

# Comparisons between speech and singing with focus on synchronization process

Beatriz Raposo de Medeiros

Universidade de São Paulo  
biarm@usp.br

Dinafon 2014 August 18 - 21

**Round Table: Gestural Phonology in Brazil**



# Presentation Outline

1. Interplay between speech/language and singing
2. The issue of aspects versus a well known primitive
3. Singing as a kind of speech
4. The synchronization experiment

Is singing good for synchronizing?

Is it better than speech in this matter?

# 1. Speech/language and Singing

- Some Studies: Lerdahl & Jackendoff, 1983; Sloboda, 2008; Patel, 2012, Deutsch et al 2011, Peretz & Coltheart, 2003.
- What is their contribution? *Discussion on functional and conceptual overlap between music and language, on brain mechanisms underlying speech and music; on possible shared specific domains of knowledge, etc.*

## 2. The issue of aspects versus a well known primitive

- Phonemes...
- Gestures...
- Syllables...

It does not matter: Linguistics has its very well delimited unities.

Phonology and Phonetics: can deal with **syllables** with the shortest speech event **VOT**, as **Ubiratã Alves** does in this round table.

On the other hand, music, has **no formal unity of analysis** as linguistic does. For instances, no distinctive features in a system as the phonological system (Lerdahl, 2012).

## 2. Lerdahl and Jackendoff GGTM

- In the field of Linguistics the most well-known relationship between language and music is the **Generative Grammar of Tonal Music**, by Lerdahl and Jackendoff, 1983.
- GGTM has developed in TPS (Tonal Pitch Space, Lerdahl, 1988, 2001).
- GGTM and TPS: a theory that argues in terms of rules of preference that would not be coherent with generative rules. Besides TPS reached an empirical and numerical level that is not part of generative theory.
- BUT: both theories do not necessarily address to a more low level of interplay: as for instance the acoustic level.

### 3. Speech compared to sung speech

- The interplay between song and speech can be a way to explain music and language as interconnected capacities in more empirical grounds.
- Our claim: singing can be studied as a type of speech
- For a long time sung speech was a strange object to Linguistics
- It was not considered a structure or an abstract phenomenon. Well. Maybe it still is : |

# Why dynamics?

- When two people speak in synchrony, what is going on?
- Dynamical Systems Theory gives us a language to describe the *joint* movements
- We can characterize a new, temporary, system that is made up of two people

## 4. Experiments: synchronization in speech and song

### • Experiment 1

#### Questions:

- 1) Does synchronization among speakers or singers require the presence of a beat?
- 2) Would singing behave differently from speech in terms of synchronization?

Rock (NoSyncsong)



NurseryRhyme



Samba(SyncSong)



Prose



### • Experiment 2

#### Questions:

- 1) Can asynchrony in Samba, compared to a more synchronized Rock, be explained by syncopation, so by a musical specific feature?
- 2) Can we say that asynchrony in Prose and Samba are the same?



# Experiment 1

## – **Methods:**

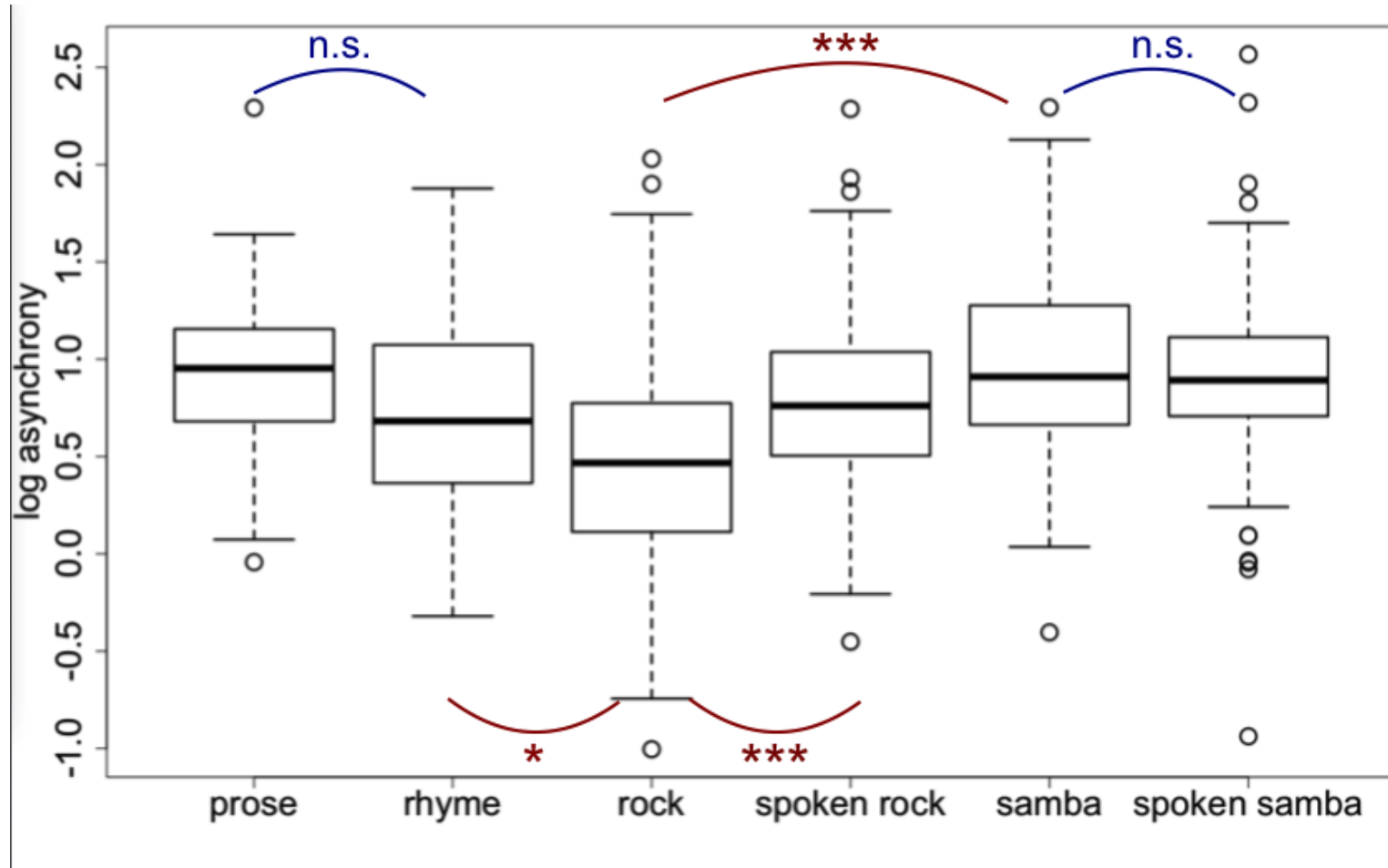
- 6 text units repeated one time by 10 pairs of subjects, Brazilian Portuguese native speakers and competent singers.
- Recordings done in sound attenuated booth with Shure head-mounted microphones.
- Text units segmented into sentences.
- Quantitative estimation of asynchrony computes the amount of temporal warping required to map one utterance onto another. More warping → more asynchrony [Cummins, 2009]
- Asynchrony scores are normalized by utterance length, so we can compare asynchrony for sentences of different duration.

## – **Planned Comparisons:** T-tests with Bonferroni correction

## – **General results :** Box plot next slide

# Experiment 1: general results

(Raposo de Medeiros and Cummins, 2014)



# Experiment 1 results indicate that

- There is no difference between Samba and Spoken Samba
- But there is difference between Samba and Rock
- Syncopation has some influence on synchronization  
(Large, 2000 has evidence for syncopation influence in movements synchronized with music)
- And what about Prose related to Samba?
  - One can hypothesize that there is no difference between Prose and Samba

## ...some more discussion

- Can we deepen the idea that SYNCOPATION plays a strong influence to asynchrony?
- Let us see some possible comparisons with our Singing data:
  - **Samba X Spoken Samba**
  - **Rock X Spoken Rock**
  - **...and if we have time, some difference on Prose X Samba**

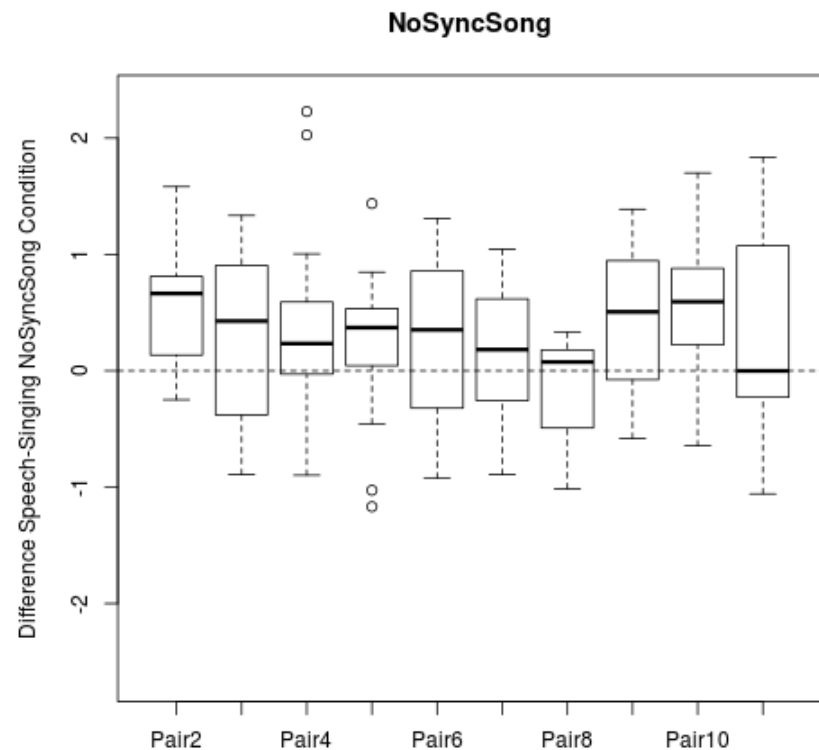
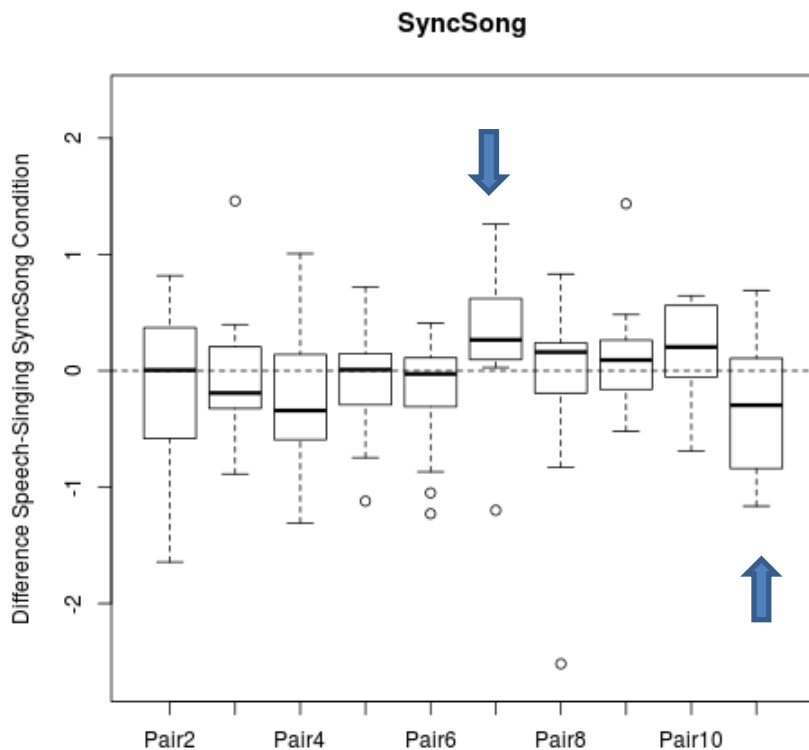
# Experiment 2

- **Methods:** Same of Experiment 1
- **2 Comparisons:**
  - One paired t-test : Singing data
  - (Box Plots and Variance of Prose versus Samba: speech versus singing Data)
- **Results :** Boxplots and numerical results next slides

# Experiment 2

2 Paired T-tests: Differences in sentence level.

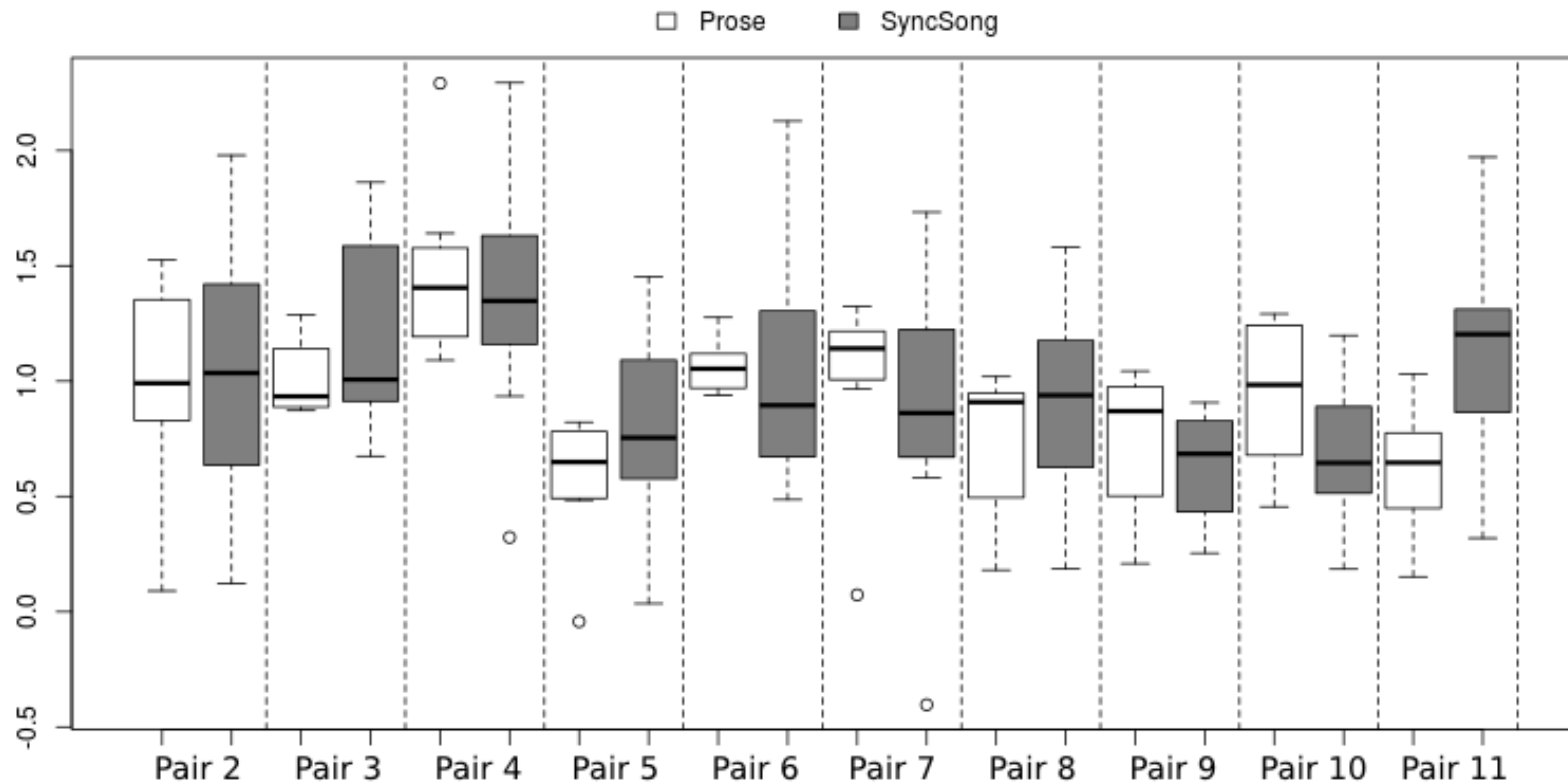
- (i) Samba (SyncSong) X Spoken Samba. P-value = 0.264 (NS)
- (ii) Rock (NoSyncSong) X Spoken Rock. p-value = 0.00001 (S)



# Experiment 2: partial discussion

- Syncopation plays a role in Samba asynchrony
- Assuming singers are influenced by musical rhythm when they speak the song...
- ...Syncopation may influence samba spoken version, too.
- ...and can be responsible for variance of sung samba.
- so we doubt that Prose asynchrony behaves the same way as samba asynchrony as general results of [Experiment 1](#) may lead us think.

Prose x Samba: Variance Box plot : per dyad.  
F-test to compare two variances per condition  
p-value = 0.077





# Issues on Prose asynchrony

- If Syncopation makes it difficult to synchronize, even in spoken samba...
- Then there must have some temporal structure in Prose that makes it as “asynchronous”
  - Sentences length/ Some freedom to put pauses/ pause duration/ Low expectation compared to music expectation

# Final discussion

- A first approach on synchronization in speech and singing ([Experiment 1](#)) showed that a beat is not needed to synchronic speech, but it helps.
- Still, in the first approach we can say that a simple rhythm (rock) facilitates synchronization
- More results (Experiment 2) brought some evidence about the complex aspect of synchronization in singing. We were showed that it is not every musical beat that facilitate synchronization.
- Syncopation can be called na off-beat and can lead to instability.

# References

- Cummins , F. Rhythm as entrainment: The case of synchronous speech. *Journal of Phonetics*. 37(1):16-28. 2009.
- Deutsch, D. et al. Illusory transformation from speech to song. *J. Acoust. Soc. Am.* 129(4): 2245-2252. 2011.
- Large, E. W. On synchronizing movements to music. *Human Movement Science*, 19, 527–566. 2000.
- Lerdahl, F. Musical Syntax and its Relation to Linguistic Syntax . Talk in *Le Collège de France*, Nov. 2012
- Patel, A. Language, music and the brain: a resource- sharing framework. In Rebuschat et al. *Language and music as cognitive systems*. Oxford university Press. 204-223. 2012.
- Peretz , I. and Coltheart, M. Modularity of music processing. *Nature Neuroscience*. 6 (7). 2003.
- Raposo de Medeiros, B. and Cummins, F. Speech and song synchronization: a comparative study. *Speech Prosody*, 2014.
- Sloboda, J.A. *A mente musical*. Londrina. Eduel.2008. [translation by Beatriz Ilari na Rodolfo Ilari)

A special thanks to Fred Cummins, whose tools and statistics analysis  
made possible a great part of this project (Projeto FAPESP  
2011/14435-3)

Things I like  
in Campinas!



Thanks, many of them, to André Baceti and to Murabei  
Data Science <http://www.murabei.com/>

Things I like  
in Campinas!





I am deeply grateful to Eleonora Albano for teaching us, getting us together and moving us around the sounds of speech...

And singing!

Things I like  
in Campinas!

