

# Assistive Real-Time Technology in Singing

Project Meeting

February 22, 2014

Inês Moura

# How can singers use technology?

# Agenda

- I. Objectives of task 4 and 6
- II. Metodology
- III. Procedures
- IV. Results & Discussion

# Agenda

I. Objectives of task 4 and 6

II. Metodology

III. Procedures

IV. Results & Discussion

# I. Objectives of task 4...

## Task 4

Correlation between objective acoustic features of the singing voice and voice disorders in singing

## Goals

- ① Identify in recent literature what **singing disorders** are typical
- ② Associate **perceptual classification parameters to common voice disorders**
- ③ Investigate **what acoustic features are correlated with voice disorders**

## Needs

Databases of both singing and spoken voices, healthy or exhibiting voice disorders

# I. ... and objectives of task 6

## Task 6

Real-time preventive assessment of the singing voice

## Goals

- ① **Improve the SingingStudio** software (extension of Task 2)
- ② **Allow singers to monitor their singing voice in real-time** with the purpose to detect stress or overload manifestations
- ③ **Extract meaningful acoustic features from running singing** (and not only from sustained vowels)

## Needs

Validation work that involves researchers from FEUP and FMUP

# I. Objectives of task 4

## Task 4

Correlation between objective acoustic features of the singing voice and voice disorders in singing

## Goals

- 1 Identity in recent literature what **singing disorders** are typical
- 2 Associate **perceptual classification parameters** to common voice disorders
- 3 Investigate what **acoustic features** are correlated with voice disorders

## Needs

Databases of both singing and spoken voices, healthy or exhibiting voice disorders

# I. Objectives of task 4

① | Identify in recent literature what singing disorders are typical

Studies suggest ...

- 44% of singers has voice problems
- 27% dysphonia caused by inflammatory problems
- Lack of voice care (vocal warm up...)
- Compensatory postures (neck, shoulders...)
- Vocal abuse/ strain / constriction

# I. Objectives of task 4

## Task 4

Correlation between objective acoustic features of the singing voice and voice disorders in singing

## Goals

① Identify in recent literature what singing disorders are typical

② Associate perceptual classification parameters to common voice disorders

③ Investigate what acoustic features are correlated with voice disorders

## Needs

Databases of both singing and spoken voices, healthy or exhibiting voice disorders

# I. Objectives of task 4

## ② | Perceptual parameters common in voice disorders

Voice specialists judge:

- Instability ( $p=0,745$ )
- Tension ( $p=0,661$ )
- Breathness ( $p=0,645$ )

Using RASATI scale (based on GRBAS - Grade, Roughness, Breathiness, Asthenia, Strain)

Singers tasks: 3 vowels, 1 song, 1 text

# I. Objectives of task 4

## ② | Perceptual parameters common in voice disorders

ARTTS - Avaliação perceptiva.

### Tecnologia de Apoio em Tempo-Real ao Canto

O projeto de investigação "Tecnologia de Apoio em Tempo-Real ao Canto", pretende articular conhecimento a partir de diferentes disciplinas, com o intuito de validar tecnologias e metodologias para cantores, alunos e professores de canto.

No âmbito do plano de investigação, é solicitada a colaboração de Terapeutas da Fala para a classificação de amostras de voz, com diferentes graus de alteração de qualidade vocal, em cinco tarefas distintas: vogal sustentada, vogal em crescendo de intensidade, vogal em crescendo tonal, leitura e canto.

A escala de avaliação a ser utilizada é a escala RASATI, sendo os parâmetros de avaliação:

- R - Rouquidão
- A - Aspreza
- S - Soprosidade
- A - Astenia
- T - Tensão
- I - Instabilidade

Estará disponível nas páginas correspondentes à avaliação uma explicação escrita de cada parâmetro. Será visível quando o ponteiro do rato estiver sobre a letra correspondente.

A avaliação de cada parâmetro é feita através de uma escala numérica de 0 a 3. Os números apresentados correspondem ao seguinte grau:

- 0 (Normal) – nenhuma alteração é identificada;
- 1 (Leve) – para alterações vocais discretas ou em caso de dúvida;
- 1,5 (Leve-Moderado) – alteração vocal leve a moderada;
- 2 (Moderado) – quando a alteração é evidente;
- 2,5 (Moderado-Intenso) – alteração moderada a intensa;
- 3 (Intenso) – alterações vocais extremas.

Depois de ouvidas as amostras e serem seleccionados os valores de cada prova, deverá submeter a avaliação e passar para a prova seguinte. O tempo previsto para a avaliação é de 50 minutos. Ao concluir cada módulo da avaliação esta fica definitivamente guardada na nossa base de dados, podendo ser feito um intervalo entre os módulos sem risco de perder a avaliação dos módulos já submetidos.

Pode ouvir cada amostra as vezes necessárias, antes de submeter a avaliação.

Obrigada pela colaboração e ao dispor para qualquer esclarecimento adicional.  
Pela equipa de investigação,  
Inês Moura (inesmoura\_@hotmail.com)

**Informações:**  
Sugere-se a utilização de auscultadores tipo head phones com o volume no máximo (evitar auscultadores de ouvidos).  
A sua avaliação de forma faseada, desde que completa até ao final a prova em que se encontra e carregue no botão "Submeter avaliação".

Email:

# I. Objectives of task 4

## ② | Perceptual parameters common in voice disorders

ARTTS - Avaliação perceptiva.

**Questionário de caracterização do Terapeuta:**

1. Indique o número de anos de experiência como Terapeuta da Fala:

< 5     5 - 10     10 - 15     > 15

2. Exerce funções em contexto:

Público     Privado     Público e Privado

3. Nos últimos 12 meses teve experiência na avaliação de profissionais da voz da área do canto?

Sim     Não

4. Nos últimos 12 meses, nos casos de voz que atendeu, qual o motivo pelo qual mais o(a) procuraram?

Casos de aperfeiçoamento vocal (disfonia ausente ou leve)     Casos de patologia vocal (disfonias moderadas a intensas)

É necessário responder a todas as questões para poder o questionário poder ser submetido.

# I. Objectives of task 4

## ② | Perceptual parameters common in voice disorders

ARTS - Avaliação perceptiva.

	Vogal sustentada	Crescenda Intensidade	Crescência tonal	Carro	Letura	
	R	A	S	A	T	I
Amostra 1	0	3	0	0	0	0
Amostra 2	0	3	0	0	0	0
Amostra 3	0	3	0	0	0	0
Amostra 4	0	3	0	0	0	0
Amostra 5	0	3	0	0	0	0
Amostra 6	0	3	0	0	0	0
Amostra 7	0	3	0	0	0	0
Amostra 8	0	3	0	0	0	0
Amostra 9	0	3	0	0	0	0
Amostra 10	0	3	0	0	0	0
Amostra 11	0	3	0	0	0	0
Amostra 12	0	3	0	0	0	0
Amostra 13	0	3	0	0	0	0
Amostra 14	0	3	0	0	0	0
Amostra 15	0	3	0	0	0	0
Amostra 16	0	3	0	0	0	0
Amostra 17	0	3	0	0	0	0
Amostra 18	0	3	0	0	0	0
Amostra 19	0	3	0	0	0	0
Amostra 20	0	3	0	0	0	0
Amostra 21	0	3	0	0	0	0
Amostra 22	0	3	0	0	0	0

É necessário avaliar a totalidade das amostras para poder submeter a avaliação.

# I. Objectives of task 4

## ② | Perceptual parameters common in voice disorders

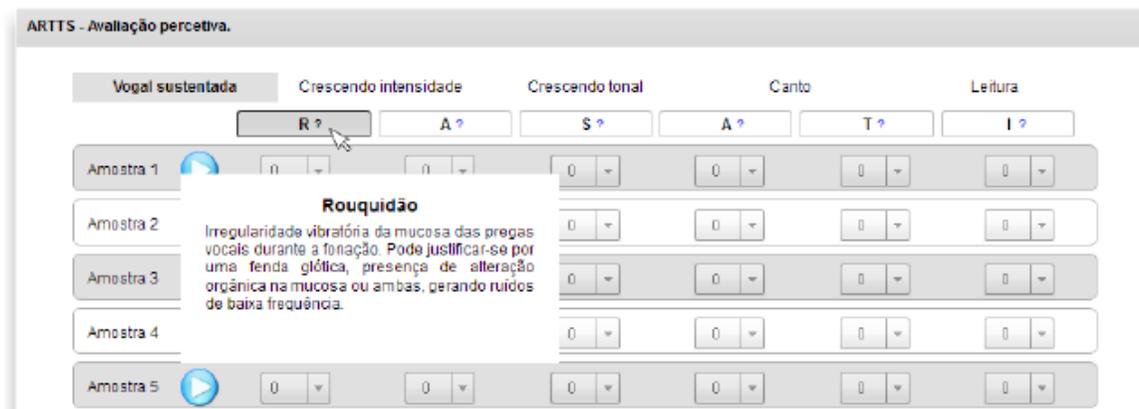


Imagem 6: Janela demonstrativa da definição de cada parâmetro (âncora).



Imagem 7: Janela demonstrativa da *drop-down-list* com a classificação numérica.

# I. Objectives of task 4

## ② | Perceptual parameters common in voice disorders

Prova		Rouquidão	Aspereza	Soprosidade	Astenia	Intensão	Instabilidade
Vogal Sustentada	Média	,511	,439	,731	,277	,580	<b>,845</b>
	Dp	,7653	,6510	,7055	,5968	,6678	,6828
	Mediana	,0000	,0000	1,0000	,0000	,0000	1,0000
Aumento de Intensidade	Média	,667	,504	,648	,220	,765	<b>1,023</b>
	Dp	,7558	,6948	,6589	,5360	,7269	,7358
	Mediana	,0000	,0000	1,0000	,0000	1,0000	1,0000
Aumento de Pitch	Média	,481	,371	,731	,106	,905	<b>,920</b>
	Dp	,6751	,5881	,6521	,3604	,7075	,6903
	Mediana	,0000	,0000	1,0000	,0000	1,0000	1,0000
Canto	Média	,337	,311	<b>,693</b>	,117	,652	,663
	Dp	,6315	,5612	,6615	,3801	,6566	,7111
	Mediana	,0000	,0000	1,0000	,0000	1,0000	1,0000
Texto	Média	,379	,345	<b>,424</b>	,080	,402	,273
	Dp	,5897	,6151	,5187	,3016	,5609	,5434
	Mediana	,0000	,0000	,0000	,0000	,0000	,0000
Total	Média	,475	,394	<b>,645</b>	,160	<b>,661</b>	<b>,745</b>
	Dp	,6945	,6258	,6507	,4541	,6858	,7238
	Mediana	,0000	,0000	1,0000	,0000	1,0000	1,0000

Tabela 1: Médias das classificações dos peritos

# I. Objectives of task 4

## Task 4

Correlation between objective acoustic features of the singing voice and voice disorders in singing

## Goals

① Identify in recent literature what singing disorders are typical

② Associate perceptual classification parameters to common voice disorders

③ Investigate what acoustic features are correlated with voice disorders

## Needs

Databases of both singing and spoken voices, healthy or exhibiting voice disorders

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

**First step:** test the behavior of the acoustic parameters

**Second step:** choose the appropriate statistic tests (parametric or non parametric)

**Third step:** analyse all data



Extract meaningful acoustic features from running singing (and not only > from sustained vowels)

- Normality tests
- Kurtosis
- Symmetry

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

- Acoustic parameters have been excluded on speech and singing analyses
- In the other proofs we choose the ones that can bring relevant information.

	Vogal sustentada	Aumento de intensidade	Aumento de pitch
Desv. P. F0	x	x	o
Desv. P. Energia	x	o	o
Jitter (PPQ5)	x	x	o
Shimmer (APQ5)	x	o	o
Shimmer local	x	o	o
HNR	x	x	-

Tabela 8: Parâmetros acústicos avaliados nas diferentes provas.

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

- HNR results of the pitch exercise using VoiceStudio and Praat
- 8 case studies have been selected

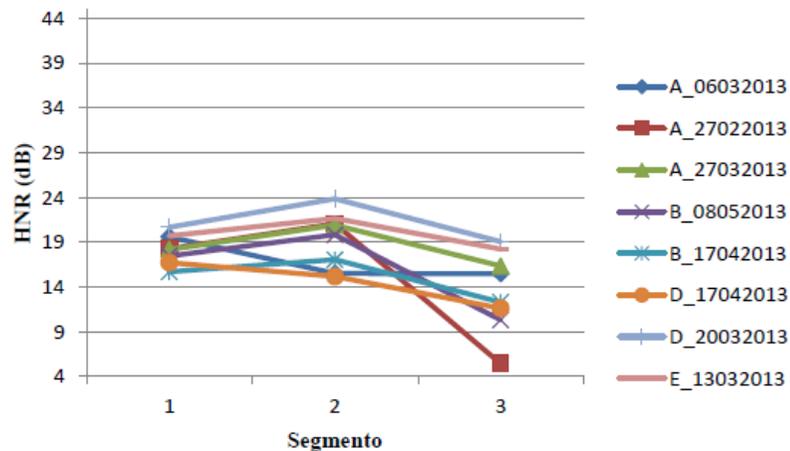


Gráfico 4: Medidas de HNR no software "VoiceStudio" na prova de aumento de pitch.

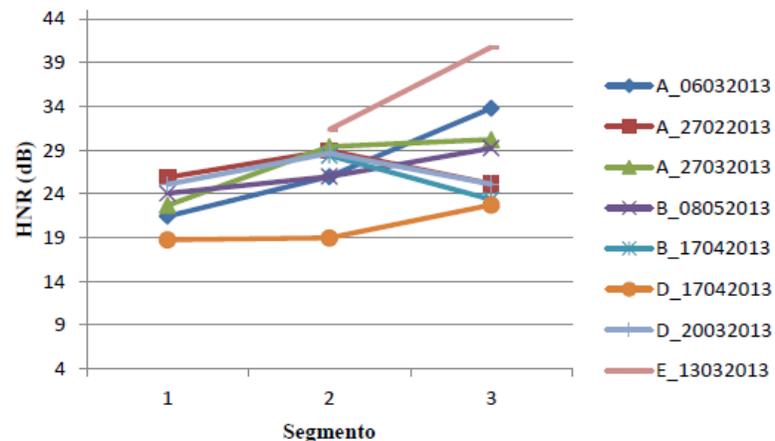


Gráfico 5: Medidas de HNR no software "Praat" na prova de aumento de pitch.

**P (1-2)=0,235**

**p (2-3)=0,822;**

**p (1-3)=0,838**

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

- HNR results of the pitch exercise using VoiceStudio and Praat

Segmentos	Software	N	Média	Desvio padrão	Erro padrão da média
Um	VoiceStudio	22	17,272	2,074	0,442
	Praat	20	22,113	2,439	0,545
Dois	VoiceStudio	22	19,277	2,871	0,612
	Praat	22	26,332	2,915	0,621
Três	VoiceStudio	22	17,330	4,304	0,918
	Praat	22	28,390	4,388	0,935

Tabela 15: Análise estatística das medidas de HNR dos três segmentos para o “Praat” e “VoiceStudio”.

## I. Objectives of task 4

### ③ | Acoustic features correlated with voice disorders

- So, we rejected the HNR analysis in the third segment of the pitch exercise

Segmentos	N	Média	Desvio padrão	Erro padrão da média
Um	20	4,882	2,355	0,527
Dois	22	7,055	2,426	0,517
Três	22	11,060	5,154	1,099

Tabela 19: Análise estatística das diferenças de HNR dos três segmentos para o “VoiceStudio” e “Praat”.

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

- Acoustic parameters that had been analysed (x)

	Vogal sustentada	Aumento de intensidade	Aumento de pitch
Desv. P. F0	x	x	o
Desv. P. Energia	x	o	o
Jitter (PPQ5)	x	x	o
Shimmer (APQ5)	x	o	o
Shimmer local	x	o	o
HNR	x	x	o

Tabela 20: Parâmetros acústicos comparativamente testados para a prova de “Vogal sustentada” e “Aumento de intensidade”.

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

- Hypotheses

H0 – There is a significant correspondence between acoustic and perceptive parameters.

H1 – There is no significant correspondence between acoustic and perceptive parameters.

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

### Results – Sustained vowel (“Kruskal-Wallis”- non-parametric test)

- **R** (hoarseness): “Shimmer APQ5” ( $p=0,144$ );
- **A** (roughness): “Standard deviation of F0” ( $p=0,068$ ) e o “Jitter” ( $p=0,067$ );
- **S** (breathiness): “Shimmer APQ5” ( $p=0,215$ );
- **A** (asthenia): “Shimmer APQ5” ( $p=0,138$ );
- **T** (strain): “Standard deviation of F0” ( $p=0,089$ ), o “HNR” e o “Standard Deviation of Energy”, both with  $p$  value ( $p= 0,094$ );
- **I** (instability) “HNR” ( $p=0,140$ ).

The more frequent is “Shimmer APQ5” (3) , “Desvio padrão de F0” (2) e “HNR”(2)

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

**Results** for the "Increasing Intensity" voice exercise  
(“Kruskal-Wallis”- non-parametric test)

- **Rouquidão:** “Standard deviation of F0” ( $p=0,191$ );
- **Aspereza:** “Jitter” ( $p=0,028$ );
- **Soprosidade:** “Jitter” ( $p=0,042$ );
- **Astenia:** “Jitter” ( $p=0,024$ );
- **Tensão:** “Standard deviation of F0” ( $p=0,030$ );
- **Instabilidade:** “HNR” ( $p=0,143$ ).

The more frequent is “Jitter” (3), “Standard deviation of F0” (2)

# I. Objectives of task 4

## ③ | Acoustic features correlated with voice disorders

**Rouquidão:** “Standard deviation of F0” and “Shimmer APQ5”

**Aspereza:** “Standard deviation of F0” and “Jitter”

**Soprosidade:** “**Shimmer APQ5**”

**Astenia:** “Shimmer APQ5” and “Jitter”

**Tensão:** “**Desvio Padrão de F0**”, “HNR”

**Instabilidade:** “**HNR**” 

# I. Objectives of task 6

## Task 6

Real-time preventive assessment of the singing voice

## Goals

Improve the SingingStudio software (extention of Task 2)

Allow singers to monitor their singing voice in real-time with the purpose to detect stress or overload manifestations

Extract from running singing (and not only from sustained vowels) meaningful acoustic features

## Needs

Validation work that involves researchers from FEUP and FMUP

# Agenda

I. Objectives of task 4 and 6

**II. Metodology**

III. Procedures

IV. Results & Discussion

## II. Metodology

### 10 Steps

1. Announcement
2. Pre-testing of the protocols
3. Recruitment of singers
4. Self-assessment inquiries
5. Recording voice samples

## II. Metodology

### 10 Steps (cont.)

6. ORL exams

7. Segmentation of voice records

8. Website construction for samples evaluation

9. Voice specialists evaluation

10. Statistical procedures— analyse and conclude

# Agenda

I. Objectives of task 4 and 6

II. Metodology

**III. Procedures**

IV. Results & Discussion

# III. Procedures

## 1. Self-assessment inquiries:

- Singing experience
- Self-perception (voice quality, voice symptoms)
- Specific voice problems (last 12 months)
- General health
- Vocal health

# III. Procedures

## 2. Recording voice samples:

- Sustained vowel /a/ (but, in current portuguese speech – Monday (...)  
**Saaaaturday**)
- /a/ increasing volume
- /a/ increasing pitch
- “Happy Birthday” song
- Text reading (“The North Wind and the Sun”)

# III. Procedures

## 3. Segmentation of voice records:

- Separate the voice records by vocal exercises
- Select the meaningful part in each one

# III. Procedures

## 4. ORL exams:

- Rigid Laryngeal stroboscope (Xion Endostrob-dx system)
- Divas V 2.1 software

# III. Procedures

## 5. Website construction

ARTTS - Avaliação perceptiva.

	Vogal sustentada	Crescendo intensidade	Crescendo tonal	Canto	Leitura	
	R ?	A ?	S ?	A ?	T ?	I ?
Amostra 1		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Amostra 2		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Amostra 3		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Amostra 4		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Amostra 5		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾

The image shows a web interface for a perceptual evaluation tool. It features a table with five rows of samples (Amostra 1 to Amostra 5) and six columns of parameters: 'Vogal sustentada', 'Crescendo intensidade', 'Crescendo tonal', 'Canto', and 'Leitura'. Each parameter has a dropdown menu. The 'Crescendo intensidade' dropdown is open, showing options 0, 1, 1.5, 2, 2.5, and 3. A mouse cursor is pointing at the value '2'. The interface also includes play buttons for each sample and a header 'ARTTS - Avaliação perceptiva.'

# III. Procedures

## 6. Analysis:

- “Excel”
- “Voice Studio” v.1
- “Praat” v.5.3.32
- “SPSS” v.20

# Agenda

- I. Objectives of task 4 and 6
- II. Metodology
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- IV. Results & Discussion**

## IV. Results & Discussion

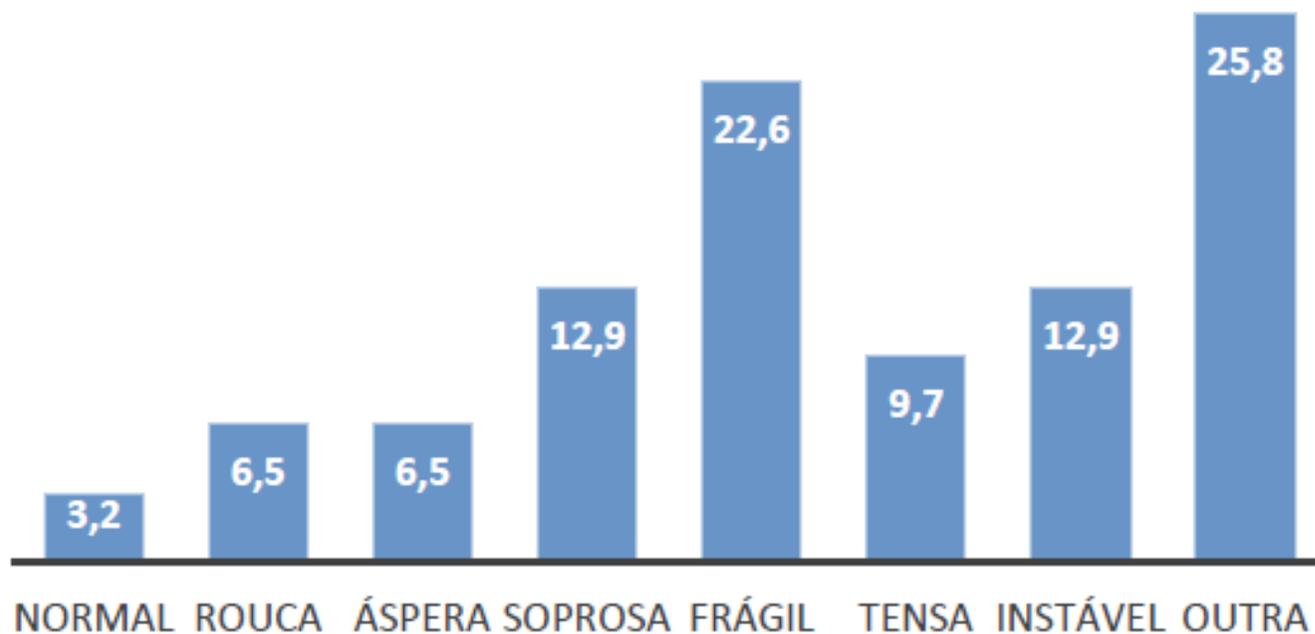


Gráfico 1: Auto classificação da voz pelos cantores [22 cantores em análise].

## IV. Results & Discussion

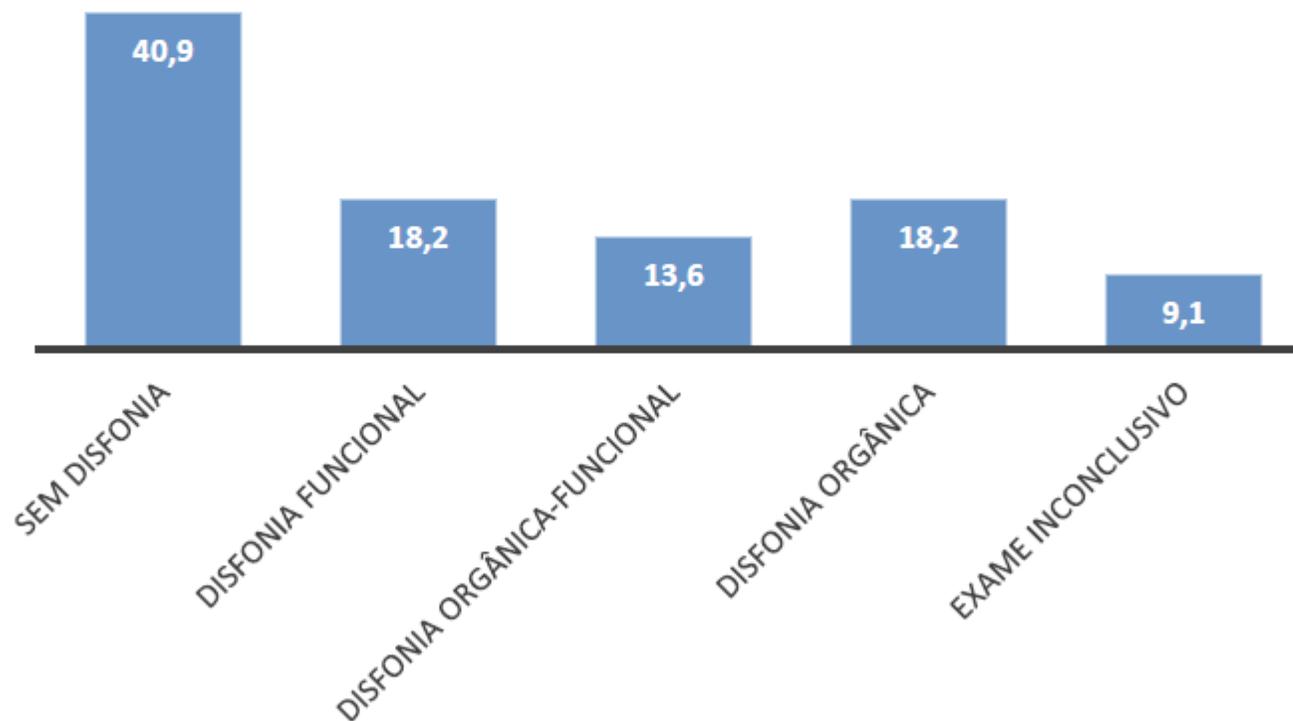
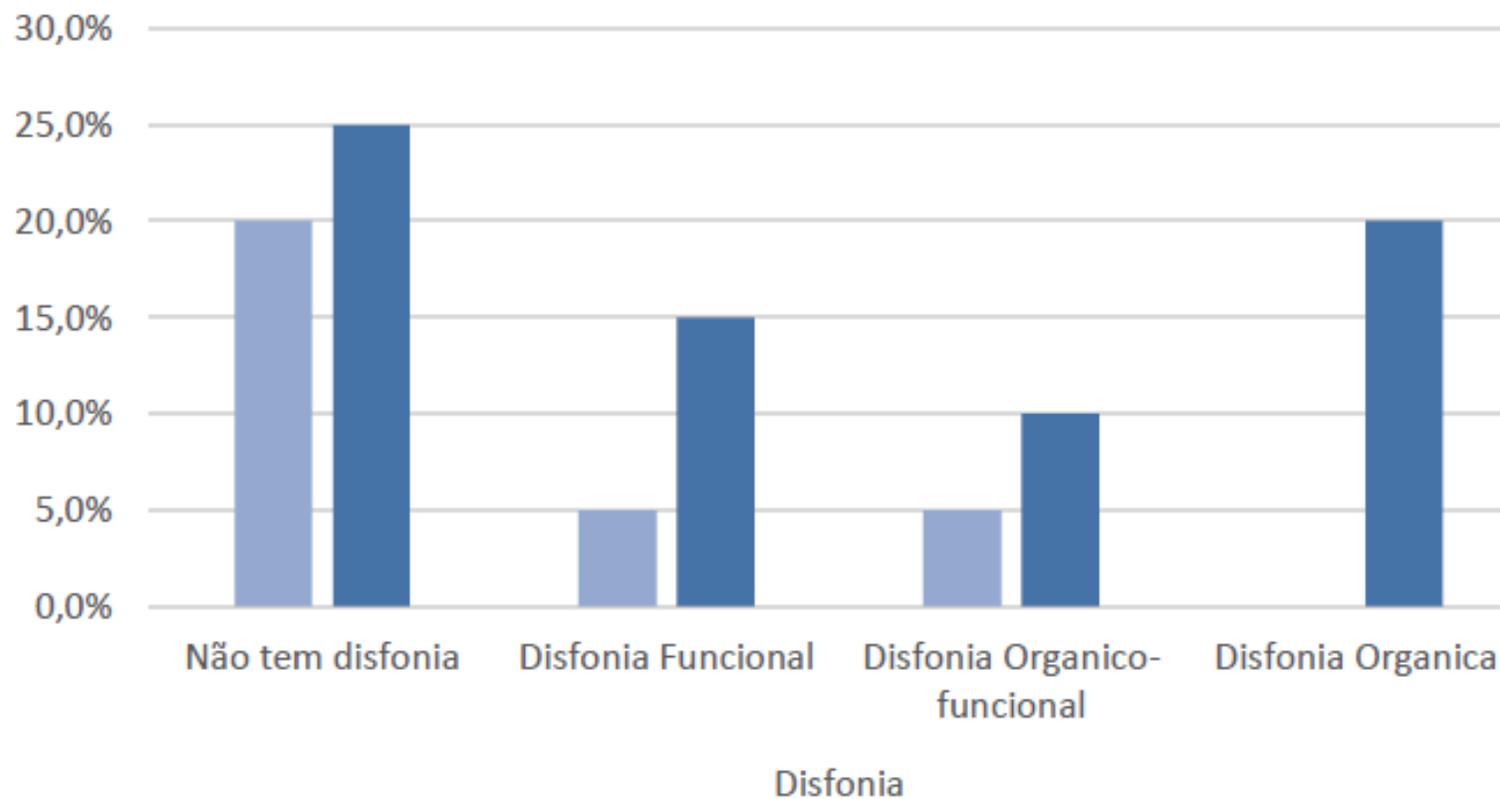


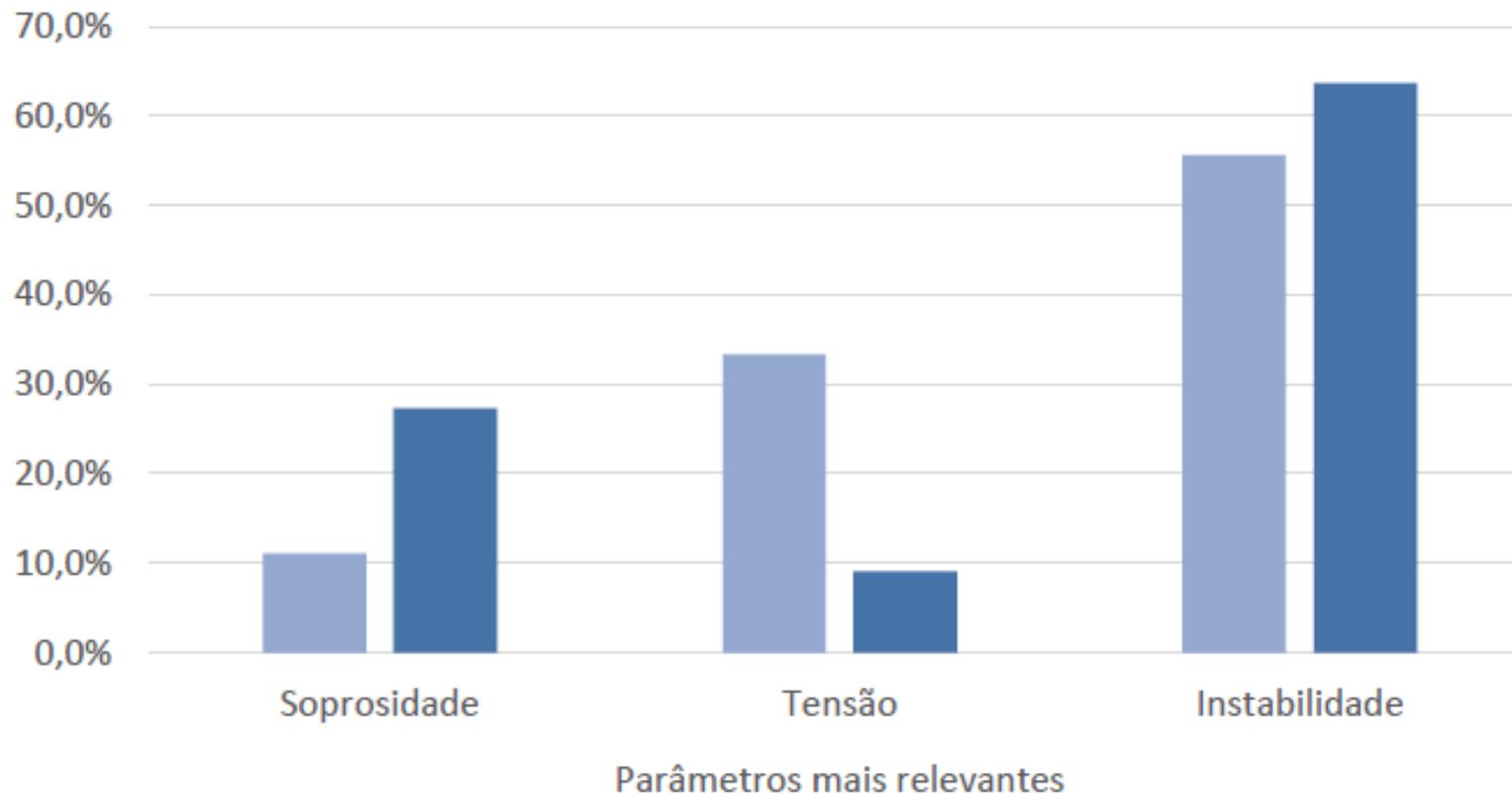
Gráfico 2: Distribuição de patologia vocal [22 cantores em análise].

## IV. Results & Discussion



- Sem queixa vocal
- Com queixa vocal

## IV. Results & Discussion



- Sem patologia\* vocal
- Com patologia vocal

## IV. Results & Discussion

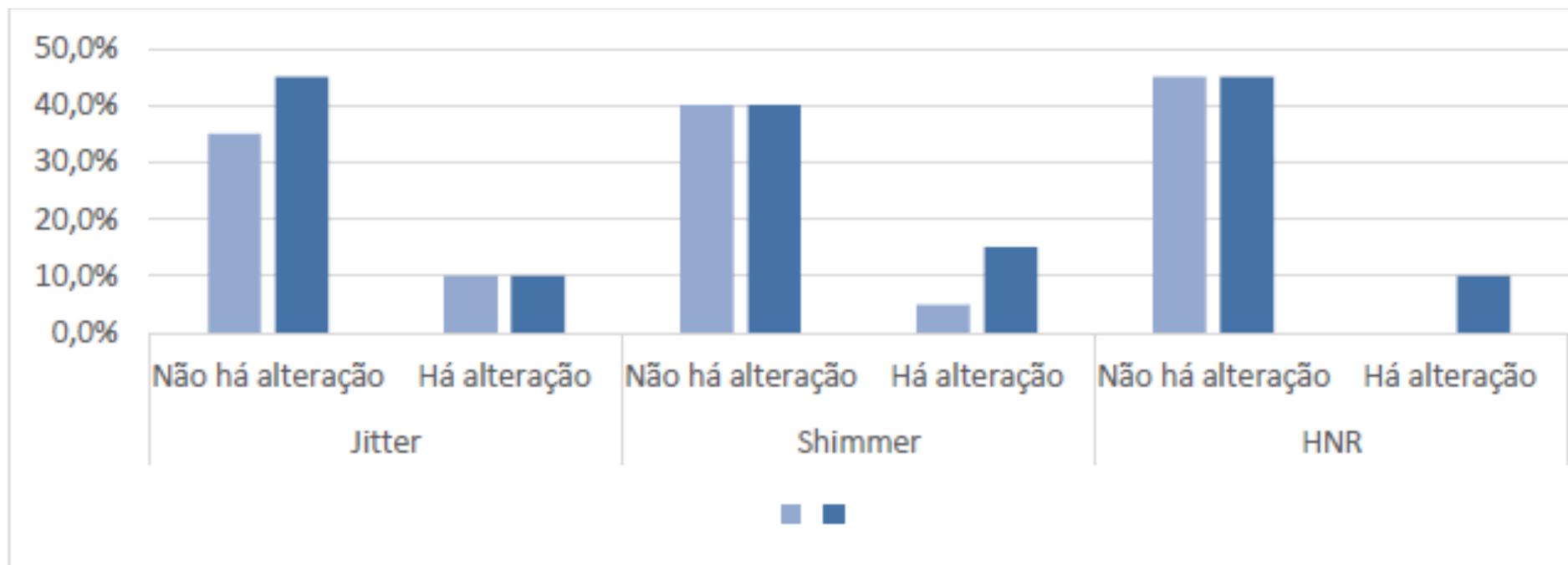
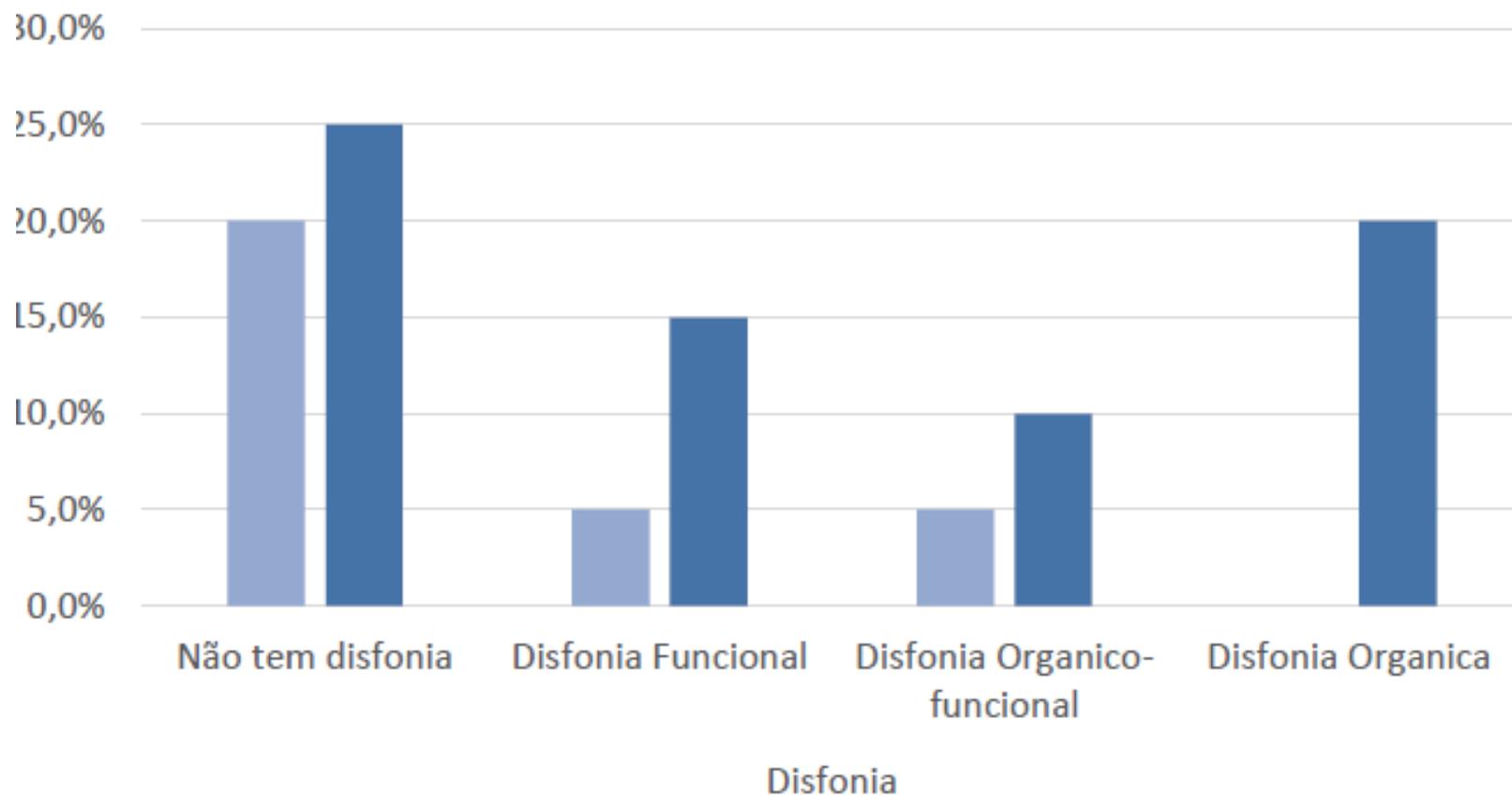


Gráfico 8: Relação parâmetros acústicos com patologia.

## IV. Results & Discussion



- Sem queixa vocal
- Com queixa vocal

# Final conclusions

- ✓ Tension, instability and breathness are the most common perceptual parameters in the 22 singers group.
- ✓ Instability exists in all vocal alterations, with or without pathology.
- ✓ Tension is more relevant when visual or kinesthetic clues exist to support it and it was perceived by 67% of singers.
- ✓ Acoustic parameters that most frequently signal voice disturbances are “HNR”, “Standard deviation of F0” e “Shimmer APQ5”.
- ✓ Tension is revealed by “Standard deviation of F0”, “HNR” and “Energy standard deviation”.
- ✓ Sustained vowel, increasing intensity and singing are the type of vocal exercises that lead to most consensual opinions by voice specialists.

# Challenges

1. Use speaking and singing exercises to extract more acoustic patterns
2. Create a singer-friendly software

# Thanks for you attention!

