Statistical analysis of the change in accuracy of tabla players with increasing mathematical abilities

Malank Goel
goelmalank10@gmail.com
Delhi Public School, R.K Puram, New Delhi, Delhi

ABSTRACT

Tabla has been the principal percussion instrument in Indian classical music for decades. In this paper, accuracy will be considered as the ability to stay on beat and within the taal, while also increasing the tempo. This paper analyses the difference in the accuracy of a player's performance based on their mathematical ability. The performances were collected from 5 tabla players with varying mathematical expertise. The performances were analysed and based on the accuracy, statistical tools were used to compute whether a higher mathematical aptitude will lead to more accuracy.

Keywords— *Tabla, Instrument, Accuracy, Statistics, Standard Deviation, Maths, Mathematical Aptitude, Mathematical Operations, Fibonacci Series*

1. INTRODUCTION

Tabla is a percussion instrument which is primarily used in North Indian music. It can be played solo or as an accompaniment to other instruments, and vocals as part of an ensemble. It requires very precise strokes because a myriad of sounds can be produced by this instrument, by introducing slight changes in the position and manner of striking. It consists of two single-headed, barrel-shaped small drums of slightly different sizes and shapes: *bayan* and *dayan* for left and right drums respectively. They are sealed membranophones, which have 3 different areas on their surface. They have the Kinar, Maidan and Siyahi.
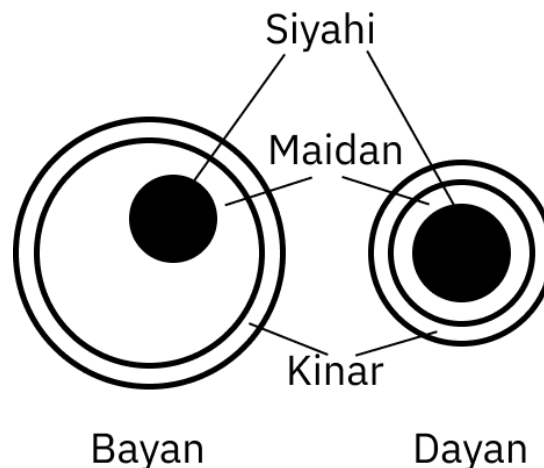

Figure 1: Labeled top view of a tabla

Tabla gharanas are responsible for the development of a variety of new bols, playing techniques, composition styles and rhythmic structures. Gharanas acted as a means of preserving these styles between generations of tabla players. There are 6 gharanas: Delhi Gharana, Lucknow Gharana, Ajrada Gharana, Farukhabad Gharana, Benares Gharana, Punjab Gharana.

Tabla primarily consists of 8 bols (TA, TIN, TUN, TI, RE, KHE, GHE, DHA) and 2 (DHIN, TAK) additional bols which are played by combining 2 of the 8 bols. The bols and their playing technique is as follows:

Table 1: Tabla Bol and their respective manner of playing

TA	Index finger strikes Kinar, third finger rests on Maidan, and other fingers in the air
TIN	Index finger strikes Maidan, third finger rests on Maidan, and other fingers in the air
TUN	Index finger strikers Siyahi and is immediately withdrawn
TI	Middle and third finger strike the Siyahi together
RE	Right after Ti, index finger strikes the Siyahi
KE	Flat hand is striked across Siyahi on the Maidan
GHE	Tip of index finger strikes across the Siyahi while heel of the hand rests on Maidan
DHA	Simultaneously playing TA and GHE
DHIN	Simultaneously playing TIN and GHE
TAK	Playing TA and KE in quick succession

A group of a definite number of Matras is known as Taal in Indian music. Every Taal is made up of fixed numbers and these numbers are known as Matra. The matra in the taal is used to estimate the length of the word taal. For example, Teentaal has 16 matras and Dadra taal has 6 matras. So it is easy to guess that the Teentaal is a bigger taal than Dadra Taal. These definite numbers of Matras are divided into a number of divisions. The fixed Matras of every Taal is divided into fixed divisions known as Vibhaag. For Example, Teentaal – 16 matras are divided into 4 Vibhags of 4 matras each and Dadra taal - 6 matras are divided into 2 Vibhags of 3 matras each.

Possible theoretical uses of maths in tabla are the uses of basic mental maths and some complex concepts like permutation combination and the fibonacci series. While playing a taal, the increase or decrease in the tempo / speed (laya) of playing has to be done in fixed proportions. For example, playing the Teentaal in dogun (double speed), we have to play it twice in order to end the bol on sam (the first beat of the cycle). These calculations become lengthier and more difficult as we move on to more challenging and longer bols. As for complex concepts, whenever a tabla player is playing a bol, and, say, 8 matras are left in the taal, the player has to fill it with either a short bol (1 matra) or a long bol (2 matras), then the player has 34 different combinations calculated through the fibonacci series (the 8th number of the series).

The present work was carried out with the ultimate goal of answering the question, Does mathematical aptitude help in tabla?
The present work uses mathematical concepts of various levels to find out whether the level of mathematics impacts the accuracy of a player. Concepts used varied from basic mental calculations to complex concepts.

2. METHODOLOGY
5 tabla players with varying mathematical ability were asked to play a specific bol on the tabla along with 3 different nagmas to check the accuracy. To get a precise result, the players had different mathematical abilities (Table 1) and all 5 players had been playing for roughly the same amount of time.

Table 2: Players and their mathematical ability

Tabla Player	Set No.	Mathematical Ability
ID_1	Set 1	little to no ability/knowledge in mental calculations
ID_2		
ID_3	Set 2	basic ability/knowledge in mental calculations
ID_4		
ID_5	Set 3	basic mental calculations to complex concepts

After the initial collections of data, the players were taken a step further and were informed about the next level of mathematics (Set 1 were given basic mathematical knowledge and Set 2 were given about complex mathematical knowledge). Each player played the tabla till the time they got 20 accurate plays with each nagma. This was repeated at each level and then using statistical tools, the accuracy was analysed and correlated with their tabla playing ability.

3. TESTING
Each player was given two sets of tests to gauge their mental aptitude. One gauged their basic mental math knowledge and the second gauged the knowledge on complex concepts. After the tests they were allotted, a set based on their results. Then they were asked to play the tabla along with a nagma.

They played with the nagma until and unless they successfully played a solo performance of about 5 minutes, for 20 times. A successful performance was when a player played a solo performance for about 5 minutes and stayed on the beat, without losing the tempo and ended the performance on sam (the first beat of the cycle). The same process was repeated with 2 other nagmas, this was as a control to see that the difference in nagma didn't affect their accuracy. After the 5 players completed the process, they were given the knowledge for the next level, and after they passed the aptitude test, they repeated the process.

The accuracy was measured by the number of inaccurate performances for every correct performance. Here, it was the total number of inaccurate performances divided by 20. Set 3 is a control set, just to check that performing the experiment twice will not affect the performance.

4. RESULTS AND DISCUSSION
The data was tabulated and graphed to perform further statistical calculations on the same. Tables for the given figures have been added to the appendix.
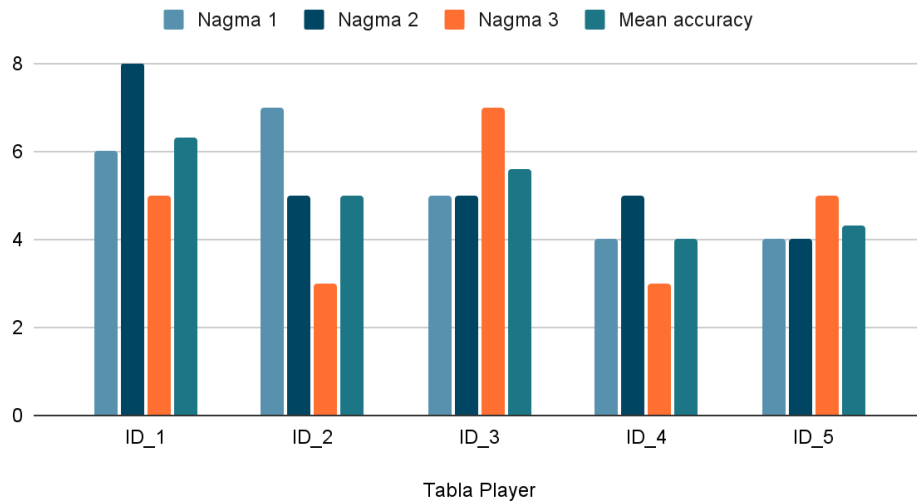
Nagma 1, Nagma 2, Nagma 3 and Mean accuracy

Figure 2: Accuracy based on initial abilities

Figure 2 shows the results of the tests based on initial ability. Figure 3 shows the databased on the upgraded ability, i.e Set 1 were taught basic mathematical calculations and Set 2 were taught complex concepts.

It is evident that Set 1 had a considerable improvement after learning the basic operations, whereas Set 2 had a minor improvement after learning the complex concepts. This shows that the general know-how of basic mental mathematical operations can elevate the accuracy of playing tabla, but the knowledge of complex concepts does not help significantly. The possible reason for this is that theoretically these concepts can help a tabla player see all the different combinations and thenchoose the best one, but while playing the player does not have this much time and therefore their artistic capabilities come into play and they play what they think fits best with the performance.

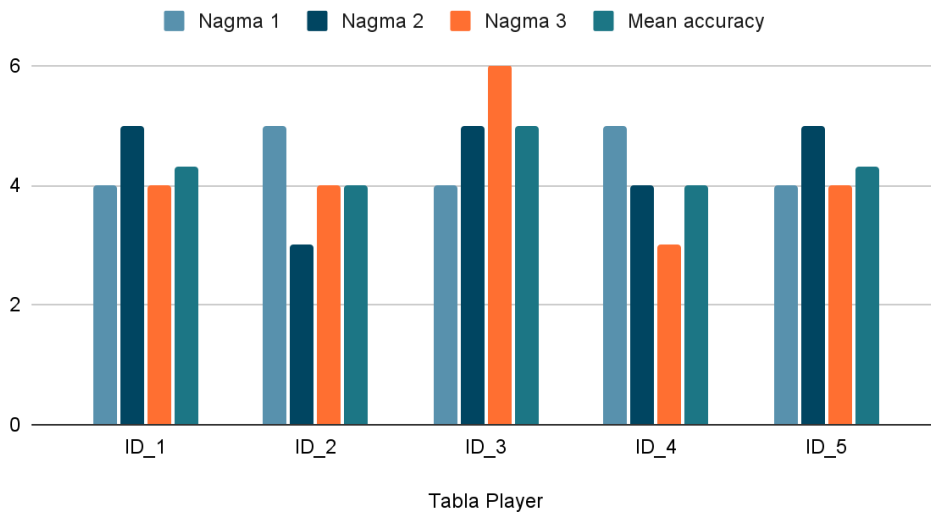Nagma 1, Nagma 2, Nagma 3 and Mean accuracy

Figure 3: Accuracy based on abilities after leveling up

Figure 4 was created in order to compare the improvement in consistency of the players. This was done using standard deviation: it is the measure of the amount of deviation of a set of values around its mean.
The formula used is:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - u)^2}{n}}$$

σ = standard deviationn
n = size of population
x_i = each value
u = mean

The data shows that Set 1 had a significant increase in their consistency as well. It is evident in Table 5, where ID_1 improved from 1.24 to 0.47 and ID_2 improved from 1.63 to 0.81. This shows that the knowledge of basic mathematical operations improves both the accuracy and the consistency of a player. Again, the knowledge of complex concepts did not have a considerable impact.
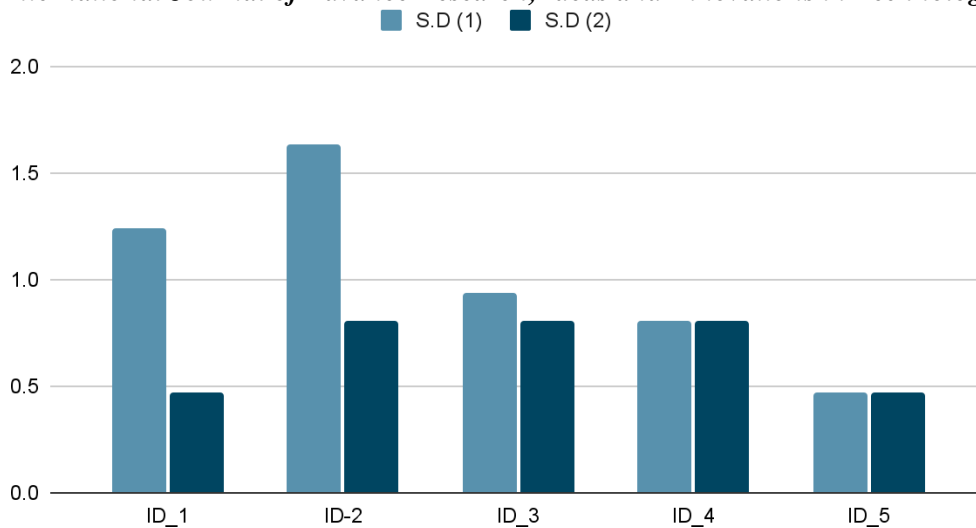
Figure 4: Graphical representation of Table 5

5. CONCLUSION

There is a significant increase in the accuracy and consistency of a tabla player when they learn basic mathematical operations, whereas there is negligible impact of the knowledge of complex concepts during performances.

The aforementioned observation can be attributed to the high pressure and time crunch during the performance, which prevents the player from computing and using the complex operations; the basic operations can be used because they require less brain power and time, which allows the tabla player to react faster and perform accurately.

This experiment used a sample space of 5 tabla players. For future work we would like to continue this research with more players, and adding more levels of mathematical concepts.

6. ACKNOWLEDGEMENT

7. REFERENCES

[1] Kippen, J. (1988). The Tabla of Lucknow: A Cultural Analysis of a Musical Tradition.Cambridge University Press.
[2] Narang, K., & Rao, P. (2017.). Acoustic Features for Determining Goodness of Tabla Stroke.18th
[3] International Society for Music Information Retrieval Conference. Suzhou, China.
[4] O. Gillet and G. Richard.(2003). Automatic labelling of tabla signals.4th International Society for Music Information Retrieval Conference
[5] Chordia, P. (2005).Segmentation and Recognition of Tabla Strokes.6th International Society for Music Information Retrieval Conference
[6] Anirban Patranabis, e. a. (2005). Harmonic and Timbre Analysis of Tabla Strokes.eprint arXiv:1510.04880.
[7] https:/ akankshasrivastavamusic.wordpress.com/2018/11/07/relation-between-ta bla-and-mathematics/
[8] https:/ www.mathsisfun.com/data/standard-deviation.html

APPENDIX

Player		Accuracy (number of incorrect plays for one correct play)			
Tabla Player	Set	Nagma 1	Nagma 2	Nagma 3	Mean accuracy
ID_1	1	6	8	5	6.3
ID_2	1	7	5	3	5
ID_3	2	5	5	7	5.6
ID_4	2	4	5	3	4
ID_5	3	4	4	5	4.3

Table 3 (Figure 2)

Player		Accuracy (number of incorrect plays for one correct play)			
Tabla Player	Set	Nagma 1	Nagma 2	Nagma 3	Mean accuracy
ID_1	1	4	5	4	4.3

ID_2	1	5	3	4	4
ID_3	2	4	5	6	5
ID_4	2	5	4	3	4
ID_5	3	4	5	4	4.3

Table 4 (Figure 3)

Tabla Player	Set	S.D (1) (initial ability)	S.D (2) (one level up ability)
ID_1	1	1.24	0.47
ID_2	1	1.63	0.81
ID_3	2	0.94	0.81
ID_4	2	0.81	0.81
ID_5	3	0.47	0.47

Table 5 (Figure 4)