REPORT ON PITCH PERCEPTION EXPERIMENTS CARRIED OUT IN BUGANDA AND BUSOGA (UGANDA)

by

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There is a relatively long history of scholarly interest in the tuning of different musical pitch systems that African peoples have evolved for their music making. One notable contribution is the pioneer effort of Hugh Tracey from the 1930s to the 1960s with his large set of tuning forks which he used for matching the pitches of many of the African instruments he recorded. Since then many of the pages of successive issues of African Music have contained tables of tunings for xylophones, harps, mbiras and such like instruments. A special cause for concern by scholars has been the attempt to understand the variety of tunings measured from instruments belonging to those pentatonic traditions that in the light of other evidence lead one to think that the scale consists of five equal spaced divisions of the octave. The problem has been that, to Europeans at least, the scales do not *sound* equally spaced and this is supported by the results of scientific measurement of the fundamental pitches of xylophone keys and harp strings on pentatonic instruments. The resulting scale measurements often show discrepancies of anything from a few cents to more than 60 cents from the theoretical equal spaced norm of successive intervals of 240 cents.

Wachsmann pointed to the essence of the problem in his paper on "An equal-stepped tuning in a Ganda harp" (Wachsmann 1950) and coined the term 'pen-equidistance' to describe such scales (see Wachsmann 1967). The problem stated simply is – 'Are such departures from equal sized steps in the scale significant to the musicians themselves?' Before going further the reader should know that Schneider has produced evidence warning one against using measurements of the pitch of the fundamental harmonic of complex tones as criterion for measuring scales, so in spite of the ready availability of computer-based methods for measuring fundamental pitch, one should complement such work with other approaches to the problem including those that may be considered to belong more to the discipline of music psychology.

During August 1990 a visit to Uganda enabled me to test the tuning tolerance of traditional Ganda and Soga musicians, that is to try to discover from the musicians themselves how they viewed a variety of scales all describable as 'pentatonic without semitones' (i.e. anhemitonic pentatonic). The method was to play over to them a set of recordings of different xylophone tunings (created with the help of a digital sampler and an Atari computer) and invite their comments. The results suggest that Ganda and Soga traditional musicians tolerate a wide range of pentatonic tunings. They readily gave favourable judgements to scales ranging between (and including) equipentatonic scales of large tones (240 cent steps) and scales using 'European' intervals of tones and minor thirds (200 and 300 cents). The implications of these findings are discussed at the end of this brief report.

Test materials.

Seven different pentatonic scales spanning one octave were created from a sample

tone played on a Ganda amadinda xylophone in the possession of the writer (see Sets 1-7 below). Each descending scale was played to subjects three times slowly. Then, to introduce some more musical content to the tests, each scale was immediately followed by 3 repeats of the kernel melody (the okunaga part) of the well known Ganda akadinda song 'Omusango gw'abalere' using the same tuning as the preceding scale. Each set was played over twice before participants made judgements on the tunings and the listeners used headphones fitted to the playback machine adjusting the volume themselves to a comfortable listening level. Where it was possible to administer the test twice to the same subjects this was done at an interval of about two weeks. For the second test the order of the sets was changed (randomly, thus it was chance that led to Set 7 being last in both tests).

Tunings (Variations shown in cents + or -)

Note name	C4	A	G	F	D	C3	
	1	2	3	4	5	6	
Set 1	+Octs.	+0	+0	+0	+0	+0	(European)
Set 2	+0	+60	+20	- 20	+40	+0	(Equi-penta)
Set 3	+0	+60	+20	+0	+40	+0	
Set 4	+0	+60	+0	+0	+40	+0	
Set 5	+0	+100	+0	- 40	+20	+0	
Set 6	+0	+80	+20	+0	+60	+0	
Set 7	+0	+56	+12	- 32	+24	-20	(Equi-penta)

Order of presentation of sets:

First test	1 2 3 4 5 6 7
Second test	3 6 2 4 1 5 7

Notes

Scale 1 is derived from equal-temperament European

Scale 2 is equi-pentatonic (1200 cent octave)

Scale 7 is equi-pentatonic (1220 cent octave, each step 244 cents) (This was to cater for the possibility of the perceptual octave being approximately 1220 cents. See Dowling 1973 and Cooke 1990).Scales 3, 4, 5, 6 are tunings (varying by steps of 20 cents or multiples thereof) often found when measuring the fundamental pitches of xylophone keys in Buganda and Busoga.

Diagrammatic comparison of tuning intervals in cents (high to low):

Note:	1		2		3		4		5		6
Set 1	*	300	*	200	*	200	*	300	*	200	*
Set 2	*	240	*	240	*	240	*	240	*	240	*
Set 3	*	240	*	240	*	220	*	260	*	240	*
Set 4	*	240	*	260	*	200	*	260	*	240	*
Set 5	*	200	*	300	*	240	*	240	*	220	*
Set 6	*	220	*	260	*	220	*	240	*	260	*
Set 7	*	244	*	244	*	244	*	244	*	244	*

Subjects were asked to assess each test set on a 3-point scale namely: A = Excellent, B = Acceptable, C = Not good, but most chose to use even finer shadings of distinction when assessing the tunings.

Results

Test 1 Set:	1	2	3	4	5	6	7
A. Ssempeke (GT)	A	A	A	A	A	A	A
C. Kizza (GT)	B	A	A	A	A?	B/A?	A
S. Ssebuwufu (GT)	A	B	B	B	A	A	A
H. Kiyaga (GT)	A/B	A	B	B	B	A	A+
Silagi's gp. (ST)	A	B	A/B	A	B	A	A
J. Ndhote (S St)	A	B/A	A	A	A	A	A
P. Mugabi (G St)	B/A	C	B	B/A	C/B	B	B/A
C. Yawe (G St)	B	B	B	B	C	A	A
T. Kikonyogo (G St)	B	B	A	B	C	B	A
Score A's	4	3	4	4	3	6	8
A/B or B/A's	2	1	1	1	0	1	1
B's	3	4	4	4	3	2	0
B/C's	0	0	0	0	1	0	0
Cs	0	1	0	0	2	0	0

Test 2 (Sets were presented this time in this order:- 3, 6, 2, 4, 1, 5, 7, produced randomly. Not all musicians were available for a repeat of the test)

Set:	1	2	3	4	5	6	7
A. Ssempeke (GT)	A	A+	A	A	A	A+	A+
L. Sserwanga (GT)	?	A+	A+	A+	?	A+	A+
C. Kizza (GT)	C	A	A	B	B	A	A/B
S. Ssebuwufu	C	B	A	B	C	A	A
Score A's	1	3	4	2	1	4	4
A/B	0	0	0	0	0	0	1
B's	0	1	0	2	1	0	0
C's	2	0	0	0	1	0	0

Test 1: Two Teso students (maintained that their pentatonic system is slightly different from the systems of southern Uganda).

Set:	1	2	3	4	5	6	7
P. Omunyokol	A	B	B	B	B	B	A
C.S. Ejalu	C	A	B/A	A/B	B/C	C	C

Biographical key to personnel:

GT = Traditional Ganda musician

ST = Traditional Soga musicians

G St = Young Ganda student (sons of traditional musicians)

S St = Young Soga student (son of traditional musician)

The most "traditional" musicians (the least exposed to Western music influence) were the following:

A. Ssempeke, one of the most versatile and gifted traditional musicians in Buganda who learned his flute and harp playing from palace musicians;

S. Ssebuwufu, formerly one of the Kabaka's *akadinda* players (now a maker and tuner of xylophones at the Institute of Teacher Education, Kyambogo);

Hudson Kiyaga, a member of the traditional music group headed by Evaristo Muyinda (who was not available to take part in the test);

Ludovico Serwanga, brother of Ssempeke and member of his traditional group; Silagi's group, two members (including Silagi himself) of a traditional semi-professional group of Soga musicians living at Bukoona, east of Iganga in eastern Uganda. The group forms an ensemble of panpipes, xylophone, lamellaphone and one-string fiddle players. These two gave a joint verdict.

Results suggest that when pitches are presented in succession (rather than, for example, harmonically) tuning tolerances are large. Little consistent preference for scale set 7 might simply be a result of its position as the last set of both tests. This could be interpreted as possibly that aural fatigue had set in, or conversely, that "learning" during the course of the other six sets had sharpened their discrimination and that this was indeed the perfect scale. Clearly it would be necessary to give repeats of the test with further randomisation of the order of the sets (see below).

Some idea of the inconsistency or difficulty in making judgements is given by the comments made in English by Hudson Kiyaga as he listened to Test 1:

Set 1 – Perfect Kiganda.
Set 2 – Better, more like Kisoga tuning. Second note needs to be higher.
Set 3 – Same as for no. 2, the second note is low.
Set 4 – Note 2 is not good.
Set 5 – Note 2 is too low.
Set 6 – Tuning is OK.
Set 7 – Good – the best of all.

Two students from Teso district (north-eastern Uganda) also sat the test. They were both proficient performers on the Teso akogo lamellaphone but being music teachers on an in-service course for teachers had been exposed to both European as well as traditional musical styles from the time of their secondary education. There was no agreement between them as to the merits of either the European scale (set 1) or the equipentatonic scales (sets 2 & 7).

In 1992 I was able to repeat the tests with some of the musicians I had tested 18 months earlier – once again randomising the order. The extra 1992 data in no way changed my findings significantly but the results are summarised in the table below for sake of completeness.

Results

	Set	1	2	3	4	5	6	7
Ssempeke	1990	A	A	A	A	A	A	A
	1990	A	A+	A	A	A	A+	A+
	1992	A	A	A	A	A	A	A
	1992	A	A	A	A	A	A	A
Sserwanga	1990	?	A+	A+	A+	?	A+	A+
	1992	B	A	A	A	B	A	A
	1992	B	A	A	A	B	A	A
Ssebuwufu	1990	A	B	B	B	A	A	A
	1990	C	B	A	B	C	A	A
	1992	A	B/A	B	A	B	B	C
	1992	C	A	B	A	B	A	B
Score	A's	6	8+	8	9	5	9	9
	B's & C's &?	5	2	3	2	6	0	1

Mugabi	1990	B/A	C	B	B/A	C/B	B	B/A
	1992	C	B	C	B	B	B	B
	1992	A	B	B	B	B	A	A
Yawe	1990	B	B	B	B	C	A	A
	1992	A	B	B	A	B	B	C
	1992	C	A	B	A	B	A	B
Overall	A	8	9	8	11	5	13	11
Score	B/A	1	1	0	1	0	0	1
	B	3	6	8	5	8	4	3
	B/C	0	0	0	0	1	0	3
	C	4	1	1	0	2	0	2
	?	1	0	0	0	1	0	0

The most "traditional" musicians (the least exposed to Western music influence) were the first three listed above. Peter Mugabi and Charles Yawe (students in their 20s) were the sons of Christopher Kizza, with whom they took part in 1990. Perhaps the most perceptive comments came from Ssempeke's brother, Sserwanga, who was consistent in finding problems with Sets 1 and 5 (in both 1990 and 1992). Ssempeke's findings suggest he might just have been bored with the whole exercise by 1992; he had previous experience of pitch tests administered by Klaus Wachsmann when he taught in the USA.

Results suggest that tuning tolerances are large *when sounds are presented in sequence*. Among the traditional musicians the scale to score the lowest number of A's was the European scale. Many subjects gave high marks to both the European set and the equi-pentatonic set; this may arise from the fact that both European and traditional local musical traditions exist side by side in Uganda today (or as Wachsmann put it in his article on Buganda in The New Grove Dictionary, "the pen-equidistant variety...tends to adapt to Western diatonic tuning"). Or it may again simply be an indication of the high degree of tuning tolerance.

In view of the findings of Siegel and Siegel (1977) these inconsistent results were entirely predictable (their paper had shown that even the best Western musicians had problems in judging the accuracy of intervals within standard Western pitch classes). Recent research of my own with Western music students supported the findings of the Siegels (Cooke 1990). In this research I measured the scales sung by a number of university music students and asked a panel of other music students to comment on the accuracy of the scale singing. They often accepted as in tune intervals that were as much as 35 cents wider or narrower than the theoretical norm of 100 or 200 cents.

If one bears in mind that the smallest Western interval is around 100 cents (the size of the interval between *te* and *doh,* i.e. the Sol-fa for notes 7 and 8 in the ascending diatonic European scale, actually averaged out at 81 cents in the scale singing of the students), one would expect similar problems for any African musicians. Poor tuning only becomes apparent to the listener as one moves closer to the boundary between adjacent pitch 'classes'. In the case of the European students the boundary lies 50 cents away from the theoretical ideal pitch centre and mistuning becomes progressively more apparent as a note moves into the area between 35-50 cents sharp or flat. In the case of the Ugandan musicians their 'smallest' interval is probably not less than 200 cents and possibly nearer 240 cents. In this case the boundaries between pitch classes lie some-

where around 100-120 cents from the ideal centre of adjacent pitches. So on the basis of the Siegel experiments one would expect to find that the Ugandan musicians might also judge as "out of tune" only those pitches near the boundaries between pitch classes. That is, notes could be approximately 100 cents and more sharp or flat of the hypothetical ideal before any mistuning was consistently identified.

It is still therefore something of a mystery how musicians such as the harpists tested by Wachsmann achieved scales so close to the hypothetical equipentatonic scale of 240-cent steps. I repeat, however, that the tests discussed above presented notes in purely melodic succession, for no two pitches were sounded together, whereas African tuners may well sound notes simultaneously when tuning instruments or play them in such rapid succession that dissonance and mistuning can be more readily perceived. One musician (not included in the results) refused to continue with the test because he insisted that this was not how he would test pitches: rather he would play them in descending groups of three, e.g. 6-5-4, 5-4-3, 4-3-2, 3-2-1 etc. and this was precisely the way former palace musicians checked on the pitches of a newly made instrument that they had set out to play on when I visited them at the their home village in February of 1992.

In my 1992 visit I planned also to record the processes by which a xylophone maker tunes an instrument. This was only partly successful. I was unable to revisit one tuner who had agreed on our first meeting to tune an instrument for me and a second maker used the pitches of a Kiganda flute as a reference, so he was only involved in making octave or unison judgements rather than establishing a scale. The tuning steps he took still have to be analysed in detail.

Conclusion.

The frequency of pen-equidistant tunings in Ganda and Soga musical traditions have given rise among researchers to the concept "equi-pentatonic" (see Schneider 1990 for a full discussion of the issues). My researches suggest that this concept is not invalidated by the existence of measured instrumental tunings that include non-equal intervals. They further suggest that, however they are measured, differences in interval size of up to 80 cents (possibly more) are not 'emically' significant, that is, they do not cause problems for the musicians themselves (not counting octave comparisons). In addition, the readiness with which Ganda musicians transpose their melodies up or down one or more steps in the *amadinda* (xylophone) and other instrumental traditions (flute, lyre, harp and fiddle playing) without admitting to any 'modal' differences, lends support to their possessing an unverbalised cognitive scheme of equidistance.

One may well ask the value of persistent enquiry into these instrumental tunings. Quite apart from the value of it in working towards an understanding of African musical systems, there is at least one practical application of this research: I am often asked by students who become keen on *amadinda* xylophone playing how they should tune instruments they have made for themselves and what the exact tuning should be. Now I can happily reply advising them that almost any pentatonic scale that does not contain intervals of much less than one whole tone should be satisfactory and that they should not worry about attempting to achieve a precisely calibrated scale. The only problem they might have is that any larger intervals will probably sound like minor thirds to them and the smaller ones like whole tones and this can be confusing for them if they have

learned to play songs on another instrument where the larger intervals appear in a different position in the scale. It is stressed, however, that this will only be a problem for Europeans and others encultured in a heptatonic (or dodecaphonic) tradition, where the aural distinction between a whole tone and a minor third is significant. Furthermore, in the absence of African instruments one need not hesitate to use European tuned percussion. When I played over some of the tunes recorded on European classroom instruments for the self-tutorial package, *Play Amadinda*, Ganda musicians expressed delight at the sound quality and – more importantly – found the European tuning quite acceptable.

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