

On the Measurement of the Musical Scales of Various Nations  
and Introducing the Ellis

An unpublished ESEM Seminar paper

Since the publication of Ellis's paper 'On the Musical Scales of Various Nations'<sup>1</sup> a century ago, and his 'Tonometrical Observations on some existing non-harmonic Scales'<sup>2</sup> a year earlier, many ethnomusicologists have produced measurements of the musical scales of different cultures, sometimes, like Ellis, Kunst,<sup>3</sup> or Jones,<sup>4</sup> for example, by measuring instruments of fixed pitch; sometimes by measuring the pitches produced by singers or instrumentalists in field recordings, and sometimes even those rendered in live performances. Many examples of the two latter practices come to mind and need not be listed in the present company. Such work has often led to discussion, and one example of this was the Congr s de Musique Arabe held in Cairo in the early 1930s.<sup>5</sup> Participants there included many of the most eminent European musicologists of the day and, of course, all the leading experts of the lands then regarding themselves as 'Arabe'. When microtonal inflections were discussed, those from the 'Arabe' areas insisted that the microtones they heard were identical with European quarter-tones (presumably the quarter-tones of the equal-tempered scale, though this was not specified; quarter-tones were very much the 'in thing' at that time in European art music, and a small number, perhaps only three or four, quarter-tone pianos were built for the performance of this music. One of these instruments was still in Cairo, in the Institut Fouad Premier de Musique Arabe, in 1948, and may still be there today, though I presume that the name of the Institute has been changed). All the European musicologists were equally convinced that the microtones were not the quarter-tones of the European equal-tempered scale (and how often, for that matter, are the quarter-tones that we hear in the concert hall? Has anyone ever measured the pitches actually played in a Bart k string quartet. for instance, or, perhaps more significantly, since there is a normal piano involved, in the Bloch Piano Quintet?), but that they were different microtones, characteristic 'Arabe' microtones. This contrasts interestingly with a number of the papers we have heard here, in which speakers have tried to pull 'local' intervals into European terms. It is, in fact, significant of our Eurocentrism that in all the years since Ellis's papers appeared, we are still speaking eurocentrically of intervals being, for example, fifths or fourths and using other such terms familiar to any student in one of our Conservatories, and not using, as Professor Blacking has told us Ellis had in mind, the advantages of his invention of the cent to arrive at some terminology which will be acceptable to all peoples and usable in all musics [see the Appendix to this paper]. But, to return; the point in recalling this discussion in Cairo of over fifty years ago is that it was the result of measuring scales by ear, rather than by using a series of tuning forks, as Hipkins did on Ellis's

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1 Journal of the Society of Arts, 1885

2 Proceedings of the Royal Society, 1884

3 Jaap Kunst, *Music in Java*, Martinus Nijhoff, The Hague, 1949

4 A.M.Jones, *Africa and Indonesia*, E.J.Brill, Leiden, 1964

5 *Recueil des travaux du Congr s de musique arabe*, Cairo, 1934

behalf,<sup>6</sup> or on a monochord, as Kunst did in Java (all of Kunst's measurements have been alleged to be invalid by Ernst Heins fairly recently,<sup>7</sup> chiefly because Kunst bowed his monochord, which distorts the pitch), or a Strobocorn, such as Jones employed, or the various models of the Melograph, or any of the small and inexpensive electronic devices which the Japanese have produced in recent years.

By using electronic gadgetry, we can nowadays eliminate the subjective element, the impression of our ears, which caused the discussion in Cairo, and we can be quite certain that the figures produced by our Strobocorn, our Melograph, our Korg, or whatever else we use, are a true and accurate record of the scale, tuning, and/or temperament used by our performer. We then assume that this is the scale, tuning, and/or temperament used by the culture to which our performer belongs. It is here, I believe, that we are liable to go astray. We have eliminated the subjective factors at our end of the process, but we have ignored the equally important subjective factors at the other end.

If I sang you a tune, you would get a very odd idea indeed of the English musical scale. Obviously, nobody but an idiot would knowingly make field recordings of a singer as bad as I am, but to what extent, I wonder, do we try to find out how good, within the parameters of the local musical culture, our informants are? If I came from a different culture from yours, one of which you had no musical experience, would you know how bad a singer I am? Do we look for the Flagstads or the Carusos in our chosen culture, or do we just take what comes? And do we ask any other members of the culture whether our musician is regarded as good, bad or indifferent? Even if we discover that we have recorded the local Heifetz, do we get other members of the culture to listen to the recording and say whether this particular performance is a good one or not? After all, we have all heard the Menuhins and similarly great artists of our own culture play like a pig on some occasion – is there any reason to suppose that members of other cultures don't also suffer from the occasional off-day, when they can neither sing nor play in tune?

Do we ever make allowances, when measuring the scales and tunings of instrumental music for the different inherent natures of the instruments? Experiment and experience have shown that string players in our culture tend towards a Pythagorean temperament, with sharpened leading notes, playing B sharp, to take just one example, well above the normal position for C natural in the slow movement of Bach's E major Violin Concerto; that brass players, imbued with the influence of the harmonic series, tend towards Just intonation; that pianists, in the rare cases of those who are capable of hearing tunings at all, naturally tend towards the Equal temperament in which all notes may be theoretically out of tune but which may be, and often are, somewhat ameliorated by the ear of the tuner. Are there similarly varying concepts of a scale between, let us say, an *alghaita*, a *goge* and a *kakaki* player in Nigeria, and is there any allowance made for this before publishing a transcription of an *alghaita* performance, or a song performed by an *alghaita* player, as **the** Hausa scale? In the case of fixed-pitch instruments, has anyone except Hugh Tracey<sup>8</sup> deliberately measured the instruments of different makers within one cultural area, and thus established personal, rather than cultural, tunings, just as an aurally aware concert pianist can tell you which of Steinway's tuners is on duty today without seeing him, but simply by

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6 Hermann Helmholtz, *On the Sensations of Tone*, transl. A.J.Ellis, 1885 (Appendix XX) (Dover reprint, 1954)

7 Personal communication in conversation

8 *Chopi Musicians*, International African Institute, 1970

running over the keyboard? Kunst measured only the central octave of each instrument, as is well known, and did not seem to be aware that this might not be typical, indeed was deliberately not typical, of the instrument as a whole, for the Javanese not only deliberately build in beating octaves, but, just as our piano tuners do, distort the upper and lower ends of the compass. Father Jones certainly ignored all such matters, just as he ignored so many other crucial factors, such as dessication after years of incarceration in museums and the absence of tuning wax, and anyway his margin of error, the number of cents which he said should be ignored in coming to conclusions, was greater than the difference between a Just and an Equal tempered major third.

Do we allow for different performance situations? We have heard of singers refusing to perform a lament to the ethnomusicologist unless they can think of a close relative who has died, someone to lament for. Even then, does a lament sung at home into the microphone or the note book have the same qualities, the same microtonal inflections, as a lament at the grave side? In our culture, how many people can agree on how flat is a minor third or a flat seventh?

Do we allow for technique? Let us take a concrete example, one from our own culture so that we can say that we all know the norms, the parameters within which such a performance is acceptable, and a singer who was acknowledged by critics and public alike as one of the greats of our time: [TAPE example of Maria Callas: 40 seconds]. And here is the same performance at half speed: [TAPE example; 70 seconds]. Now, what was the intended pitch of any of those notes? Was it the upper level of the wobble (singers call it vibrato; recording engineers call it wow, with a certain amount of flutter – what do we call it?) or was it the lower level? Or are we intended to strike an average? What conclusions should we reach from this recording about the intervals of the musical scale used at La Scala?

We can take further concrete examples. We are all musicologists here; most of us are musicians, and surely some of us can sing. Who will sing a scale? Can any of us say, before we start, that we are going to sing an Equal-tempered scale, or a Pythagorean, a Mean-tone, or a Just scale? After all, we assume that a Javanese can sing, at will and accurately to a few cents, either a *pelog* or a *slendro* scale.

[At this point, Professor Blacking sang while I noted the pitches he produced on a Korg tuner. The results were close to, but, as one would expect, were not identical on all pitches with the theoretical cents figures of any recognised European temperament]

So, what conclusions can we come to from these examples of the musical scales of our culture? And if we cannot take our performances as evidence of our scales, how justified are we in taking the results of our fieldwork as evidence of the musical scales of other cultures? Surely all that we can say is that Mr. Smith's scale was this on January 10th, and Mr. Brown's scale was that on February 3rd. Only after we have built up a corpus of recordings which can show an unanimity of intonation could we consider that we have ascertained the musical scale of any culture. And I would be willing to bet, from the experience of thirty-five years as a professional musician in our culture, that the scale which we would then adduce would be heard in that culture about as often as the true Equal temperament, with exact 100 cent semitones and 200 cent whole tones, is heard in ours. What might in some ways be more interesting, though perhaps this leaves the realm of ethnomusicology and approaches that of ethnopsychology, would be to establish the degrees of musical tolerance of intonation in various cultures. Ours is pretty lax – you heard Maria Callas just now, and you can all name other singers with wobbles as wide who are the favourites of both critics and public. Perhaps we should investigate how other cultures compare with ours in this respect. It might even tell us more about their musicality than would establishing the

intervals of the tune that they sing in or out of.

## APPENDIX

During the discussion on this paper, Robert Stuckey produced the concept of the Absolute Cent [subsequently renamed the Ellis, to be abbreviated to El, as Hertz (previously vibrations or *vibrations doubles*) are abbreviated to Hz; since many of us write hz, one suspects that El will become el]. This is the complete answer to this point made in my paper. A few of my non-European students have objected to cents, as a manifestation of eurocentrism because they are based on the European equal-tempered semitone, this objection is no more valid than would be an objection to the millimetre because it was a product of the French Revolution and the result of a French savant's inaccurate measurement of the circumference of the terrestrial globe. We must have some unit of measurement, and over the past century, the cent has proved itself to be the best, partly because it is small enough, in contrast with the savart, that one can always use whole numbers, even to distinguish so small an interval as the difference between the true and the equal-tempered fifth. Again, one can counter the argument that the basis of calculation, the 64-foot C, is a European concept, with the fact that one has to start somewhere, and that only by using a pitch based on normal 'European' (in fact, world-wide) usage would it be possible to take advantage of the widely available, and very inexpensive, electronic pitch-measuring devices. If one were to use a 1 Hz as the base, one could not take advantage of these machines, for it would be prohibitively expensive to have them recalibrated on that base in the small quantities which would be required by the ethnomusicological community.

I have used this concept of the Ellis in measuring the pitches of the Javanese Gamelan *Kyai Madu Laras*, recently presented to the Bate Collection of Historical Instruments by the Indonesian Minister of Forestry through their Embassy in London. It was extremely useful, immediately revealing a number of details which would not have been apparent had I merely used cents for intervals, and would certainly not have been apparent with the use of Hz for pitches. To give one example, these are the pitches, in Ellis, of *Nem* throughout the Gamelan:

	SLENDRO	PELOG
Kempul	${}_2 1035$	${}_2 1057$
Slentem	${}_2 1072$	
	${}_3 1043$	${}_3 1038$
Gender barung	${}_2 1050$	${}_2 1023$ (without 7)
	${}_3 1042$	${}_3 1038$
	${}_4 1030$	${}_4 1035$
		${}_2 1052$ (without 1)
		${}_3 1040$
		${}_4 1032$
Gender panerus	${}_3 1035$	${}_3 1035$ (without 7)
	${}_4 1038$	${}_4 1032$
	${}_5 1045$	${}_5 1045$
		${}_3 1048$ (without 1)
		${}_4 1032$
		${}_5 1048$
Saron demung	${}_3 1050$	

	${}_4 1032$	${}_4 1035$
Saron Wayang	${}_4 1030$	
	${}_5 1035$	
Saron barung	${}_4 1027$	
	${}_5 1043$	${}_5 1042$
Peking	${}_5 1034$	
	${}_6 1080$	${}_6 1088$
Kenong	${}_4 1038$	${}_4 1037$
Bonang barung	${}_4 1040$	${}_4 1023$
	${}_5 1038$	${}_5 1040$
Bonang panerus	${}_5 1045$	${}_5 1048$

[The subscript figures denote the octave above the base pitch of 64-foot C. Thus our tuning A at 440 hz would be shown as  ${}_4 900$ ]

With these figures, it becomes very easy to tabulate all the values for nem, or any other note, in each octave in each system, or to compare each octave between each system, or to perform any of the other intricate calculations with which musicologists like to confuse musicians. Mr. Stuckey has given us a tool of great value and enormous usefulness, one which we have, in fact, been waiting for ever since A.J. Ellis gave us the cent, the centenary of which we were celebrating at this conference.