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[illegible]tended Reference: An Unrecognized Dynamic in Melody

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"It is an astounding fact," said Paul Hindemith,*1 "that instruction in composition has never developed a theory of melody." In a similar vein Paul Henry Lang*2 commented, "A study of melody construction is almost unknown." This article submits experimental results which indicate that a factor not previously recognized, to which we give the name 'extended reference,' is significant in melody. Extended reference is a source, perhaps the chief source, of the tension that is a characteristic of melody – a tension maintained until the melody returns from extended reference to direct reference and the tonic, in resolution.

In a previous article*3 we outlined a [illegible] pattern hypothesis dealing with several musical phenomena, including harmonic combinations and roots, in which we remarked that the hypothesis also supplied material, too lengthy for inclusion then, on musical scales and melody. The present article is a companion to that one, covering the omitted material. Space will allow us to present only a sampling of the experimental results. They have been covered at more length in two mimeographed Interim Reports*4 which include pictures of the equipment, detailed descriptions, several melodic patterns with full note-by-note tunings, and, most important of all, a recorded tape comparing various melodic passages in our referential tuning, classical just intonation, and equal temperament.

Many research studies have shown that non-keyboard performers do not use the tunings of theory – in fact, of any theory. Greene's*5 research at Iowa is well known and typical in this respect. Zuckerkandl*6 describes an experiment designed to measure the intonation used by singers, to determine if they used just intonation or equal temperament: "What appeared was that the singers sang neither in just intonation nor in equal temperament – they simply sang unimaginably off pitch. . . . Such facts can no longer be discussed in terms of poor intonation; the singers simply sang different notes than those which the text prescribed." Later, the same author writes: "But the most significant thing about the results of this experiment is that it required the intervention of the measuring instrument to reveal these grotesque distortions of pitch, these false tones. The audience, which included experienced musicians, had not noticed them at all."

To this we can add that the audience would have noticed, and— improbable as it may at first seem – would have been disturbed, if the singers had sung the notes "on pitch," in the theoretically correct tunings prescribed by the just scale or equal temperament. On our apparatus it is possible to test this by playing back and forth, alternating between a tuning pattern chosen as correct by ear, and the tuning of a theoretical scale. There emerges no problem of lack of discrimination. Listeners of various backgrounds hear the difference; their selection runs steadily counter to the tuning prescribed by just intonation or equal temperament. Given a three-way choice, among just tuning, tempered tuning, or the referential tuning they prefer the referential, and it is food for thought that, on some patterns, they say that, if limited to just intonation and tempered they would choose tempered. These results have been uniform over a wide range of listeners, including trained musicians invited for experiments, faculty members, students who volunteered as experimental subjects, and a variety of casual visitors. These results would not surprise Zuckerkandl, who went on to say: "But what do 'wrong' and 'false' mean here—where obviously, so long as the approach is purely musical, so long as no experiments are undertaken, everything is right and nothing is wrong or false. For what is musically right, musically wrong, the court of last resort is the ear of the musician, not the physicist's apparatus."

Since 1956 we have been working with equipment designed to identify the notes chosen by "the ear of the musician" in playing melodies. The findings show that musicians, even in standard melodies, consistently use many notes that are "unbelievably off pitch" if measured by the yardstick of the conventional scale, yet they sound right, and fall into regular patterns. The error lies with the yardstick, not with the musicians. For example, certain melodic sequences that seem to be running along the line of a chord do not actually do so. The ear's preferred tuning unmistakably avoids the structure of the chord, exhibiting instead another and more complex structural order, which gives an advantage in analysis, since it offers an explanation for some of the phenomena of melody.

Before submitting melodic examples with detailed tunings, it will be necessary to clear the ground on preliminary matters: What methods and apparatus were used? Was the tuning accurate? How competent were the musicians who selected tuning patterns? Two pieces of apparatus were used, a Modified Monochord and a Search Organ (both pictured in the First Interim Report). We began with the Modified Monochord in 1956. It uses a thin steel string, like a guitar string, strung on a resonator six feet long. It is laid flat, and played with a steel, like a Hawaiian guitar. The position of the steel governs the pitch, which can be read from a diagram under the string. Having no frets, it allows unlimited choice in tuning. After some practice a musician playing a melody finds his hand automatically sliding the steel to the pitch that his ear wants. This is frequently an unexpected tuning, revealing an unforeseen organization.

Notes are played without vibrato in these experiments, of course. The very long, thin string has proved satisfactorily accurate. Tests with a Strobocorn have shown that a musician produces a given tuning in a melodic context within plus or minus three cents in ten repetitions. Musician subjects have found that, on a strategic note in a melodic context, a tuning error as large as three cents is distinctly noticeable to the ear. The drawbacks are that the procedure is slow, and familiarity with the instrument requires time and practice, for which good musicians' commitments leave little time. In spite of this, a collection of tunings of various types of melodies was built up over a period of time, and from these certain patterns began to emerge.

The selections of notes called for by the results of these free-choice experiments were embodied in the Search Organ, which was built in 1961 with financial aid from a Danforth Foundation grant. It is a reed organ apparatus, making available more than sixty notes in the octave, in arrangements to be described later. It is built around six three-octave Estey reed organ actions, with the reeds keyed electrically, from a keyboard on which each tab is an electrical switch. The reeds have been tuned to a Strobocorn (which measures to within one cent) and have the stability in pitch for which organ reeds are noted. The tone, that of a parlor harmonium, is "homespun" but adequate for experiments until better equipment becomes available. Power to the blower motors is supplied through a Sola voltage-regulating transformer, to ensure stability in air pressure, hence in pitch. A player at the keyboard of the Search Organ can pick out the sound his ear wants from among the wide choice of tunings offered. The keyboard does not supply the unlimited choice of the string apparatus, but its presently available selection of notes came in the first place from the experiments on the Modified Monochord, which is used as a cross check.

The advantages of the Search Organ are that it does not require the learning of a new technique, and that it allows experiments with harmonies in addition to melody. Because it is less demanding of the operator's time it allows for faster experiments, with more musicians than could be induced to work with the string equipment. At present it is tuned for one key only. The five dozen and more notes in the octave are required for accurate tuning of the wanted tonal distinctions for standard melodies in a single key. Provision for playing in a number of keys would require many more notes.

To use the Search Organ, a player begins by orienting his ear to the one key available, by sounding the Do or a chord, and then proceeds to pick out, by ear, the tuning that sounds right for the melody he is analyzing. This may require a certain amount of experimentation with different tabs to find the right pitch, yet musicians of the caliber we have used as subjects know what they want, and in most cases are able to locate it on the keyboard of the Search Organ. They compare notes in melodic context. The keyboard supplies the notes of classical just intonation, Pythagorean intonation, and many more. They can play a phrase in their chosen tuning, and then compare it with just intonation, to hear which sounds right, and we ask them to do this. (To date, no musician has selected just intonation or the Pythagorean scale for any melody, although they regularly use some notes that occur in these scales.) An adjacent keyboard supplies equal temperament, which also is used for comparison. The result, when written down, is a record of this musician's preferred tuning for this melody (or melody and harmony, although we have worked to date very little on harmony).

The experiments hinge on competent judgment. The most active music consultant in the experiments has been Edgar Curtis, conductor and music director of the Albany Symphony and head of the music department at Union College. Others include Rev. Reynold McKeown, canon of the Episcopal Diocese of Albany, choir director, director of a radio program of liturgical music, and former college music teacher; Sylvia Dickstein, soprano soloist in a choir, member of the Advisory Council of the Albany Symphony and of the Board of Directors of the Albany Civic Music Association; Henry Sullivan, high school music teacher and choral director for the Albany Barbershoppers and other choral groups; Russell Locke, head of the music department at Emma Willard school in Troy; and Robert Enman, music teacher at Emma Willard. Many others have cooperated in brief experiments. Three professionals filling engagements in the area accepted invitations to come to the College and experiment with the organ: Clyde McCoy and Bobby Hackett, both trumpet players and band leaders, and Joseph Boatner, bass and arranger for the Ink Spots. Each worked out one or more melodies for us. They are listed, with our thanks, as having selected patterns, and not as endorsing any theories.

Having covered these details, we can now take up a specific melody, to illumine the structure implied in these tunings. Figure 1 presents the tuning chosen by Edgar Curtis on the Search Organ for the opening of Mozart's Serenata Notturna. The first part covers the opening, and the second the close of the passage. (It is given in full in the first Interim Report, and is recorded on the accompanying tape, with passages compared in this tuning, just intonation, and equal temperament). The fractions above the line of notes are referential ratios, which will be left for discussion later. The line below the notes, marked "Ref." for Referential, shows his preferred notes by names. In brief, he opened with the notes we call Do, May and Say, rather than the Do, Mi and Sol called for by just intonation. The notes Do, Mi and Sol make a good chord; Do, May and Say do not sound well as a chord. Nevertheless, the three referential notes sound right in this melody, the notes of just intonation sound wrong, not only to Curtis, but to many others who have heard this passage on the organ in the studio, and on the tape recording with the first Interim Report. The decision is not a close one; the justly tuned notes are characterized as "very wrong" and the referential tuning as "right" and the way one wants to hear this melody.

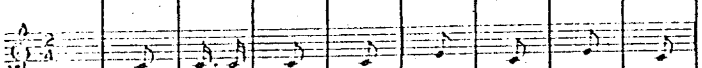
The names May and Say are part of our own coined sol-fa for this project. With five dozen notes at hand we become confused by ratios like 81/64 and 243/160. The names are recognizable variations of the standard forms; thus May is a high Mi and Say is a high Sol. The names signify the ratios, which can be referred to when needed.

figure

1 PART 1

START OF MOZART THEME
MAJOR LINKAGE, 3/2

Referential Keyboard Level								
5								
4								
3					9/8		9/8	
2 3/2				4/3		4/3		4/3
Major 1	1/1	1/1	1/1	1/1				



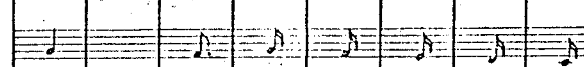
Ref.	Do	" "	"	"	May	Do	May	Do
Cents	0				407.8			
Abs. Ratio	1/1				81/64			
Class	Do				Mi	Do	Mi	Do
Cents	0				386.3			
Abs. Ratio	1/1				5/4			
Temp.	C				E	C	E	C
Cents	0				400			

figure

1 PART 1

END OF MOZART THEME
MAJOR LINKAGE, 3/2

9/5		8/5	9/5	8/5	3/2	4/3	6/5



Say		Fay	Say	Fay	May	Re	Day
723.5		519.5			407.8	203.9	21.5
243/160		27/20			81/64	9/8	81/80
Sol		Fa	Sol	Fa	Mi	Re	Do
702.0		498.0			386.3	203.9	0
3/2	-	4/3			5/4	9/8	1/1
G		F	G	F	E	D	C
700		500			400	200	0

The alternative tunings are shown. The note Do is the same in all scales. May, ratio 81/64 to Do, is tuned at 407.8 cents. Classical Mi in just intonation, ratio 5/4 to Do, is at 386.3 cents; thus May is 21.5 cents sharper than Mi. The note Say, ratio 243/160 to Do, is tuned at 723.5 cents. Sol in just intonation, ratio 3/2 to Do, is 702 cents. Again the difference is 21.5 cents, approximately a fifth of a tempered half-step. May 81/64 is the Pythagorean third, but Say is certainly not Pythagorean, so we are not dealing with Pythagorean tuning. This melody is not exceptional, it is typical of a large class, and it opens a Pandora's box of questions. Why does the ear reject the just tunings, in simple ratios to the tonic? How is it possible for the ear to seek out, and prefer, tunings in ratios so complex that they seem beyond all management?

We must go back to our examination of experimental details. The early Greek investigators held that pleasing combinations of tone are associated with simple ratios. Readers of the long pattern article know that we agree, and we suggest that simple ratios may be favored because they are neurally codable as combinations, by processes that are inherent in the auditory neural system. The experimental results on melody patterns suggest that simple ratios also operate in melodic combination, with the modification that the neural system is capable of using simple ratios in chains, or linkages, as well as in direct relationship. For example, in certain melodies subjects produce a sharp sixth, which we call Lay, rejecting the La of just intonation. Lay is 27/16 to Do. In the key of C it is A-445.5. Lay can be understood as produced by auditory organization in simple ratios. It stands a pure fifth, 3/2, above Re. If Re has become a temporary tonal center in the organization of the melody, and the ear is tuning in reference to Re, then the ear will call for the simple manageable 3/2 relationship to Re, producing Lay. The complex ratio to Do, 27/16, is a mathematical convenience in a tuning formula, but musically irrelevant, because the note is not acting musically with Do. It acts as 3/2 over Re, and should be thought of as 3/2 over Re. La, A-440, is 5/3 to Do, but 40/27 to Re.

A clue pointing to tonal sub-centers is that Lay frequently occurs in melodic sequences in which all the other notes also stand in simple ratios to Re, indicating that Re indeed is being used by the ear as reference for tuning the sequence. It is true that Re itself, 9/8 to Do, is verging on the complex. However, Re is 3/2 above Sol, which is 3/2 above Do. Thus 27/16 amounts to the third link in a chain of ratios of 3/2 from the tonic. Such chains play a large role, as we shall see.

Description of Re as a tonal sub-center does not imply that a modulation has made Re the new tonic. Such centers of reference act without modulation. Further, although it must be conceded that a ratio like 27/16 is not in a good ratio to the tonic, it does not follow that the thread of connection to the tonic has been lost, since the melody must and does retrace the chain to resolve on the tonic, Do. This is illustrated at the end of the Serenata Notturna in Part 2 of Figure 1.

We use the term "extended reference" to denote such relationship to the tonic through a chain of simple ratios, as opposed to "direct reference," which is relationship by a single simple ratio.

Now we are ready for a partial explanation of the beginning of the Serenata Notturna. This phrase does not follow the major chord because the organization in this opening is in process of shifting from direct reference to extended reference to the tonic. The melody will stay in extended reference until the close, when it will shift back to direct reference and resolve the pattern. Examination of many major melodies as found on the string apparatus indicated that the references for major melodies were linked in a chain of successive ratios of 3/2. This is the scheme of the Pythagorean scale, but a chain of references is not a scale, it is rather a backbone to which notes can be tuned in simple ratios, giving rise to a number of different plans of major tuning, depending on the organization of the melody. (Two other linkages, minor and blue, will be described later).

The resources of referential tuning can be seen in the plan of a referential keyboard. Figure 2 is a diagram of the keyboard of the Search Organ set for major, showing five levels. The organ is now built with five levels, plus plug-in arrangements that give the equivalent of eight levels. Each level contains one note of the reference chain, plus all possible ratio relatives of it, within certain limits of complexity. Thus a player moving along the chain moves up the keyboard. In planning this first keyboard we decided to use no unusual direct ratios, because we were beginning with standard music. We excluded all ratios more complex than 9/8, and all to the base seven (such as 8/7 or 9/7). There is no implication that they are not musically useful, only that we could do without them at the start. Within these limits, each keyboard level contains all the mathematically possible ratios within the octave. The sequence of ratios happens to include the notes of the just scale except for Ti, but it did not come from this scale or any other. A single keyboard level is not meant to be a scale, but rather a note and its collection of relatives. The diagram shows for every note its ratio to the reference, ratio to the tonic, tuning in cents from the tonic, and its sol-fa name, standard when there is one, otherwise our own coinage.

On the first level, at the bottom, 1/1 is the base, the tonic, Do. 9/8 is the just Re, at 203.9 cents. 7/6 is rie, 6/5 is ri— two different tunings for D♯, as the names suggest. 5/4 is the just Mi, as the standard name indicates, and so on across the first level. The other levels are identical in plan, except for the difference in base. On the second level, the frequency that was 3/2 to the tonic, Sol, becomes the base, 1/1, and all notes are in pure ratios to it. 9/8 to the second reference is Lay, sharper than La, as the cents values show, as does the position in the diagram, which is laid out by cents. 6/5 over Sol is li, the same frequency as 9/5 over Do; the two tabs are wired to the same reed. 5/4 over Sol gives 15/8 over Do, which is Ti, the one note missing from the just scale on the first level. 4/3 over Sol is Do, wired to the same reed as 1/1 on the first, but reminding us, by this position on the keyboard, that Do need not always be the tonic when it is working in reference to something else. In fact, it is customary to use a leading tone or some other contextual device to introduce Do in its capacity as tonic and resolver of the pattern. 3/2 over Sol is standard Re, and so on across this level. In sum, the second level adds some notes, such as Ti, makes some alterations, as Lay instead of La, and retains some notes unchanged in frequency, although a new orientation is implied by the keyboard scheme. The third level carries the chain a step farther. The 3/2 of the second level becomes 1/1 of the third, Re. 9/8 to Re is May, sharper than Mi, and so on across the third level. Note especially the disappearance of the Do frequency. There is a low first, Du, standing a natural seventh, 7/4, above Re (the ratio relations to the tonic are irrelevant), and a high first, Day, 9/5 above Re. And so on. Figure 2 shows 33 frequencies to the octave in the major chain through five levels. As mentioned, we find melodies needing eight levels, which call for still more

Now we can return to Figure 1. The upper part, which shows ratios on keyboard levels, is self-explanatory with respect to Figure 2. This melody works upward into extended reference, to the fourth keyboard level. It stays there through the intervening part (not shown here, for lack of space, but included in the Interim Report) and comes down the keyboard to the tonic at the end. Notes of multiple reference are placed in the dia-

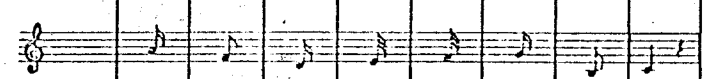
figure

1 PART 2

END OF MOZART THEME

MAJOR LINKAGE, 3/2

Referential Keyboard Level								
5								
4	1/1	8/5	4/3	3/2	8/5			
3						4/3		
2 3/2						1/1	5/4	
Major 1								1/1



Ref.	Lay	Fay	Re	May	Fay	Sol	Ti	Do
Cents	909.9	519.5	203.9	407.8		702.0	1088.3	0
Abs. Ratio	27/16	27/20	9/8	81/64		3/2	15/8	1/1
Class.	La	Fa	Re	Mi	Fa	Sol	Ti	Do
Cents	884.4	498.0	203.9	368.3		702.0	1088.3	0
Abs. Ratio	5/3	4/3	9/8	5/4		3/2	15/8	1/1
Temp.	A	F	D	E	F	G	B	C
Cents	900	500	200	400		700	1100	0

gram according to context. An example is the note Re, next to the last note in Part 1 of Figure 1. It is shown there as 4/3 to the fourth reference, because it is in a sequence of notes on the fourth keyboard level. This is the classical Re; the keyboard diagram, Figure 2, shows it as 9/8 to Do on the first level, as 3/2 to the second reference, as the reference note on the third level, and as 4/3 to the fourth reference. It is the same frequency in all cases; all four tabs are wired to the same reed. When the ear demands a note with only one reference there is no doubt about where to place it, but a note of multiple reference requires interpretation; we place it with its context. In some cases, where a melody seems to be traveling up or down the keyboard on a note of multiple reference it is shown simultaneously on more than one level. An example is Sol, near the end of Part 2 of Figure 1. To repeat: 1) The Serenata Notturna is a fair sample, typical of many major melodies, in the patterns chosen by good musicians. 2) The referential keyboard scheme is not a mathematical construction, but comes from patterns produced empirically on unlimited string apparatus. It comes from the same phenomena of variation found by all research studies, plus skepticism about the interpretation that variation by musicians constitutes being "off pitch."

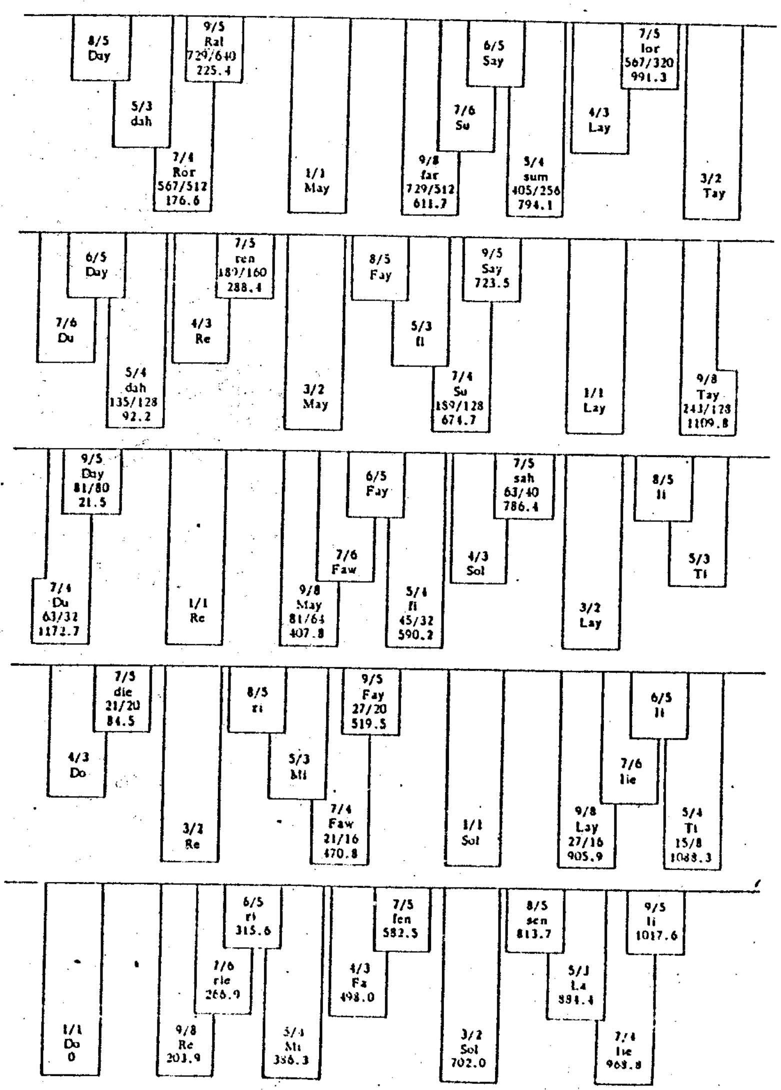
Minor and blue patterns, examples of which will be described later, differ from major in detail but are similar in principle. A sheaf of melodies could be cited if space allowed. All of them "go up the keyboard" into extended reference. It appears that extended reference is a characteristic of the melody phenomenon in music. A melody typically uses direct reference at the start to establish the tonic, then goes into extended reference and stays there until the extended organization is resolved at the end, which normally is on the tonic. This implies a new approach to the theory of melody.

The Greek theorists, who shaped the foundations of Western music theory, favored simple ratios from a philosophical bias toward order, which we consider a basically correct intuition, but oversimplified in application. Modern hypotheses about musical scales drawn from the partial series have supported the same tendency to look for direct reference to the tonic. Consequently, investigators have tended to interpret variety in musical pitch as error in performance, or personal emotionalism, or some other type of unstable variation from direct reference, the assumed normal supplied by the formula. Theorists seeking new musical resources have sought notes higher on the partial series, which can be described as seeking a

figure 2

MAJOR KEYBOARD

By Reference Ratio, Absolute Ratio, and Cents



more remote form of direct reference.

Music theorists have customarily taken harmony as the source of melody, treating a melodic sequence as the surface of a harmony or of a chord progression, again a form of direct reference. Yet difficulties arise when this is applied to a specific melodic sequence. Let us take as example the opening strain of The Marseillaise, Figure 3. The tuning, selected on the Search Organ by Robert Enman, music teacher at the Emma Willard school in Troy, New York, begins: Sol Sol Sol Day Day Re Re Say May Day. Of course classical just intonation would be Do instead of Day, Sol instead of Say, and Mi instead of May. Mr. Enman starts with Sol, a direct reference, 3/2 to Do. It has multiple references, being 1/1 on the second level, and 4/3 on the third. The melody goes promptly into extended reference, to Day, 9/5 to the third reference. (The cent values and ratios of all notes are shown on Figure 2). Played in just tuning the melody does not have the quality of a good Marseillaise; it sounds dull. The just notes Sol Do Re Mi and Sol, sounded as a chord or combination of chords, do not have the quality of the Marseillaise. This opening phrase is notably electrifying melody, and it has the Marseillaise quality in Mr. Enman's tuning. The effect cannot plausibly be described as that of any chord. Sol and Day sounded together do not harmonize, yet the tuning the ear wants in this melodic sequence is Day, while the sound of Do is rejected as wrong and dull.

Conventional theory explains melodic vitality, or melodic tension, by a principle of consonance and dissonance which cannot be narrowly applied, and by the tendency of certain notes to serve as points of rest, and the tendency of other notes to pull toward these, which can indeed be observed if one plays up the scale, treating the scale as a melody. However, we submit that in this phrase of The Marseillaise the tension is not heard simply as a pull of some notes toward other notes which sound restful. In addition to any tensions between note and note, the whole phrase has tension, which may well be caused by the tense relationship, the extended reference, to the tonic.

It is observable that all melodies have, throughout their course, an effect of something started but not yet finished, of motion toward a destination that is known, but not yet reached. It is also true that all melodies begin by establishing a tonic and going into extended reference to it, and they stay in extended reference until the end, which is accomplished by a return to direct reference and, normally, to the tonic. We submit then,

that extended reference is the characteristic organization of melody; it is possibly the chief source (although certainly not the only source) of the tension and relaxation that go on in melody.

To illustrate in detail: The note Day has the ratio 81/80 to the tonic. This is impossibly complex as a direct ratio. In terms of the partial series it is the relationship between the 81st partial and the 80th – impracticably high. With a maximum of transposing down it is the relation between the 81st partial and the 5th – still impracticable, It cannot be explained by cultural conditioning to the tempered scale, since the tempered first is Do, zero cents, exactly like just Do. This note, and others in its sequence, can be explained as an auditory result of organization in simple ratios, if we assume that the auditory system can handle simple ratios in linkages, or chains.

The implications of this hypothesis for auditory theory are discussed at some length in the Second Interim Report. In brief, we hold that normal hearing is designed to operate through interfering noise, since nature provides no soundproof rooms. We select and organize the various partials of a normal complex tone by the fact that the partials synchronize; they are in step with each other. We exclude interfering vibrations from the sensation because they do not keep step; thus we perform the essential operation of hearing through interference. This normal organization by direct synchronization is the constant function of our hearing in all tones, and it is altogether too ordinary to be musically interesting. It is child's play. The auditory nerve network, equipped for synchronization by the necessities of normal hearing, is also able to project a matrix that organizes synchronizations linked together one after another, in a pattern different from the partial series. Now this is interesting. It stimulates and rivets the attention because it is not the same easy partial series pattern. It requires effort to maintain the linked matrix (keep the key). Such a linked matrix of simple ratios, although manageable, is unusual, therefore tense, and requires resolution by return to direct reference to end the pattern. Thus melodic tunings, except at the start and end of a melody, are organized, to depart from the partial series. At the same time these tunings are organized by extended applications of synchronization – the process that organizes the partial series.

Aside from the direct duplication of the octave, the simplest ratio is the fifth, 3/2. A sequence of linkages by 3/2 provides the strongest matrix except direct reference. This is the

figure 3

THE MARSEILLAISE
MAJOR LINKAGE, 3/2

Referential Keyboard Level									
5									
4				6/5	6/5	4/3	4/3	9/5	3/2
3									
2									
1	3/2	3/2	3/2						

Ref.	Sol	"	"	Day	"	Re	"	Say	M.iy
Cents	702.0			21.5		203.9		723.7	407.8
Abs. Ratio	3/2			81/80		9/8		243/160	81/64
Class	Sol	"	"	Do	"	Re	"	Sol	Mi
Cents	702.0			0		203.9			386.3
Abs. Ratio	3/2			1/1		9/0			5/4
Temp.	G	"	"	C	"	D	"	G	E
Cents	700			0		200		700	400

figure 3

						9/5	3/2	8/5
6/5	6/5	3/2	6/5	1/1	8/5			

Day	"	May	Day	Lay	Fay	Ral	Tay	Day
21.5		407.8		905.9	519.5	225.4	1109.8	
81/80		81.64		27/16	27/20	729/640	243/128	
Do	"	Mi	Do	La	Fa	Re	Ti	Do
0		386.3		884.4	498.0		1088.3	
1/1		5/4		5/3	4/3		15/8	
C	"	E	C	A	F	D	B	C
0		400	0	900	500	200	1100	0

linkage of reference notes for major, as shown in Figure 2. It provides tunings that sound right for major melodies.

Minor melodies require a different first link, 6/5, after which all links are by 3/2. The blue pattern uses 5/4 as the first link, and a sequence of 3/2's thereafter. Thus all three linkages use the strong ratio 3/2 for development after the first link establishes which fork of the road is to be taken.

The following table compares the reference notes (1/1 on each keyboard level) for major, minor and blue.

	Major		Minor		Blue	
5th level	May	81/64	Day	81/80	dah	135/128
4th level	Lay	27/16	Fay	27/20	fi	45/32
3rd level	Re	9/8	li	9/5	Ti	15/8
2nd level	Sol	3/2	ri	6/5	Mi	5/4
1st level	Do	1/1	Do	1/1	Do	1/1

The First Interim Report contains complete keyboard diagrams for minor and blue, with melodic examples in comparative tuning, in the format of Figure 1. The examples are played on an accompanying recorded tape, with comparisons of passages in referential, just, and tempered tuning. Many notes tuned to these references are identical with major; some are different. A minor example is No. 6 of Bela Bartok's Fifteen Hungarian Peasant Songs. Here are the opening notes, excluding repetitions, in a referential tuning selected by Edgar Curtis:

MINOR REFERENTIAL				JUST		
Referential Note	Ratio to Reference	Absolute Ratio	Cents	Just Note	Ratio	Cents
Do	1/1 to 1st	1/1	0	Do	1/1	0
Sol	3/2 to 1st 5/4 to 2nd 5/3 to 3rd	3/2	702.0	Sol	3/2	702.0
Fay	3/2 to 3rd 1/1 to 4th	27/20	519.5	Fa	4/3	498.0
Say	9/8 to 4th	243/160	723.5	Sol	3/2	702.0
son	6/5 to 4th	81/50	835.2	sen	8/5	813.7
li	4/3 to 4th	9/5	1017.6	li	9/5	1017.6

The blue melody in the First Interim Report is "If I Didn't Care," in tuning selected by Joseph Boatner, bass and arranger for the Ink Spots. This passage, the start of the refrain, begins in extended reference, the tonic being already established. It opens with a repeated phrase in standard notation, but Mr. Boatner varied the tuning.

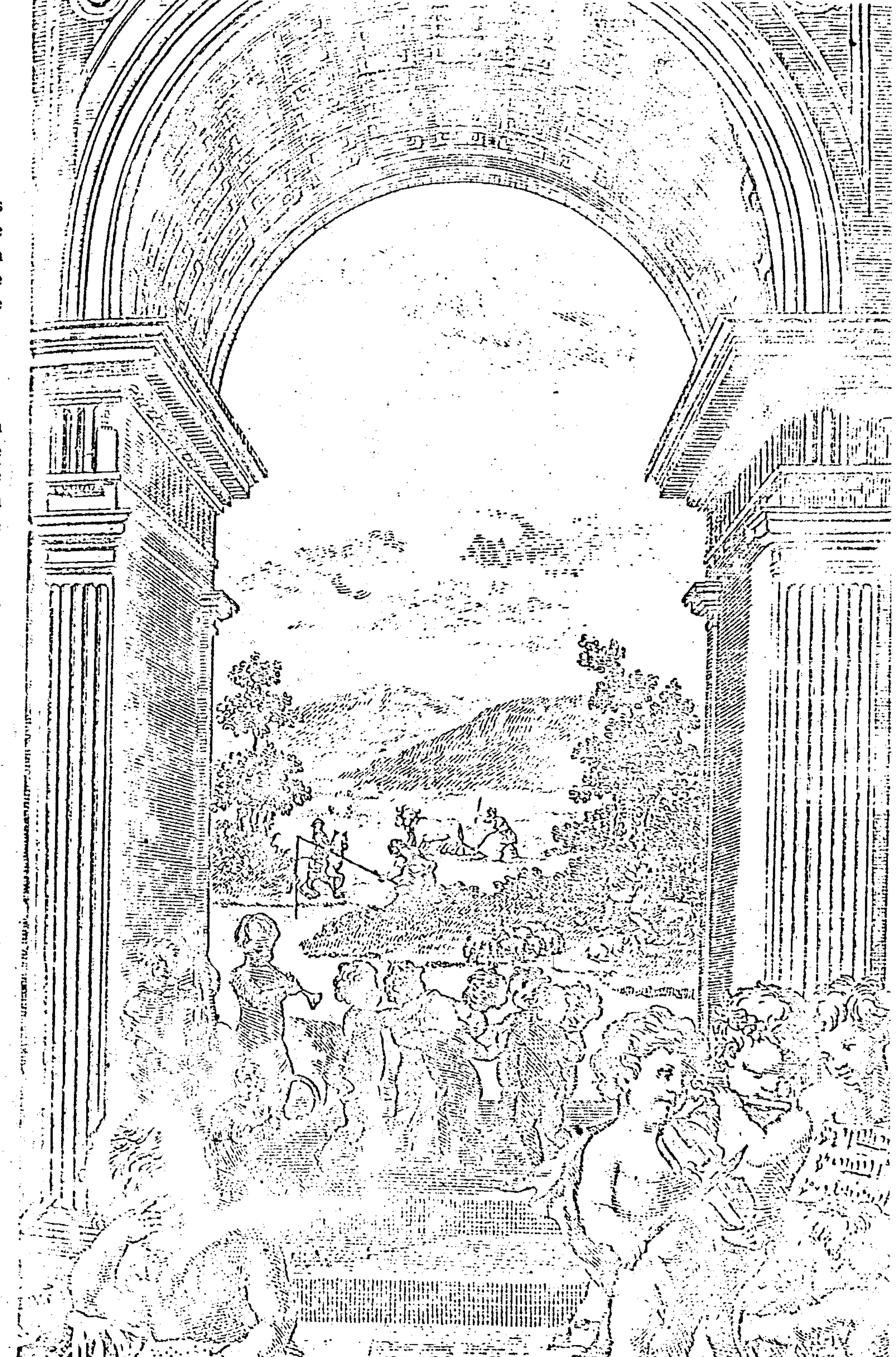
	BLUE REFERENTIAL				JUST		
	Referential Note	Ratio to Reference	Absolute Ratio	Cents	Just Note	Ratio	Cents
If	rah	5/4 to 3rd	75/64	274.6	ri	6/5	315.6
I	Mi	4/3 to 3rd 1/1 to 2nd 5/4 to 1st	5/4	386.3	Mi	5/4	386.3
did	Su	7/5 to 5th	189/128	674.7	Sol	3/2	702.0
n't	Tay	9/5 to 5th	243/128	1109.8	Ti	15/8	1088.3
care	Lay	8/5 to 5th 5/3 to 4th	27/16	905.9	La	5/3	884.4
More	rah	5/4 to 3rd	75/64	274.6	ri	6/5	315.6
than	May	9/5 to 4th	81/64	407.8	Mi	5/4	386.3
words	Sol	8/5 to 3rd 6/5 to 2nd 3/2 to 1st	3/2	702.0	Sol	3/2	702.0
can	Ti	1/1 to 3rd	15/8	1088.3	Ti	15/8	1088.3
say	Lay	9/5 to 3rd	27/16	905.9	La	5/3	884.4

He tuned the first phrase rah Mi Su Tay Lay, and the second rah May Sol Ti Lay. At our request, Mr. Boatner rechecked this variation, and held to it. The two phrases in his referential tuning are markedly different in sound, and in referential form.

A composer of melody is manipulating, among other things, the type and range of extended reference. Type of reference is illustrated in a general way by these three linkages, major minor and blue. We think of them as different matrices projected by the auditory neural system. A given note plays a different role in a minor or blue pattern, even though it may be identical in frequency with a note used in major. This is consistent with musical experience. A minor melody sounds minor throughout, not merely on isolated minor notes. We have no reason to doubt that other systems of linkage, which we have not yet found, are possible and perhaps already in use in music, or waiting to be put to use. It is probable that some devices of melodic phrasing, not embodied in these diagrams, are also manipulations of type of extended reference.

As for range of extended reference, this means, in our terms, how far up the keyboard the melody travels. Differences in range do produce flavors in music; after some acquaintance with the keyboard one can make a good guess about the range from the sound of the music. Range is the number of steps in linkage that the auditory neural system is expected to organize a matrix for.

Classification and study of these types will require examination of a mass of melodic material. We believe that it will be rewarding, as valuable data on musical structure becomes available when extended reference is defined. Extended reference has gone unrecognized by music theory; perhaps its study will initiate some answers to the challenges quoted at the beginning of this article, that "Instruction in composition has never developed a theory of melody" (Hindemith), and "A study of melody construction is almost unknown" (Lang).



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