dorian mode
1326	Melodic minor ascending (or "Jazz Melodic")
1335	4th mode of Harmonic minor
1358	Mixolydian [flat]6 (5th mode of Melodic minor ascending)
1360	Mixolydian mode
1361	Major (Ionian mode)
1364	3rd mode of Harmonic minor
1370	Lydian [flat]7 (4th mode of Melodic minor ascending)
1371	Lydian mode
1374	Lydian Augmented (3rd mode of Melodic minor ascending)
1427	6th mode of Harmonic minor
1636	Auxiliary Diminished
1739	Diminished

It seems surprising, at first glance, that so often these commonly used scales should be simple chromatic versions of each other. However, an analysis of the internal interval structure of these scales reveals some common threads.

HOW WEIRD THINGS CAN GET -- "MOST DIFFERENT" KEYS

If two musicians improvise in different keys using a major scale each, there will always be at least two common notes between these keys. If the two musicians change to another scale type, the number of common notes may change.

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It is important to recognize that in any piece of music where two scales/keys are being used at once then each scale/key will exert its own "pull" on the ear of the listener to a lesser or greater degree. The most familiar scale/key will exert the strongest pull (a melody played in one key with the same melody played in parallel in another key will result in a single, stronger pull!). A scale can be familiar for different reasons: it may have been just heard in the piece, or it may be a commonly recognized convention, e.g., a major scale, a blues scale, a famous melody, etc. The familiar is incredibly strong. It is perhaps not surprising that many of the pantonal excursions of Ornette Coleman and his colleagues are based around these conventions.

It is possible to calculate for any given scale type the "key-defining cell(s)"; i.e., the shortest lists of notes that contain intervals which only occur in, and thus define, one particular key. It is often surprising how many of these key-defining cells there are for a given scale type, and, indeed, how small they can be. For example, there are five possible key-defining cells for the major scale (and its modes), each made up of three notes, thus (the following example is for C major): [lcub]C,F,B[rcub], [lcub]D,F,B[rcub], [lcub]E,F,B[rcub], [lcub]F,G,B[rcub] and [lcub]F,A,B[rcub] (notice that, in this case, each of these cells consists of the tritone, F and B, and one of the other five notes of the scale). While these key-defining cells are of academic interest, they often do not provide sufficient aural information to define the relevant key in the mind of a listener (for example, most of these cells do not contain the tonic). Most musicians express themselves through the various levels of solidity/ambiguity allowed by the use of more complete/ complete scales, whether in a tonal, bitonal, polytonal, or pantonal environment. And, after all, a small part of one scale could easily be mistaken for a similar part of a different, more familiar, scale. This approach results in an "ambiguity" of tonal purpose.

When playing "outside the changes" musicians are often keen to express real difference with the tonic key -- perhaps to repeat a familiar device (i.e., something already performed or already known) "out of position," in order to heighten our understanding of the device's individuality, its importance, its defiance. This will be most effective in keys that are "most different," i.e., where ambiguity can be reduced to a minimum. For example, the scale of D major is obviously more chromatic to C major than G major is. But how can we calculate the minimum number of common notes between two different keys of any given scale? What are the "most different" keys of any given scale? The answer to these questions lies in the interval frequency structure of these 2048 different scales. For

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example, if we search a scale like a major scale for the number of minor 2nds, the number of major 2nds, and so on, we get the following results:

	to C	D	E	F	G	A	B
from							
C	Ã	Ma2	Ma3	Perf4	Perf5	Ma6	Ma7
D	mi7	Ã	Ma2	mi3	Perf4	Perf5	Ma6
E	mi6	mi7	Ã	mi2	mi3	Perf4	Perf5
F	Perf5	Ma6	Ma7	Ã	Ma2	Ma3	Aug4
G	Perf4	Perf5	Ma6	mi7	Ã	Ma2	Ma3
A	mi3	Perf4	Perf5	mi6	mi7	Ã	Ma2
B	mi2	mi3	Perf4	Aug4	mi6	mi7	Ã

(Note that all similar sounding intervals have are given the same "standard" name for this exercise -- for example, all diminished 5ths are called "Augmented 4ths.")

Frequency of Intervals (compiled from diagram above):

mi2	Ma2	mi3	Ma3	Perf4	Aug4	Perf5	mi6	Ma6	mi7	Ma7
2	5	4	3	6	2	6	3	4	5	2

Enlarge this image.

Notice the symmetry of this result about the central axis of Aug4 -- there is a lot of symmetry to be found in this type of analysis! [10]

We can see that in a major scale each of the 11 interval types is represented at least once; this is true of many of the other 7-note scales (although not all of them), but is never true of scales that contain less than 4 notes. This Frequency of Intervals table is useful in that it allows us to calculate (a) the name of the keys that are most different to any given tonic scale, and (b) the minimum number of common notes between any two keys of a given scale; all achieved by simply noting which intervals have the smallest results in the table above, thus:

mi2					Aug 4					Ma7
2	5	4	3	6	2	6	3	4	5	2

This result means that the keys a minor 2nd, an Augmented 4th, and a major 7th above a major scale are the most different to that major scale (i.e., [flat]II, [sharp]IV and VII are most different to I), and that these keys each contain two notes in common with that major scale. So, if C major is our given scale, then D[flat], F[sharp], and B are the "most different" keys (and each only share two notes with the scale of C major); all defined by the table

[10] Students of atonal music will recognize this Frequency of Intervals table as being similar, but not identical, to the "interval vector" array (introduced to atonal music theory by Donald Martino in 1961 in "The Source-Set and Its Aggregate Formations," *Journal of Music Theory* 5, no. 2.). The structure and implications of this array are well explained by Allen Forte in his book, *The Structure of Atonal Music* (New Haven: Yale University Press, 1973). By altering this established convention, it is the author's intention to provide a tool directly relevant to the analysis and construction of maps for pantonal (rather than atonal) music. The key difference lies in the counting of the tritone (Aug 4) interval(s). The "atonal" method sees a pair of tritone intervals within an octave as a single equivalent interval, whilst this "pantonal" method sees them not only as discrete sounds in/against another tonality, but also as essential data in the comparison of keys (discussed later in the main text). It is, however, a simple matter to "translate" between the two systems (in either direction) should a musician wish to use, for example, a table of prime forms and interval vectors (e.g., Forte, op. cit., Appendix 1) by: (i) ignoring/recreating the symmetry of the Frequency of Intervals data, and (ii) dividing/multiplying the tritone (Aug 4) result in the relevant table by 2 (this subtle but essential change is Shown below in bold type for clarity); so, for the major scale:Pantonal -- Frequency of Intervals = 25436263452 Atonal -- 7-35 interval vector= [254361] (Martino, Forte, etc.)

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above. This confirms the good sense of a common described/prescribed "map" for "playing outside the changes" where a musician will play up or down a semitone from the "home" key in order to create a really strong sense of "difference" with the underlying tonality; musicians often repeat a melodic pattern "out of key" by performing it, or a close variation of it, up or down a semitone. In this way, musicians are being as weird as they can get (with transpositions of a major scale) without sacrificing the identity of the scale or device being played! Indeed, if we examine all of the (previously mentioned) commonly used scales in the same way, we find that playing up or down a semitone will indeed create this sense of "difference" most clearly in each case:

No.	Scale	"Most Different" Keys (tonic = C)
1361	Major (Ionian mode)	D[flat] F[sharp] B
1325	Dorian mode	D[flat] F[sharp] B
1197	Phrygian mode	D[flat] F[sharp] B
1371	Lydian mode	D[flat] F[sharp] B
1360	Mixolydian mode	D[flat] F[sharp] B
1323	Aeolian mode	D[flat] F[sharp] B
1191	Locrian mode	D[flat] F[sharp] B
(2 common notes between each of D[flat] F[sharp] B and the tonic major scale)	1326	Melodic minor ascending (or "Jazz Melodic")
D[flat] B	1199	Dorian [flat]2 (2nd mode of Melodic minor ascending)
D[flat] B	1374	Lydian Augmented (3rd mode of Melodic minor ascending)
D[flat] B	1370	Lydian [flat]7 (4th mode of Melodic minor ascending)
D[flat] B	1358	Mixolydian [flat]6 (5th mode of Melodic minor ascending)
D[flat] B	1317	Locrian [sharp]2 (6th mode of Melodic minor ascending)
D [flat] B	1171	Super Locrian (7th mode of Melodic minor ascending)

D[flat] B	(2 common notes between each of D[flat] B and the tonic Melodic minorscale)	1324
Harmonic minor	D[flat] D B[flat]B	1193
2nd mode of Harmonic minor	D[flat] D B[flat] B	1364
3rd mode of Harmonic minor	D[flat] D B[flat] B	1335
4th mode of Harmonic minor	D[flat] D B[flat] B	1232
5th mode of Harmonic minor	D[flat] D B[flat] B	1427
6th mode of Harmonic minor	D[flat] D B[flat] B	1170
7th mode of Harmonic minor	D[flat] D B[flat] B	(3 common notes between each of D[flat] D B[flat] B and the tonic Harmonic minor scale)
936	Blues Scale (+ C E[flat] F F[sharp] G B[flat])	D[flat] E F[sharp] A[flat] B
785	Major Blues Scale (= C D E[flat] E G A)	D[flat] E F[sharp] A[flat] B
(2 common notes between each of D[flat] E F[sharp] A[flat] B and the tonic Blues/Major Blues scale)	393	Pentatonic
D[flat] F[sharp] B	465	Minor Pentatonic
D[flat] F[sharp] B	(0 common notes between each of D[flat] F[sharp] B and the tonic Pentatonic scale)	1739
Diminished	C D[flat] D E F G A[flat] B[flat] B	1636
Auxiliary Diminished	C D[flat] D E F G A[flat] B[flat] B	(4 common notes between each of C D[flat] D E F G A[flat] B[flat] B and the tonic Diminished scale)

It can also be seen from the data above that all of the modes of any scale share the same results -- the reason being that all of the modes of any scale have an identical interval pattern as the scale itself. Note, however, that not all scales reveal their "most different" keys to be [flat]II and VII; there are many scales for which playing up or down a semitone will not be as weird as it would first seem to be. For example, an analysis of the frequency of intervals in the "Augmented" scale (C D[sharp] E G A[flat] B) reveals

mi2	Ma2	mi3	Ma3	Perf4	Aug4	Perf5	mi6	Ma6	mi7	Ma7
3	0	3	6	3	0	3	6	3	0	3

and thus the fact that II, [sharp]IV, and [flat]VII are, in fact, the most different transpositions. It is possible to assess the "most different" keys for any of the 2048 scales in this way -- by simply adding up the number of times that each of the 11 intervals occurs. It's good to draw a "from... to..." table like the one above to avoid forgetting to go beyond the octave -- otherwise the result will not be symmetrical around the central Aug4 position -- a good check of your counting! Another good check is to make sure that the following is true:
Sum of Frequency of Intervals = (No. of notes in scale x No. of notes in scale) No. of notes in scale
An example (major scale): (2+5+4+3+6+2+6+3+4+5+2) = 42 = (7 Ã7)-7 true!

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Another example (Augmented scale):
(3+0+3+6+3+0+3+6+3+0+3) = 30 = (6 x 6)-6 true!
Commonly used scales, then, often display the characteristic that their "most different" keys include those a semitone away (is their common usage symbolic of a kind of cultural chromatic "obsession"?). But why are the other scales (all 2021 of them) so little used, even if they display this characteristic (e.g., scale number 1052, C D[flat] D E[flat] F G A -- "most different" (to C) at D[flat], E[flat] A and B)? Of course, there are many musicians who have tried to exploit this resource; the European school (both classical and jazz) is famous for such experiments. However, before musicians choose a scale and rashes off to calculate weird keys and practice them, they should understand the following in order to choose well.
If we sort the 2048 scales into groups (i.e. scales with one note, scales with two notes, scales with three notes, etc.), and then order these groups by their frequency of interval data (starting with those that contain the lowest number of minor 2nds, then major 2nds, then minor 3rds, and so on) several interesting features are revealed. Firstly, all of the scales that are modes of each other are collected together as "neighbors." Secondly, commonly used scales appear at or very near to the top of their respective groups -- because they often contain a relatively small number of "small" and (by default) "large" intervals (e.g., mi2 [thus also Ma7], Ma2 [thus also mi7], etc.), compared to the number of "medium-sized" intervals (e.g., Aug4, Perf4 and Perf5, etc.). For example, the top of the list of 7-note scales looks like this (note that this list is spelled with the notes of the C chromatic scale for convenience, i.e., C D[flat] D E[flat] E F F[sharp] G A[flat] A B[flat] B):

No.	Scale	Frequency of Interval	Common Name =/[sim]
1191	C D[flat] E[flat] F F[sharp] A[flat] B[flat]	2 5 4 3 6 2 6 3 4 5 2	=Locrian mode
1197	C D[flat] E[flat] F G A[flat] B[flat]	25436263452	=Phrygian mode
1323	C D E[flat] F G A[flat] B[flat]	25436263452	=Aeolian mode
1325	C D E[flat] F G A B[flat]	25436263452	=Dorian mode
1360	C D E F G A B[flat]	25436263452	=Mixolydian mode\
1361	C D E F G A B	25436263452	=Major scale (Ionian mode)
1371	C D E F[sharp]G A B	25436263452	=Lydian mode
1171	C D[flat] E[flat] E F[sharp] A[flat] B[flat]	25444444452	=Super Locrian
1199	C D[flat] E[flat] F G A B[flat]	25444444452	=Dorian [flat]2
1317	C D E[flat] F F[sharp] A[flat] B[flat]	25444444452	=Locrian[sharp]2
1326	C D E[flat] F G A B	25444444452	=Jazz Melodic
1358	C D E F G A[flat]B[flat]	25444444452	=Mixolydian [flat]6
1370	C D E F[sharp] G A B[flat]	25444444452	=Lydian [flat]7
1374	C D E F[sharp] A[flat] A B	25444444452	=Lydian Augmented
1101	C D[flat] D E F[sharp] A[flat] B[flat]	26262626262	[sim]Whole Tone + [flat]II
1200	C D[flat] E[flat] F G A B	26262626262	[sim] [flat]II Whole Tone +VII
1297	C D E[flat] E F[sharp] A[flat] B[flat]	26262626262	[sim]Whole Tone +[flat]III
1352	C D E F F[sharp] A[flat] B[flat]	26262626262	[sim]Whole Tone +IV
1368	C D E F[sharp] G A[flat] B[flat]	26262626262	[sim] Whole Tone +V
1373	C D E F[sharp] A[flat] A B[flat]	26262626262	[sim]Whole Tone +VI
1375	C D E F[sharp] A[flat] B[flat] B	26262626262	[sim]Whole Tone +VII

1170	C D[flat] E[flat] E F[sharp] A[flat] A	33544444533	=7th mode of Harmonic minor
1177	C D[flat] E[flat] E G A[flat] B[flat]	33544444533	=3rd mode of Harmonic major
1190	C D[flat] E[flat] F F[sharp] A[flat] A	33544444533	=7th mode of Harmonic major
1193	C D[flat] E[flat] F F[sharp] A B[flat]	33544444533	=2nd mode of Harmonic minor
1232	C D[flat] E F G A[flat] B[flat]	33544444533	=5th mode of Harmonic minor
1234	C D[flat] E F G A B[flat]	33544444533	=5th mode of Harmonic major
1319	C D E[flat] F F[sharp] A B[flat]	33544444533	=2nd mode of Harmonic major
1324	C D E[flat] F G A[flat] B	33544444533	=Harmonic minor
1335	C D E[flat] F[sharp]G A B[flat]	33544444533	=4th mode of Harmonic minor
1336	C D E[flat] F[sharp] G A B	33544444533	=4th mode of Harmonic major
1359	C D E F G A[flat] B	33544444533	=Harmonic major
1364	C D E F A[flat] A B	33544444533	=3rd mode of Harmonic minor
1427	C E[flat] E F[sharp] G A B	33544444533	=6th mode of Harmonic minor
1430	C E[flat] E F[sharp] A[flat] A B	33544444533	=6th mode of Harmonic major
1167	C D[flat] E[flat] E F[sharp] G A	33633633633	[sim] most of Auxiliary Diminished

etc... (the other 426 X 7-note scales)

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By examining all of the 2048 scales in this way we find that a great many of commonly used patterns and scales contain relatively few small/large intervals: [11]

Scales with 3 notes that contain relatively few small/large intervals: The four triads (Major, minor, Augmented and diminished) with their inversions, then Suspended 4th chords, etc.

Scales with 4 notes that contain relatively few small/large intervals: All common 6th and 7th chords: diminished 7th, minor 6th, Dominant 7th, major 6th with their inversions (includes minor 7th), etc.

Scales with 5 notes that contain relatively few small/large intervals: Major Pentatonic scale, and its modes (including the minor), Dominant 9th chords, etc.

Scales with 6 notes that contain relatively few small/large intervals: Whole tone scale, etc.

Scales with 7 notes that contain relatively few small/large intervals: Major scale and its modes, Jazz Melodic and its modes, etc.

Scales with 8 notes that contain relatively few small/large intervals: Auxiliary diminished and diminished scales, followed by the modes of major and minor scales, each with an additional chromatic note.

(Note that all of the commonly used patterns and scales listed here are also at their "most different" at a semitone's distance away from a given tonic. Also, note the absence of the Blues and Major Blues scales from this list -- see below.)

While this evidence alone is insufficient to suggest that scales that exhibit this characteristic of containing relatively few small/large intervals are "easy to hear," it is, however, striking that so much of the material from which music has been constructed for so much time, and by so many cultures, demonstrates this characteristic low frequency of small/large intervals. What seems to stop many musicians from going further is a combination of the aural unfamiliarity of these other scales, combined with the relatively closer (i.e., less exaggerated) relationship between "familiarly dissonant" keys and a given tonic -- all of this being determined by the relatively different interval structure of these numerous other scales. This is not to suggest that a personal program of study could not well provide a musician with a new vocabulary, based upon one or more of these other scales, but it is clear that the aural skills necessary for the effective musical use of these other scales would need to be developed. (Consider for a moment the 8-and 9-note scales that are used to explain the work of bebop musicians; these are often 7-note modes with an additional note or

[11] Note that this analysis reveals results found in any "equal divisions of the octave" table. However, importantly, these results also include many of the so-called "symmetrical" and "synthesized" scales.

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two to provide metric solutions to music founded on swung quavers, triplet quavers, and semiquavers played over 4 beats to a bar. They are not principally "new sounds"; these metric strengths overcome the tonal problems mentioned above through rhythmic implementation.) A musician needs to be very determined to learn what these other scales sound like, and what they imply, in various situations in order to use any of them effectively. This determination will have to be shared by the musician's colleagues (perhaps these "colleagues" could be a computer!).

However, an interesting anomaly found in this analysis is that the (very commonly used) Blues and Major Blues scales do not contain relatively few small/large intervals compared to other 6-note scales. Indeed, these scales occur deep into the list of 6-note scales: at position numbers 106 and 117 out of the 462 Ã6-note scales (they are relatively near neighbors!). When a Blues scale is used in an improvisation over an essentially diatonic chord progression, the shared tonic seems to act like a magnet on the listener/performer, drawing them back to this "home" note with especial force. Familiarity is clearly what allows us to accept this complex sound. Or, accepting that jazz started as a confluence of African and European influences in New Orleans, and has developed in a linear fashion since, perhaps this comparatively massive difference in interval structure is a part of the African contribution? Interestingly, a comparison of the relevant data for the Blues scale and the major scale actually reveals a great deal of similarity in the contour of the frequency of intervals:

	mi2	Ma2	mi3	Ma3	Perf4	Aug4	Perf5	mi6	Ma6	mi7	Ma7
Major scale	2	5	4	3	6	2	6	3	4	5	2
Blues scale	2	3	3	2	4	2	4	2	3	3	2

This similarity is even more striking when we remember that the sum of the frequency of interval data for the (7-note) major scale is 42, compared to the (6-note) Blues scale, which is 30. From this perspective, then, the Blues scale is not quite so "weird"!

THREE OTHER WAYS OF GETTING WEIRDMap 1. Pivoting On (or Avoiding) Notes Shared by Different Keys

The keys that are "most different" to C major are D[flat], F[sharp] and B major, as we have seen above. It is worth pointing out, however, that of these three "most different" keys, D[flat] actually contains the tonic note C (this is not

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true in keys of F[sharp] and B). Would it not be better to avoid the tonic note for most difference? Perhaps a measurement of the "weirdness" of bitonal (etc.) music would be how much the tonic note of one performer is avoided by another performer/other performers. Another approach would be for a musician to choose from the list of keys that contain a particular note, pivoting on this note as they improvise through these various keys. Calculating keys that contain (i.e., can pivot on) or do not contain (i.e., can avoid) a particular note in a given scale type is really quite simple:

- (i) Examine the interval pattern of the scale being used, including the last step up to the octave: e.g., major scale: Maj2, Maj2, min2, Maj2, Maj2, Maj2, min2;
- (ii) Reverse this list: min2, Maj2, Maj2, Maj2, min2, Maj2, Maj2;
- (iii) Calculate the notes of this new scale, starting on the given note: min2, Maj2, Maj2, Maj2, min2, Maj2, Maj2 = (e.g.) C D[flat] E[flat] F G A[flat] B[flat]-this is, in fact, C Phrygian!
  (This scale provides us with a list of all of the keys of the major scale that include the note C).
- (iv) Calculate the complement set of this scale (i.e., find out the names of the keys not represented by stage (iii) above. The author finds that this is most easily done by sorting 12 small squares of paper, each with a different note of the chromatic scale written upon it): = D E F[sharp] A B -- this is, in fact, D Pentatonic!

(This scale provides us with a list of all of the keys of the major scale that do not include the note C).

So, we can say that the list of major scales that contain the note C are those that start on the notes of C Phrygian, and that the list of major scales that do not contain the note C are those that start on the notes of D Pentatonic. Any musician wanting to use this system while improvising will clearly have to prepare and learn/notate one or two pivoting/avoiding systems in advance (or do a very quick mental calculation during the drum solo!) -- just as the scale(s) that these system(s) will be based on has had to be prepared and learned/notated in advance. This kind of preparation is also necessary for the other maps, below.

Map 2. Using Scales with Palindromic Interval Construction

Recognizing that the Phrygian mode is constructed from the same intervals as the major scale, but in reverse order, it seems sensible to examine all of the seven modes for their "retrograde partner":

Dorian	[lang]	[rang]	Dorian
Ionian	[lang]	[rang]	Phrygian
Locrian	[lang]	[rang]	Lydian
Aeolian	[lang]	[rang]	Mixolydian

Indeed, we find something significant in that Dorian mode maps onto itself. This is because its interval pattern is palindromic (i.e., it reads the same forwards and backwards; the word "palindromic" is used to avoid confusion with other so-called "symmetrical" scales, such as the Diminished scale, that do not display this palindromic quality):

Dorian= Maj2, min2, Maj2, Maj2, Maj2, min2, Maj2

=TSTTTST

We find a similar result if we examine the modes of the Jazz Melodic minor scale:

Mixolydian [flat]6	[lang]	[rang]	Mixolydian [flat]6
Lydian [flat]7	[lang]	[rang]	Locrian [sharp]2
Lydian Augmented	[lang]	[rang]	Super Locrian
Dorian [flat]2	[lang]	[rang]	Jazz Melodic

Here (as with Dorian mode above) Mixolydian [flat]6 maps onto itself because it contains a palindromic interval pattern:

Mixolydian [flat]6 = Maj2, Maj2, min2, Maj2, min2, Maj2, Maj2

=TTSTSTT

What this all means is that for any scale type constructed with a palindromic interval pattern, then the keys that contain a given note are those keys named by the very notes of the same scale type, starting from the given note. An example: improvising in the scale of C Dorian (a palindromic scale), we might stop on any note of the scale, for example, D. The list of all of the keys of the Dorian mode that contain this note D is, in fact, the same as the notes of D Dorian: D E F G A B C. The improvisation may then progress by pivoting on this common note (D) between any keys that share it (i.e., D, E, F, G, A, or B Dorian), the rougher sounds of these more dissonant keys contrasting with the familiarity and "good fit" of D Dorian. This is one option. The movement between keys will always seem smoothest, however, if the improvisation is continued in a linear way, shifting between keys on a new "pivot" note each time. This "smoothness" will, of course, be more or less offset by the relative

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differences between these various keys and the scale(s) used for any accompanying parts.
In fact, there are 64 of these scales constructed with a palindromic interval pattern:

1 Ã1-note scale	(= C)
1 Ã2-note scale	(= C F[sharp])
5 Ã3-note scales	(C D[flat] B, etc.)
5 Ã4-note scales	(C D[flat] F[sharp] B, etc.)
10 Ã5-note scales	(C D[flat] F G B, etc.)
10 Ã6-note scales	(C D, D F[sharp] B[flat] B, etc.)
10 Ã7-note scales	(C D[flat] D F G B[flat] B, etc.)
10 Ã8-note scales	(C D[flat] D E[flat] F[sharp] A B[flat] B, etc.)
5 Ã9-note scales	(C D[flat] D E[flat] F G A B[flat] B, etc.)
5 Ã10-note scales	(C D[flat] D E[flat] E F[sharp] A[flat] A B[flat] B, etc.)
1 Ã11-note scale	(= C D[flat] D E[flat] E F G A[flat] A B[flat] B)
I Ã12-note scale	(= C D[flat] D E[flat] E F F[sharp] G A[flat] A B[flat] B)

1+1+5+5+ 10+10+ 10+10+5+5+1+1 = 64 (note the symmetry of this sum) [12]

Once any of these 64 palindromic scales is chosen, it is a simple matter to work out which keys do not contain a given note by noting down the members of the complement set of the chosen scale, as for Map 1 above.

Map 3. Conjugate Pairs -- A Balancing Act

Another way of mapping a route through the world of playing "outside the changes" is for a performer to answer an initial "out of key" phrase with an equally "out of key" reply, this reply being at the same distance from the tonic of the home key as the initial phrase but on the opposite "side" of the tonic, creating a kind of tonal "symmetry." For example, if the home key is C major, then after improvising in the key of D[flat] major for a while, the musician will "balance" this (5-flat) "excursion" with the (5-sharp) key of B major (note that the type of scale used is irrelevant to the success of this operation -- any of the 2048 scales can be used). The pair of keys chosen will always be at a conjugate distance to the central, home key (this home key will not necessarily be heard -- it may just exist in the mind of the performer, and may, or may not be based on an underlying tonality or chord/scale concept). Steve Coleman is one practitioner who has described the use of just this kind of symmetrical system. [13]

[12] Note that (similar to note 9 above) this list of numbers (1,1,5,5, 10,10,10,10,5,5,1,1) (sum = 64) is closely related to

the 6th "line" of Pascal's Triangle, which in fact reads (1,5,10,10,5,1) (sum = 32). Note also that 2048/32 = 64.
[13] Steve Coleman interviewed by Michael Hrebeniak: "Black Scientist," *Jazz FM Magazine* (an Observer Newspaper Publication, London), Issue 7, 1991, p. 20.

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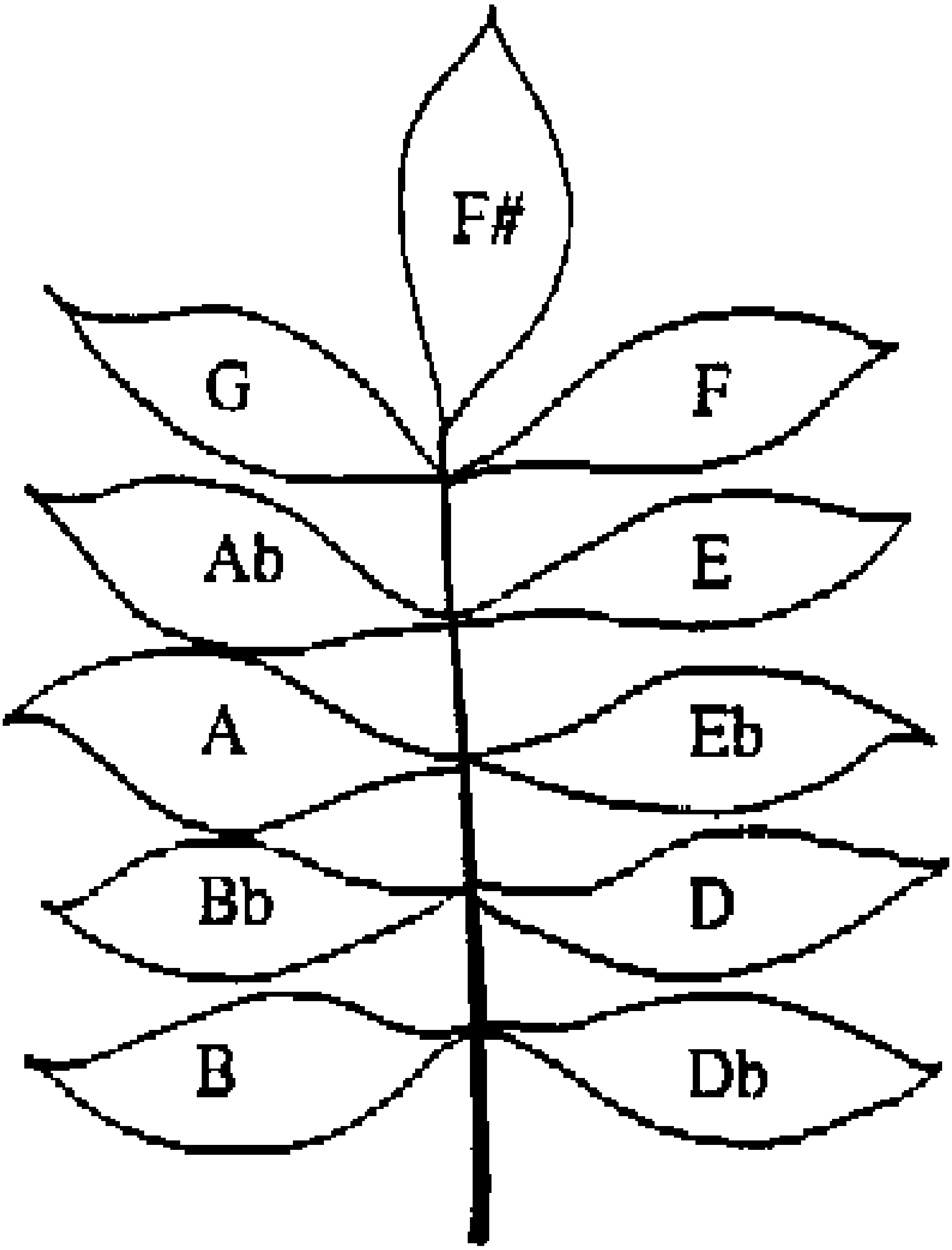
There are 6 types of "conjugate pairs." Here they are, expressed against a home key of C:

Type 1	D[flat]		B	(up and down a min 2)
Type 2	D	[lang] C [rang]	B[flat]	(up and down a Maj 2)
Type 3	E[flat]	[lang] C [rang]	A	(up and down a min 3)
Type 4	E	[lang] C [rang]	A[flat]	(up and down a Maj 3)
Type 5	F	[lang] C [rang]	G	(up and down a Perf4)
Type 6	F[flat]	[lang] C [rang]	F[flat]	(up and down an Aug 4)

Note that in conjugate pair Type 6, F[sharp] maps onto itself (the tritone). [14]
The author finds these conjugate pairs most easy to visualize when they are laid out in a pattern not unlike the shape of a Common Ash leaf (the stem represents the home key, the 11 leaflets represent the 11 possible destination keys; the conjugate pairs are arranged so as to be directly opposite each other, the tritone mapping onto itself). As above, this example (Figure 1) uses C as the home key.



(C)

Enlarge this image.

figure 1: conjugate pairs with a home key of c

[14] These six types of "conjugate pairs" correspond at a basic level to the six "interval classes" described by Forte (op. cit., p. 14); however, their applications are quite different.

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Which of these conjugate pairs will sound the "weirdest" for any given scale type will depend upon the interval construction of that scale type. For example, for improvising in a major scale, or one its modes, then the weirdest of these conjugate pairs is Type 4, represented in the diagram above by an improvisation set against the tonic key of C, first moving to the key of E, then to the key of A[flat]?; or vice versa. It is noteworthy that, for any given conjugate pair, one key will contain the tonic note of the "home" key (i.e., the mediant of A[flat] major), while the other will not (i.e., E major). This may affect the order in which a musician chooses to explore the members of a conjugate pair, dependent upon any desired tonic/antitonic effect of the improvisation. Interestingly, conjugate pair Type 4 is also the easiest to learn for all tonic keys, as the three notes concerned form an Augmented triad (e.g., C E A[flat] [A[flat] = G[sharp]]), [15] and there are only four of these in a chromatic scale. Also, experience has shown that once you leap away from the tonic key up or down a given interval (a major 3rd), it is easier then to remember to continue to move up or down by the same interval (another major 3rd), with a final, equal shift of key (a major 3rd again!) bringing you back to the tonic (which you may, or may not, sound). Examining the "difference factors" of the other conjugate pairs, we find that, for a major scale, Types 1, 3, and 6 are also fairly weird, but Types 2 and 5 (being less different to the tonic scale, and each other) are much less weird (see below for how to do this calculation for any scale).

So, the most weird conjugate pair for any given scale type will be that conjugate pair that has the highest "difference factor" between the three keys concerned: i.e., between the tonic key and the first key of the conjugate pair, between the tonic key and the second key of the conjugate pair, and (less obviously, but crucially) between the first and second keys of the conjugate pair. To calculate these "difference factors" for the six conjugate pairs of any given scale type (and thus be in a position to choose the most weird conjugate pair) we can simply multiply together the number of differences between the three keys concerned. [16] Follow this procedure:

(i) Calculate the frequency of interval data for the given scale, e.g., major scale:

mi2	Ma2	mi3	Ma3	Perf4	Aug4	Perf5	mi6	Ma6	mi7	Ma7
2	5	4	3	6	2	6	3	4	5	2

This result, as explained above, tells us how many notes are shared by keys at each of the 11 intervals of transposition.

[15] In the interview cited in note 13, Steve Coleman points out that the symmetry found in this particular triad is relevant to his work.

[16] The results of merely *adding* these numbers together would not sufficiently reflect the true difference between each of the conjugate pairs.

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(ii) Subtract each of these entries from the number of notes in the given scale (in this case, 7):

7	7	7	7	7	7	7	7	7	7	7
- 2	5	4	3	6	2	6	3	4	5	2
=5	2	3	4	1	5	1	4	3	2	5

This result provides us with a modified frequency of interval table which tells us how many notes are *not* shared by keys at each of the 11 intervals of transposition, thus:

mi2	Ma2	mi3	Ma3	Perf4	Aug4	Perf5	mi6	Ma6	mi7	Ma7
5	2	3	4	1	5	1	4	3	2	5

(iii) Insert this data in the form below into a new table (note that we only actually need the data from the mi2 to the Aug4 intervals, whatever the scale type; this is due to the symmetry of the data):

Conjugate Pair Type	1	2	3	4	5	6
(from tonic to first of conjugate pair=)	mi2	Ma2	mi3	Ma3	Perf4	Aug4
(from tonic to second of conjugate pair=)	mi2	Ma2	mi3	Ma3	Perf4	Aug4
(from first to second of conjugate pair=)	Ma2	Ma3	Aug4	Ma3	Ma2	unison*

To continue our example, completing this new table with the relevant data for the major scale, we get this:

Conjugate Pair Type	1	2	3	4	5	6
(from tonic to first of conjugate pair =)	5	2	3	4	1	5
(from tonic to second of conjugate pair =)	5	2	3	4	1	5
(from first to second of conjugate pair =)	2	4	5	4	2	1*

The asterisk (*) denotes that for conjugate pair type 6, where the tritone maps onto itself, the data is considered a "unison," which always translates as a multiplier of 1.
(iv) Finally, multiply the three interval values together for each conjugate pair, and examine the results:

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(iv) Finally, multiply the three interval values together for each conjugate pair, and examine the results:

Conjugate Pair Type	1	2	3	4	5	6	
	5	2	3	4	1	5	
	5	2	3	4	1	5	
Ã	2	4	5	4	2	1	Difference Factors

So, from this result we can see that conjugate pair Type 4 (i.e., up and down a major 3rd) is, as noted above, the most weird for a major scale, and that conjugate pair Type 5 (up and down a Perfect 4th) is the least weird.
Note that while these "difference factors" are only really "rules of thumb" created by multiplying three relevant interval values together, they do offer a fairly accurate gauge of the relative weirdness of each of the six conjugate pairs as they relate to a given scale, and thus they allow musical decisions to be made.

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