Acoustic-Prosodic Features of Tabla Bol Recitation and Correspondence with the Tabla Imitation

Rohit M A, Preeti Rao

Dept of Electrical Engg, Indian Institute of Technology Bombay, Mumbai, India

Abstract

- In the Indian classical drumming tradition, the different strokes on the tabla are named by spoken syllables('***bols***')
- We investigate the supra-segmental properties of bol recitation and their correlation with the corresponding properties of the drumming
- We find that Intensity variations in *bol* recitation and corresponding playing correlate well but pitch variations are meaningful only for the variable-pitch strokes

Background

- A previous study[#] found *bols* to be onomatopoeic on comparing phonetic features of isolated utterances of *bols* and corresponding tabla strokes
- This work investigates prosodic attributes such as pitch and intensity variations in bol recitation and the corresponding tabla imitation
- This could help develop a model for any supra-segmentals in tabla music, along similar lines as the models for speech prosody

[#]Patel, A D, & Iversen, J R (ICPhS, 2003)

Tabla compositions

- A sequence of bols set to a *tala* — a cyclic pattern of beats, and can span one or more cycles
- Can start on any beat of the cycle but mostly end on the first beat
- Below is an example of a composition set to *tintal* — a 16-beat cycle (semicolons mark beat boundaries; composition spans 1 cycle)

Dha Dha - Dha ; Dha Dha - Dhin ; Ghi,Da Na,Ga Ti,Ra Ki,Ta ; Taa Taa Ti,Ra Ki,Ta
Taa Taa - Taa ; Dha Dha - Dhin ; Ghi,Da Na,Ga Ti,Ra Ki,Ta ; Taa Taa Ti,Ra Ki,Ta
Dha Dha - Dha ; Dha Dha - Dhin ; Ghi,Da Na,Ga Ti,Ra Ki,Ta ; Taa Taa Ti,Ra Ki,Ta
Taa Taa - Dha ; Dha Dha - Dhin ; Ghi,Da Na,Ga Ti,Ra Ki,Ta ; Taa Taa Ti,Ra Ki,Ta

(Scan the QR code below to listen to it)

Dataset

- 20 tabla compositions set to *tintal*, played and recited by an expert tabla player
- 6 minutes each of the recitation and the playing audios

A distribution of the compositions over no. of cycles spanned

No of cycles	No. of compositions
1	4
2	4
3	2
4	5
6	4
8	1

No of instances of pitched bols in the dataset

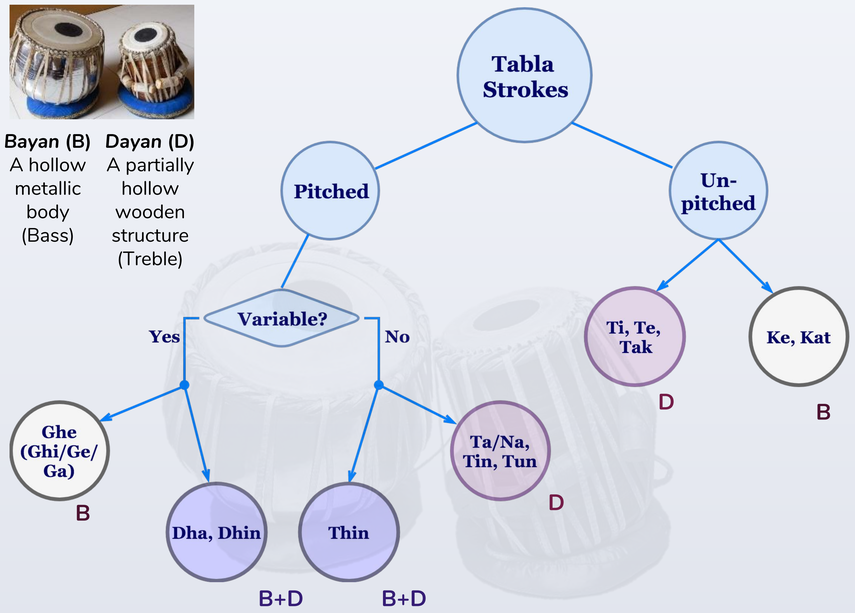
Bols	No of instances
Variable-pitch (Ghe, Dha, Dhin)	194
Fixed-pitch dayan (Ta, Tin, Tun)	157

Scan the code to listen to the above composition

The Tabla and its strokes/bols

Bayan (B) A hollow metallic body (Bass)

Dayan (D) A partially hollow wooden structure (Treble)



Results

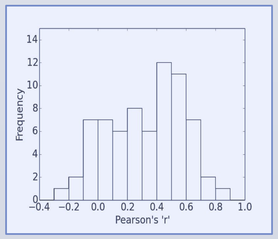
1. Comparing syllable rate, intensity range and F0 span of *bol* recitation with conversational English speech

Attribute	Bol recitation	Conversational English
Syllable rate	Min: 4-5 Max: 12-14 (no of bols/s)	4-5
Normalized intensity range(dB)	≈20 dB	≈20 dB
Normalized F0 span (SD in semitones)	Variable-pitch bols: 4.23	4.0
	Fixed-pitch dayan bols: 5.1	

Pitched dayan bols have a high F0 span despite the strokes having a fixed pitch on the Tabla

2. Cycle level Correlation – **Mean Intensity**

Histogram of 'r' values of mean intensity variations across every cycle



A peak near 0.5 indicates a moderately strong correlation in most cycles

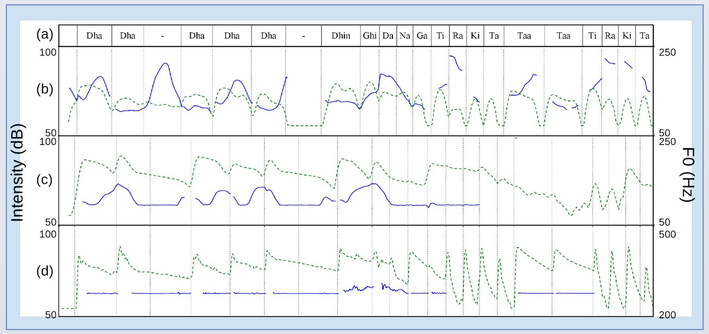
3. Bol/stroke level Correlation – **Mean F0**

Bol/ Stroke	Recitation	Playing	Pearson 'r'
Variable-pitch	$F0_{mean}$	$F0_{mean}$	0.37 ($p<0.05$)
Fixed-pitch Dayan	$F0_{mean}$	$F0_{mean}$	0.085 ($p<0.05$)

Moderately strong positive correlation in variable-pitch strokes, but, as expected, no correlation for the fixed-pitch dayan strokes

Analysis

- Segmentation and Onset detection
  - Audios of every composition first segmented into cycle-length durations
  - Within the cycle-length audios, individual bol/stroke segments extracted by identifying onsets in a spectral-flux based novelty curve
- Feature extraction
  - A short-time F0 and an intensity contour extracted and normalised
  - For the tabla audios, F0 extracted from two spectral regions: a low-pass(0-250 Hz) and a high-pass region(250-500 Hz), to capture the two drums separately
  - Figure below shows the F0 and intensity contours (in blue and green resp.) of a portion of a composition



(b): recitation (c): low-pass band (d): high-pass band

  - Contours then segmented into bols/strokes and **mean** values of **F0** and **intensity** obtained for each bol/stroke segment
- Correlation computation (Pearson's 'r')
  1. Cycle-level — to study intensity variations
     Between the sequences of **Mean Intensity** values of bols and the corresponding strokes, across a cycle
  2. Bol/stroke-level — to study pitch variations
     Between the sequences of **Mean F0** values of variable-pitch(***Ghe, Dha, Dhin***) and fixed-pitch dayan (***Ta, Tin, Tun***) bols and the corresponding strokes

Conclusions

1. Oral recitation of tabla compositions exhibits significant presence of expressive prosody
2. Intensity variations in the recitation and playing correlate well at the cycle level across all the bols/strokes
3. F0-variation correspondences are observed only in variable-pitch strokes
   This suggests a bigger role such as marking phrase boundaries or drawing a sharper contrast between the pitched bols/strokes