

# Perception of rhythmic similarity in Flamenco music: Comparing musicians and non-musicians

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**Background in Music Psychology.** Previous research on rhythmic perception has highlighted differences between novice listeners and musicians in their ability to label perceived differences as well as strategies for representing musical structures. Novice listeners tend to focus on "surface" features while musicians tend to focus on the underlying rhythmic structure and develop a specific vocabulary (see [3] for a review). Furthermore, there is evidence that changes in tempo affect novices' perception of rhythm.

**Background in Music Performance.** In the field of music performance, research tends to focus on problems related to performance practice (perception of musical structures and expressivity). Little research has been done on the perception of rhythm issued from oral tradition cultures [6, 4]. Moreover, in the case of percussionists specialized in production and perception of rhythm and flamenco dancers and musicians, to our knowledge, no tests involving the comparison of novices and trained performers or using actual rhythmic patterns related to a specific cultural area have been conducted yet.

**Aims.** Presented in the first paper were the results of a listening test conducted to evaluate the perceived similarity of six flamenco rhythmic patterns with 15 non-musicians. The psychological ratings of similarity were then compared with the mathematical measures proposed in [2]. In this paper, we present a replication of the listening test with 12 classically trained musicians to investigate differences between novice listeners and trained musicians, in terms of phylogenetic analysis and spontaneous verbal descriptions.

The results presented in the previous paper [1] are extended in two ways: first, the differences between novice listeners and trained musicians are investigated; second, we analyze the verbal data used by participants to describe the differences between the different patterns and the strategy used to compare them.

## Listening test

Twelve listeners (mean age 24.6, SD 7) with

an average of 14 years of musical training were recruited from the music student population at McGill University. They received \$10 for their participation.

As in the previous paper, listeners listened to the six MIDI-generated patterns using Finale (hand clapping sounds from the standard percussion kit). The six patterns used are the following are the five basic patterns and the ancestral rhythm derived from the phylogenetic analysis of flamenco patterns [2], namely:

- (1) Fandango [x . . x . . x . . x . .]
- (2) Soleá [ . . x . . x . x . x . x]
- (3) Bulería [ . . x . . . x x . x . x]
- (4) Seguiriya [x . x . x . . x . . x . .]
- (5) Guajira [x . . x . . x . x . x . .]
- (6) Ancestral [x . . x . . x . . x x . .]

The rhythmic patterns were generated at two different tempi, namely 70 and 90 dotted quarter notes per minute, respectively denoted Medium and Fast in Figure 1. The experiment took place in an acoustically treated room and consisted of 2 sessions corresponding to the aforementioned tempi. Half of the participants did the medium tempo first, while the other half started with the fast tempo. In each session, participants were first asked to listen to the 6 rhythmic patterns presented in the experiment to become familiar with the range of variation. After 3 randomly chosen practice trials, they were asked to rate the similarity for all possible non-identical pairs of the 6 patterns (15 pairs), presented in random order. Every pair was presented twice in counterbalanced order, resulting in 30 trials in total per session. Similarity ratings were made with the mouse on a scale presented on the computer screen with end points labelled "very similar" and "very different". Participants were instructed to keep their rating strategy as constant as possible. After the sessions, participants were asked to freely describe the difference perceived between the patterns presented and explain which criteria they used to make their judgements.

**Phylogenetic trees**

A dissimilarity matrix was created for each participant based on his/her dissimilarity ratings. A global dissimilarity matrix was obtained by summing individual matrices across the 12 participants. The BioNJ phylogenetic program [5] was used to construct the phylogenetic tree for each tempo. The resulting trees are shown in

Figure 1.

The trees corresponding to the 15 non-musicians are presented in Figure 2 (see [1] for a full description of the listening test).

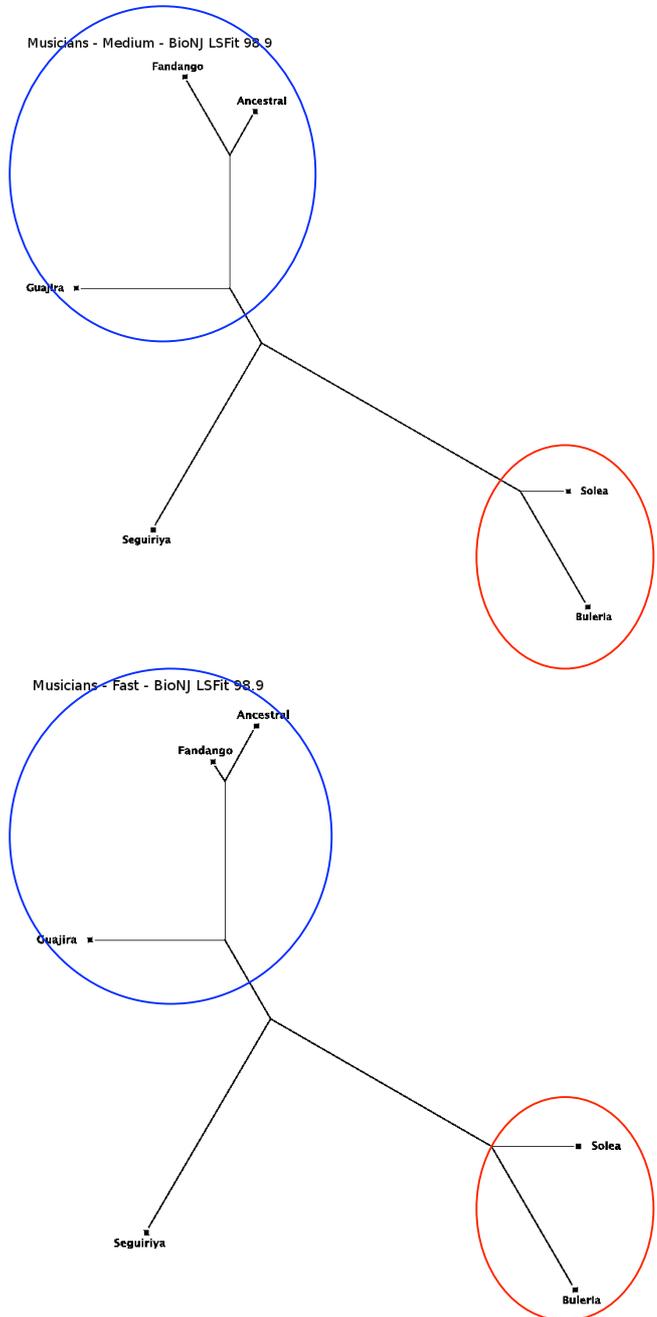


Figure 1: Phylogenetic trees for 12 musicians at the medium and fast tempo. Patterns with onsets on the 1<sup>st</sup> and 6<sup>th</sup> beats are circled in blue, patterns with anacrusis are circled in red.

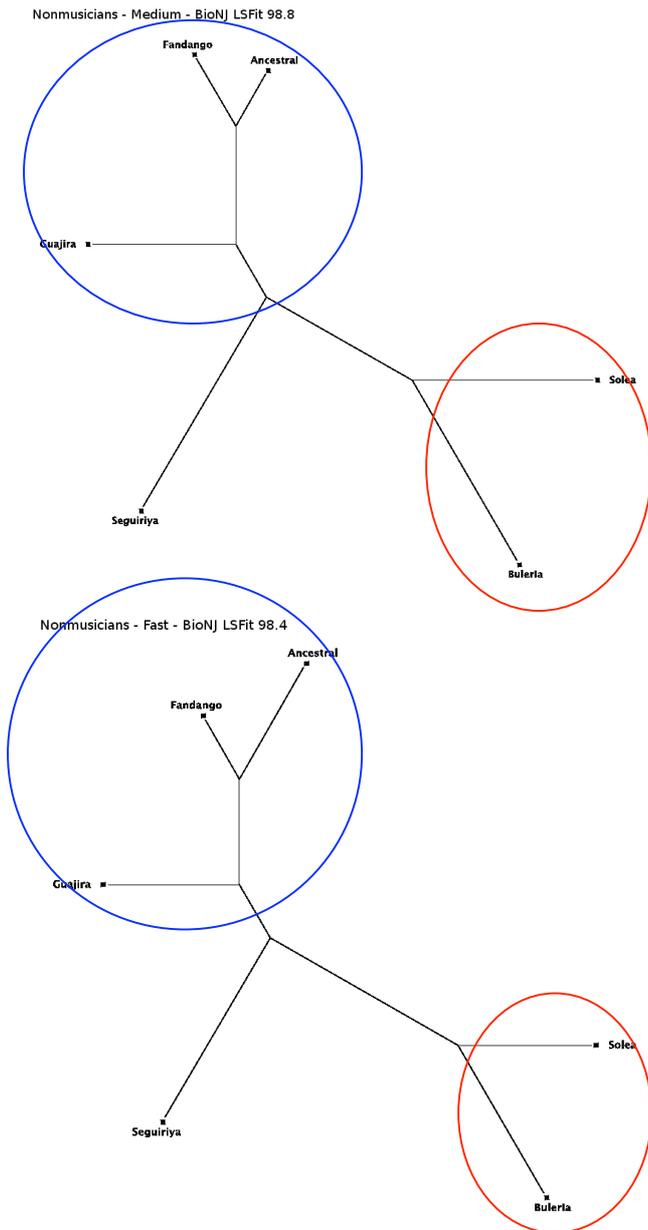


Fig 2: Phylogenetic tree for 15 non-musicians at the medium and fast tempi with the main clusters from [1]. Patterns with onsets on the 1<sup>st</sup> and 6<sup>th</sup> beats are circled in blue, patterns with anacrusis are circled in red.

The comparison of the trees reveals that 2 main clusters, one containing anacrusis patterns (Soleá and Bulería) represented in red, and one containing the 3 patterns whose first and sixth beats are accentuated (Fandango, Ancestral and Guajira), represented in blue. No major difference in terms of clusters were found across tempi or

between musicians and non-musicians. As in our first CIM paper [1], the comparison with mathematical measures of rhythmic similarity indicates the directed swap distance best matched perceived similarity in terms of clusters and the most distinct meters for musicians (as well as non-musicians).

### Analysis of the verbal comments

Participants were asked which criteria they used to make their judgment and how they would describe the difference between each pair of rhythms, besides general comments. Using an emergent theme analysis, four types of information were extracted from the verbal data regarding: the perception of the different rhythms; the criteria used for segmentation or classification; and the strategy they used to complete the task.

The analysis revealed different strategies for each group of participants. Non-musicians based their judgments on the beginning and end of the patterns, specifically whether the first and last beat were accentuated, and on the total number of accentuated beats. Trained musicians, on the other hand, relied on groupings of 2's and 3's, the presence/absence of two consecutive accentuated beats, whether the pattern started with an accentuated or non-accentuated beat and the global structure of the patterns.

Musicians also used a different strategy to complete the task: they re-created mentally a polyphonic pattern to compare patterns note by note, by tapping the first pattern as they listened to the second pattern. By superimposing mentally the two patterns to compare them, musicians are using a comparison method somewhat similar to the directed swap distance, defined as the minimum number of position interchanges of adjacent 'x's and 's (see [1] for further description of the directed swap distance). Indeed, they seem to be matching each onset of one pattern to the nearest onset of the other pattern. More detailed interviews will be conducted to further investigate this comparison strategy.

Another difference in the verbal data of musicians and non-musicians is the

vocabulary used to describe the criteria of segmentation; musicians had developed vocabularies and used formal terms to describe their strategies, whereas non-musicians used broader terms such as "beats and "rhythm.

In addition, musicians gave significantly higher ratings (i.e. judged patterns as significantly more different) than non-musicians ( $t_{(58)}=2.09$ ,  $p=0.04$  for the medium tempo;  $t_{(58)}=2.37$ ,  $p=0.02$  for the fast tempo). Similarly, musicians did not use the minimal rating (labelled as "very similar"), which they reserved for identical pairs.

### Implications

Our results show that trained musicians and novices organized the different rhythmic patterns in a very similar way, but using different cognitive processing strategies. They further extend our previous finding that the *directed swap* distance proposed by [7] closely matches human judgments of perceived similarity to classical trained musicians. Further experimentation will include flamenco musicians to further investigate the effect of expertise.

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### References

- [1] Guastavino, C., Toussaint, G., Gomez, F., Marandola, F., & Absar, R. (2008). Rhythmic Similarity in Flamenco Music: Comparing Psychological and Mathematical Measures. Proceedings of the 4th Conference on Interdisciplinary Musicology (CIM '08), July 2-6, 2008, Thessaloniki, Greece.
- [2] Díaz-Báñez, J.-M., Farigu, G., Gómez, F., Rappaport, D. & Toussaint, G. (2005). Similaridad y evolucion en la rítmica del flamenco: una uncursion de la matematica computational. *La Gaceta de la Real Sociedad de Matematica Española*, 8(2), 489-509.
- [3] Duke, R. (1994). When tempo changes rhythm: the effect of tempo on nonmusicians' perception of rhythm. *Journal of Research in Music Education*, 42, 27-35.
- [4] Düring, J. (1997). Rythmes ovoïdes et quadrature du cercle. *Rythmes - Cahiers de musique traditionnelle*, 10, Genève.
- [5] Gascuel, O. (1997). BIONJ: an improved version of the NJ algorithm based on a simple model of sequence data. *Molecular Biology and Evolution*, 14, 685-695.
- [6] Tekman, H.G., Kurt, S, & Z. Peynircioglu, Z. (2003). Perception of symmetric and asymmetric meters by listeners familiar and unfamiliar with asymmetric meters. *Abstracts of the 5th Triennial Conference of the European Society for the Cognitive Sciences of Music*, Hanover University of Music and Drama, 368-371.
- [7] Toussaint, G. (2004). A comparison of rhythmic similarity measures. Proceedings of ISMIR 2004: 5th International Conference on Music Information Retrieval, Universitat Pompeu Fabra, Barcelona, Spain, October 10-14, 242-245.