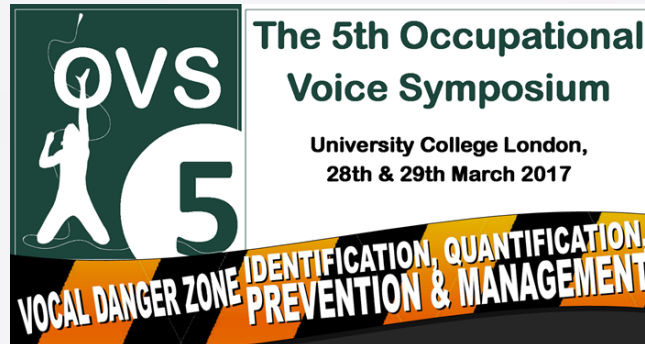




London, 29th March 2017

Acoustic analysis of Fado's speaking and singing voice

Soraia Ibrahim, Ana Mendes & Inês Vaz

Fado

- *Fatum*: fate.
- Fado is a Portuguese musical style and Intangible Heritage of Humanity by UNESCO.



Mariza
“Oh gente da minha terra”

Mariza
“Ó gente da minha terra”

Objectives

1. Fado's speaking voice acoustic profile.
2. Fado's singing voice acoustic profile.
3. Differences:
 - a) gender
 - b) age
 - c) professional experience (amateur vs. professional).

Singers - Professional voice users

Goal→ excellent *performance*

Speech Language Pathologist

Intervention in spoken voice

Adaptation of rehab techniques

Singers' vocal acoustic and physiology
SLP's audio-perception

Rehabilitation and vocal improvement

Monitoring: acoustical and
audioperceptual analysis

Classical Western
Country
Jazz
Pop
Soul
Broadway/ musical
theatre



Research & Knowledge



Fado

Pertinence - Fado

Areas	Past	Present	Future
Education	“School of life”	“School of life”	Higher education
Artistic	National level	UNESCO recognition	International demand
Clinical		Absent clinical follow up	• Voice screening • Annual ENT follow up
Scientific		Pilot study (N=15)	N=104 Voice profile

METHODS

104 subjects

		Gender			
		M		F	
		N	Mean± SD	N	Mean± SD
Age (yrs)		47	46±15	57	41±14
Professional experience	Amateur	28	-	44	-
	Professional	19	-	13	-
Subtotal		47		57	
Total			104		

M = male; F = female; SD = standard deviation; yrs = years.

		Gender			
		M		F	
		N	Mean±SD	N	Mean±SD
Music training (mo)	Past	18	19±55	14	26±16
	Present	4	4±20	2	72±34
Singing training (mo)	Past	21	21±57	21	30±35
	Present	4	4±18	7	44±30
Practice (hrs/wk)		47	15±12	57	12±10
Singing Fado experience (yrs)		47	24±16	57	17±14
Smoking habits	No	28	-	44	-
	Yes	19	-	13	-
Drinking habits	No	25	-	47	-
	Yes	22	-	20	-
Physical condition	Bad	2	-	1	-
	Reasonable	14	-	15	-
	Good	22	-	35	-
	Excellent	9	-	6	-
Subtotal		47		57	
Total		104			
M = male; F = female; SD = standard deviation; yrs = years.					

Inclusion criteria

1. Native European Portuguese (EP) speakers;
2. > 18 years;
3. No history of:
 - ✓ Voice, speech, and/or language disorders;
 - ✓ Allergic and/or respiratory problems on recording day;
4. Literacy;
5. No knowledge and/or participation on a similar study.

Amateurs vs. Professionals

- Payment for their performance
- Singing education ≥ 1 yr
- ENT exam 1x yr

Procedures

Informed consent form



Vocal health and background questionnaire



Phonatory tasks



Recording equipment



Acoustic and statistical analysis

Data collection

- Fado's Museum
- Technology, Innovation and creation school
- House of culture – Setúbal
- RPP Audiovisual Studios
- Noise environment < 50dB

Data analysis

- Voice lab
ESS-IPS

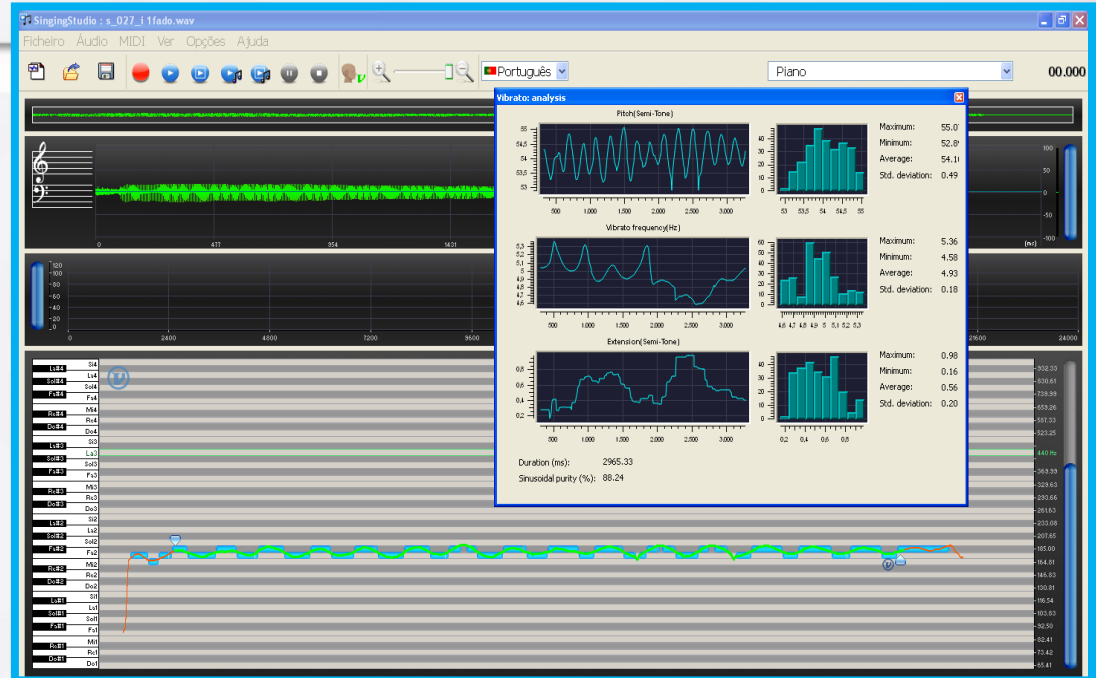
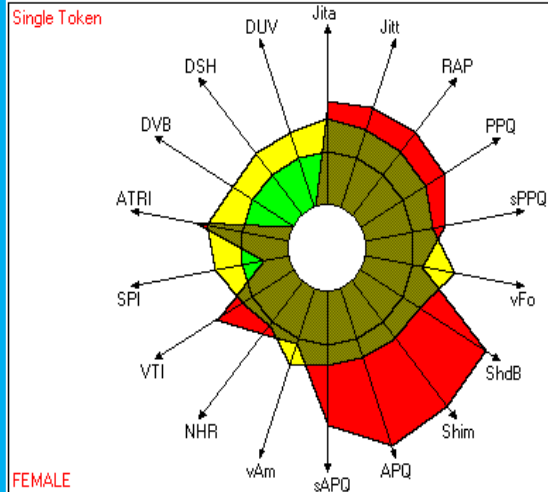


Phonatory task		Acoustic parameter	
Speaking	Sustaining [a, i, u]	MPT	
		f_0	
		Jitter	
		Shimmer	
		NHR	
	Sustaining [s, z]	s/z	
	Reading aloud text – O Sol (phonetically balanced text)	f_0	
Singing	Sustaining [a, i, u]	f_0	
		Jitter	
		Shimmer	
		NHR	
	Sustaining [a] Lowest modal < highest falsetto	MPFR	
	Fado	Vibrato	Frequency
			Extent
		Singer's formant	

Recording equipment



Analysis equipment



Adobe Audition 6.0 CC[®] (Adobe Systems)

Seegnal - VoiceStudio® (SEEGNAL Research)

Seegnal - SingingStudio® (SEEGNAL Research)

Multi-Dimensional Voice Program 5105[®] (KayPENTAX)

Computerized Speech Lab (CSL) Model 4500® (KayPENTAX)

Statistic analysis

SPSS
v.22

- Descriptive analysis
- Inferential analysis
 - t-test ($\alpha=.05$)

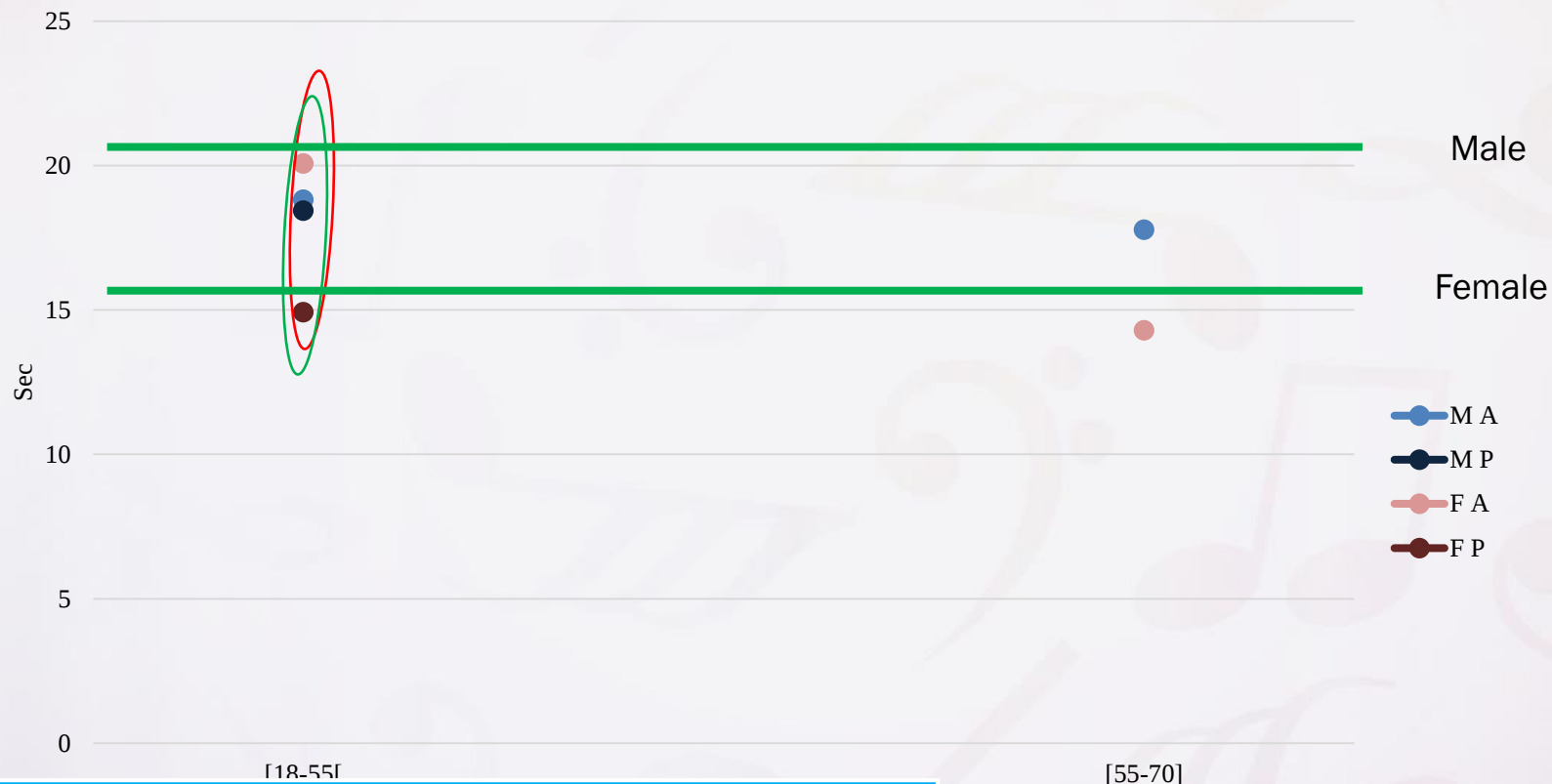
RESULTS

Speaking

Singing

Speaking voice

Maximum phonation time (MPT)



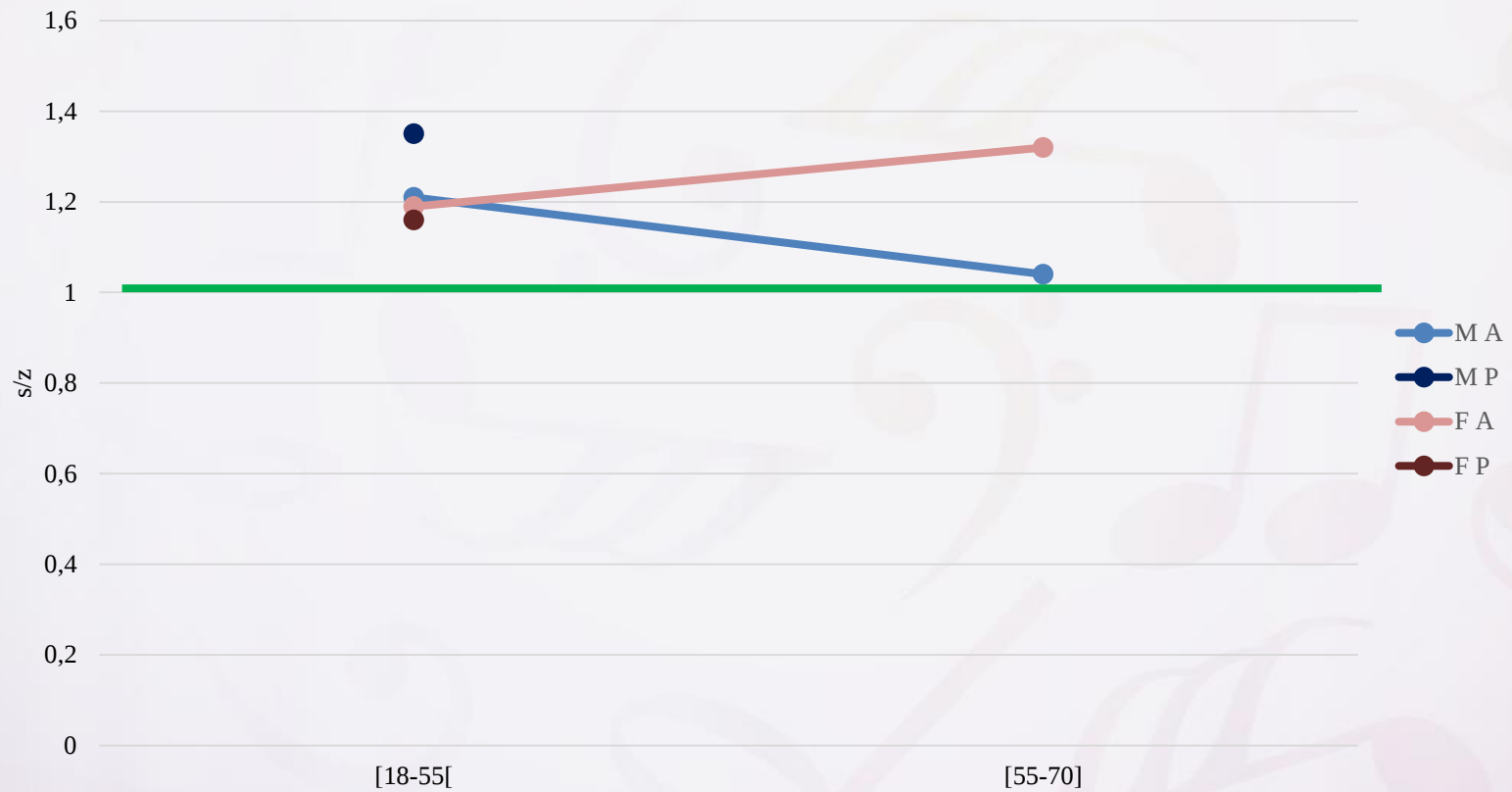
$p < .05$

*1. Female amateurs younger > older ($p = .02$)

*2. Female amateurs > professionals ($p = .01$)

(Kent, Kent & Rosenbek, 1987)

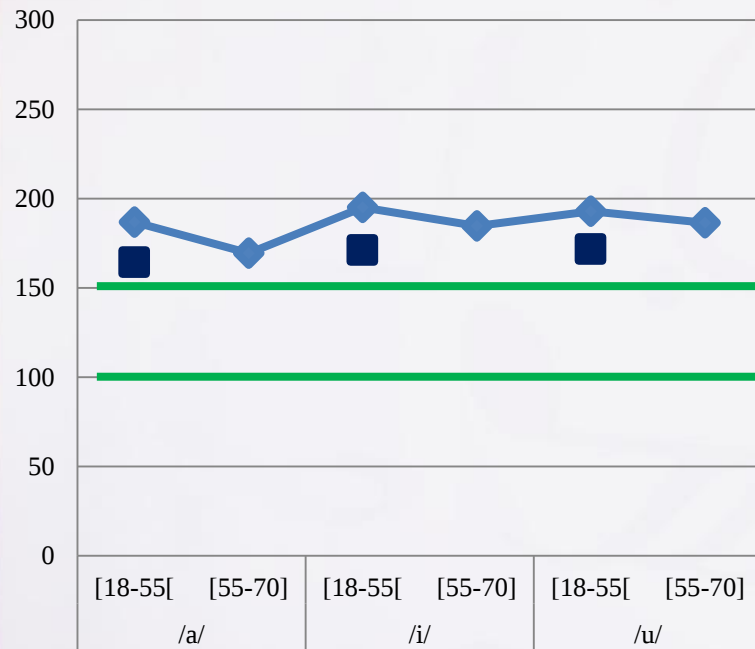
S/Z



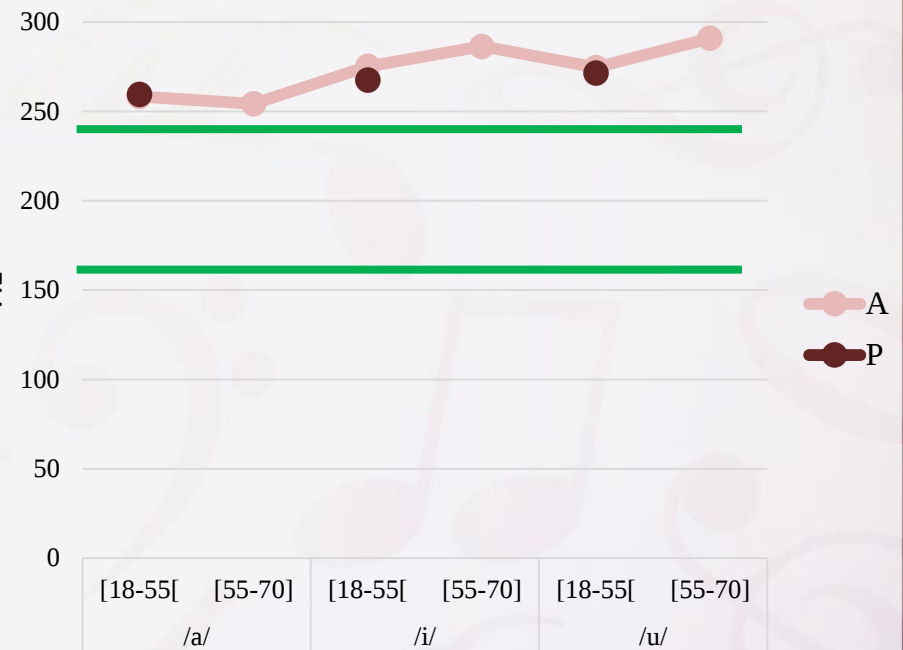
(Behlau, 2001)

Speaking vowels f_0

Male



Female



$p < .05$

Male < female ($p = .00$)

(Hollien, Hollien & Jong, 1997)

f_0 – Reading aloud



$p < .05$

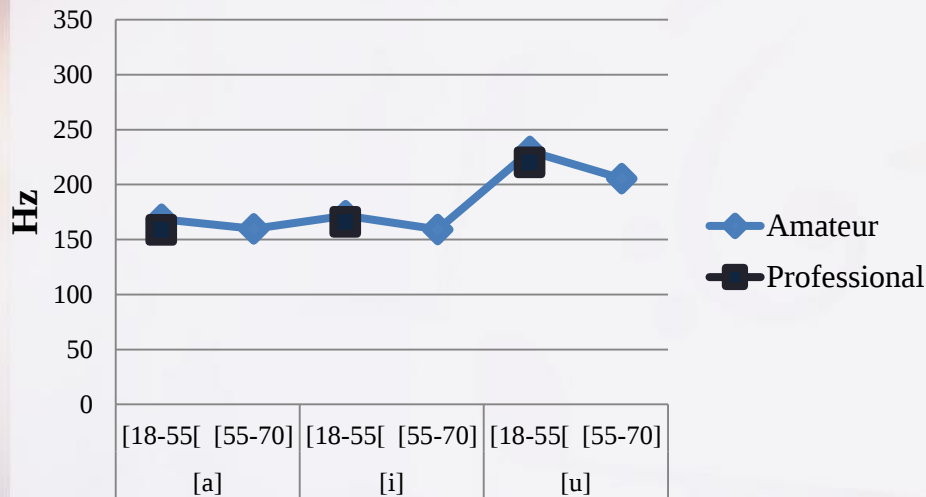
Male < female ($p = .00$)

(Rothman, Brown, Sapienza & Morris, 2001)

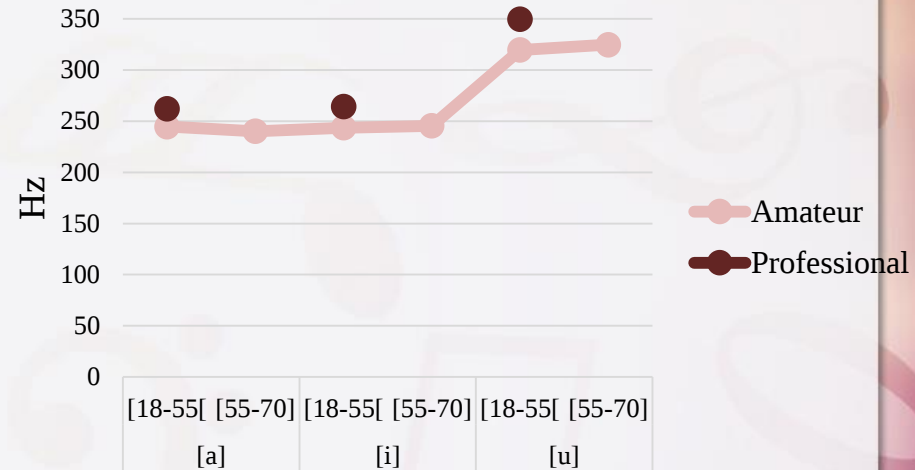
Singing voice

Singing Vowels f_0

Male

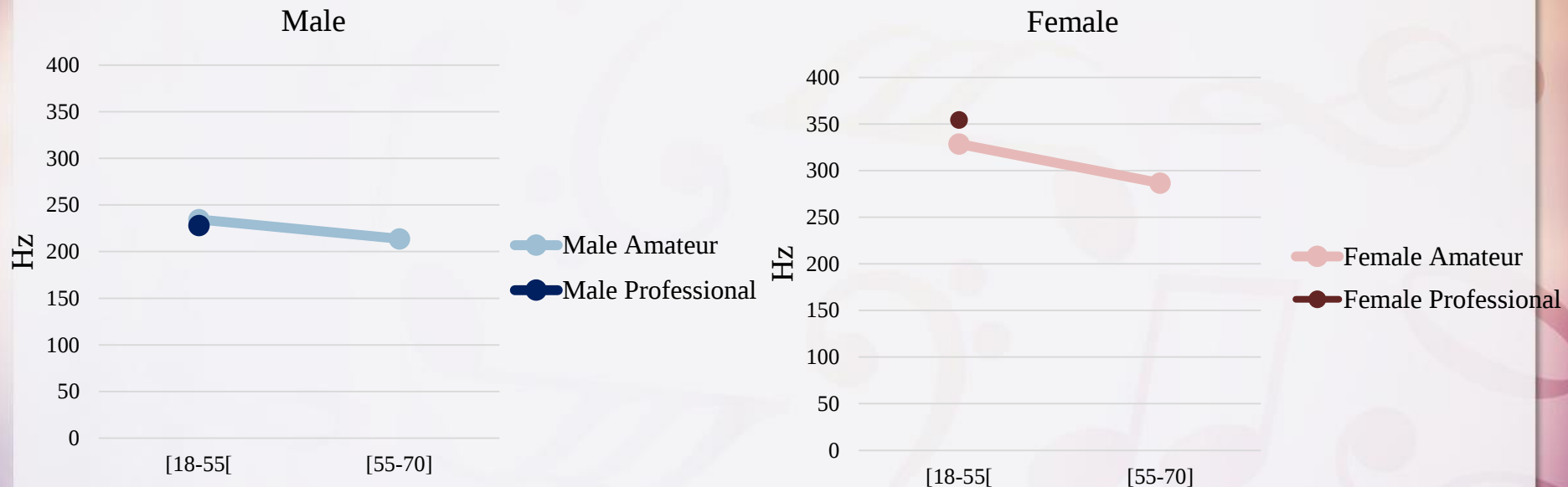


Female



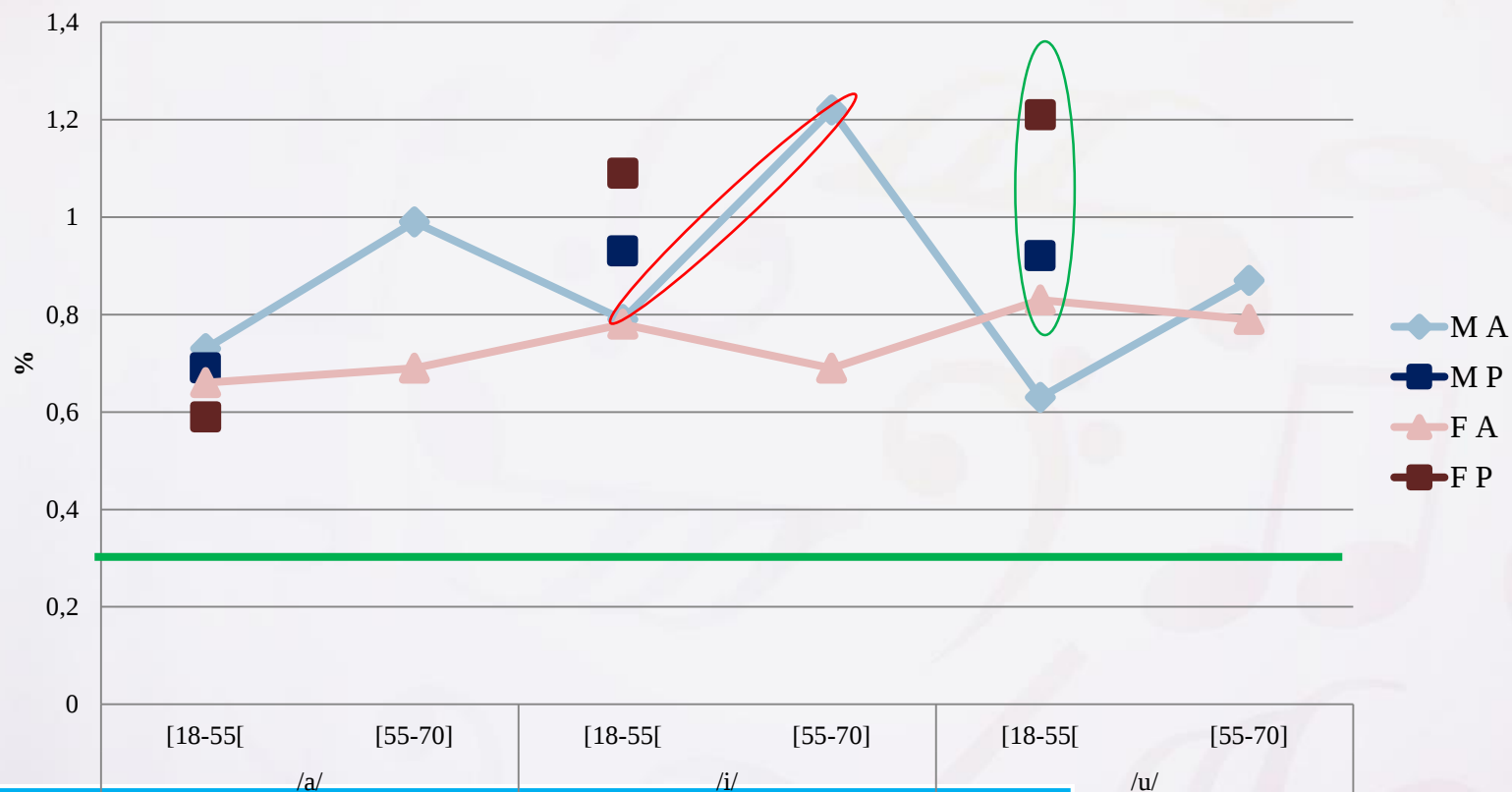
$p < .05$
Male < female ($p = .00$)

Singing f_0 of Fado chorus



$p < .05$
Male < female ($p = .00$)

Singing Jitter

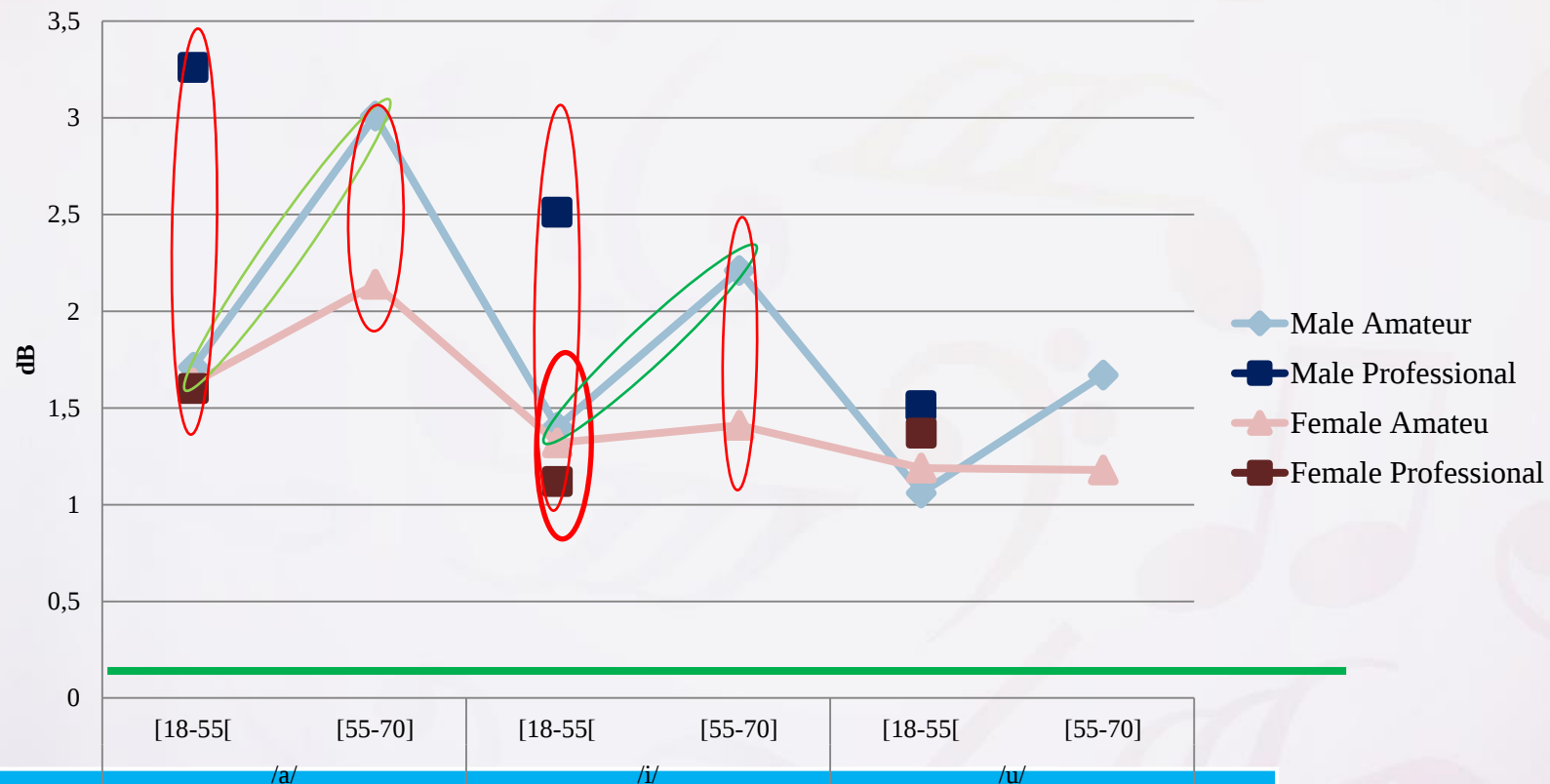


$p < .05$

*1. [i]: male amateurs younger < older ($p = .03$)

*2. [u]: female amateurs < professionals ($p = .04$)

Singing Shimmer



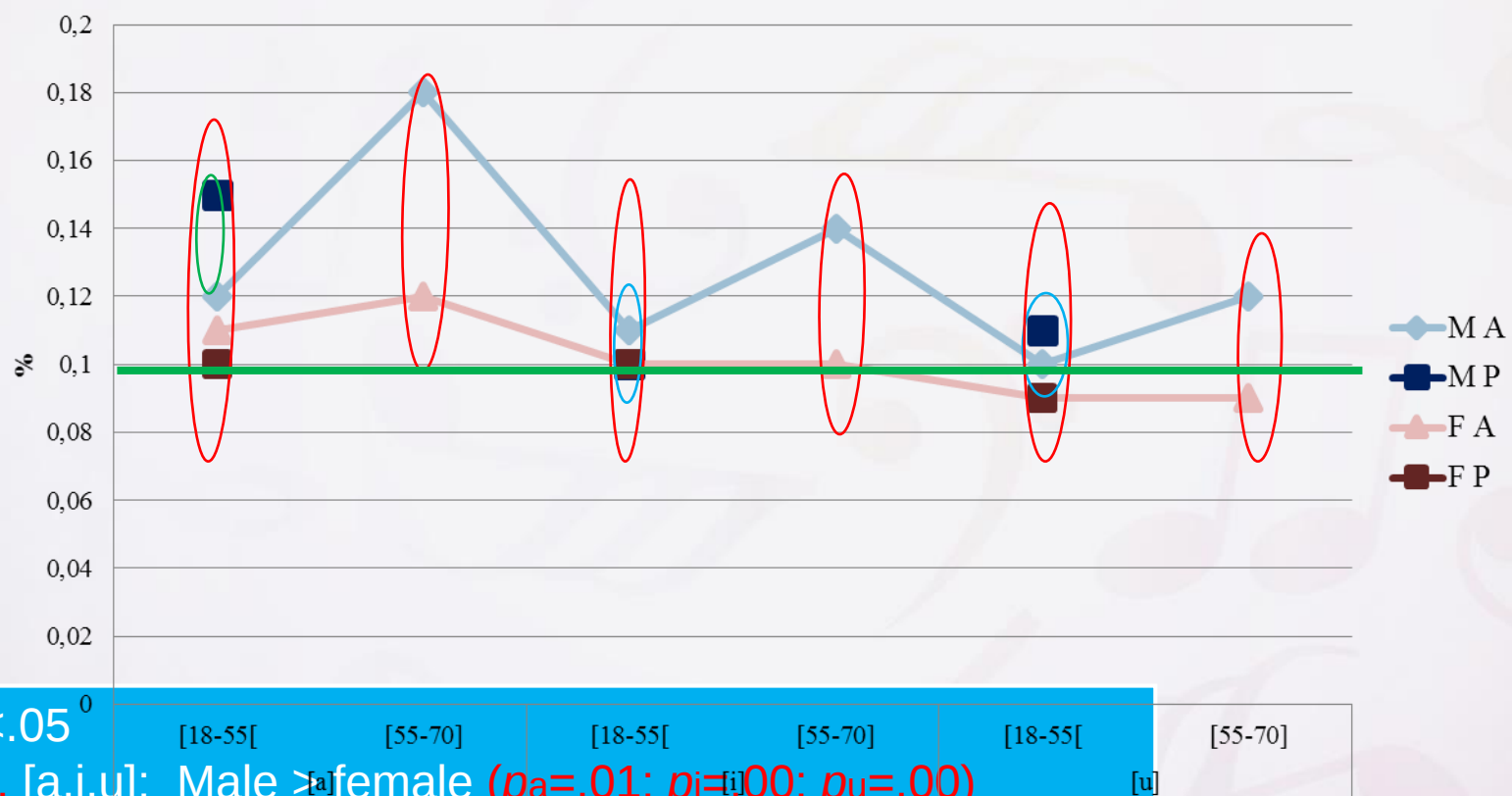
$p < .05$

*1. [a,i]: Male > female ($p_a = .02$; $p_i = .01$)

*2. [a,i]: Male amateurs younger < older ($p_a = .00$; $p_i = .03$)

(Lundy, Roy, Casiano, Xue & Evans, 2000)

Singing NHR



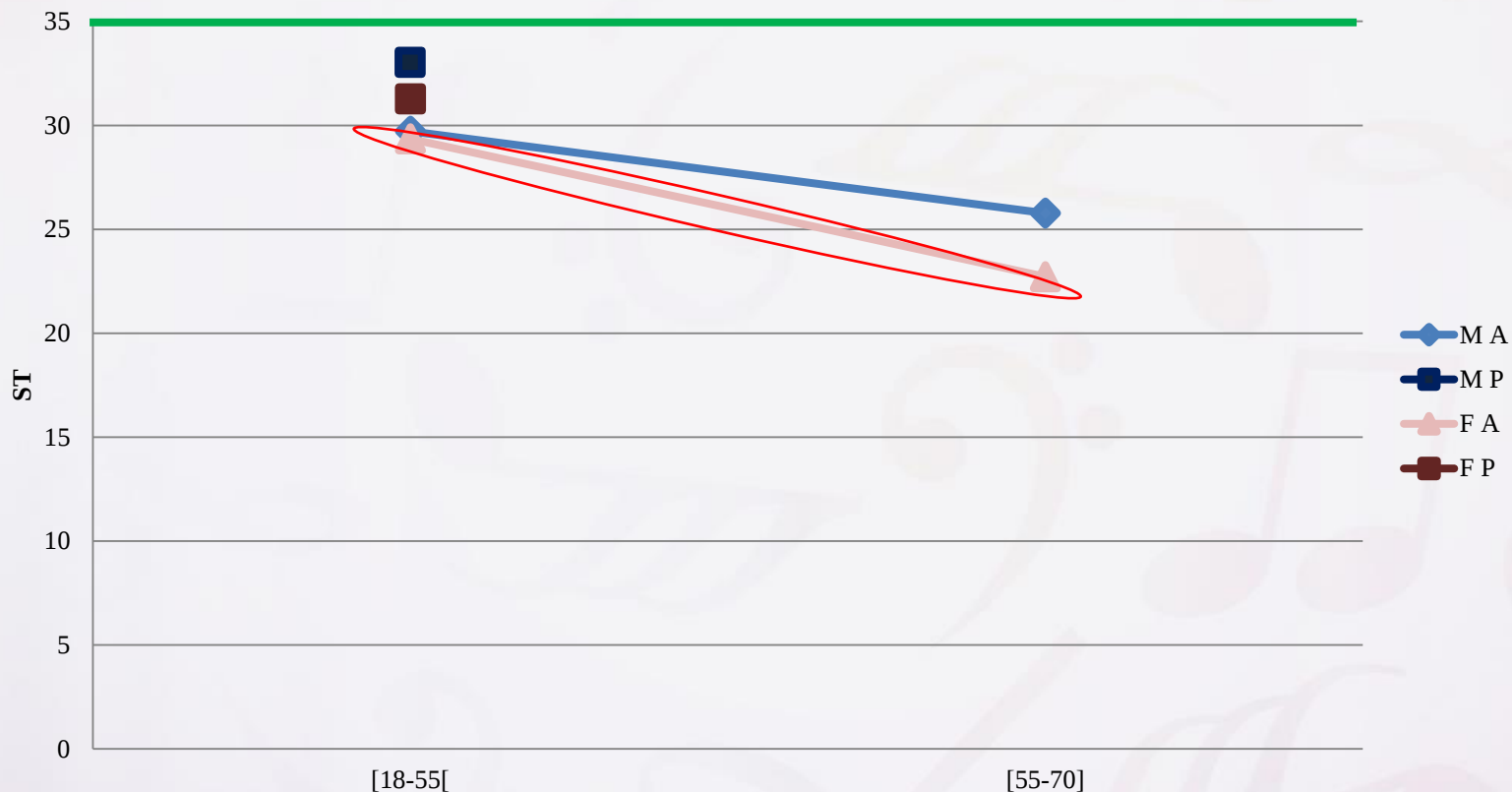
$p < .05$

*1. [a,i,u]: Male > female ($p_a = .01$; $p_i = .00$; $p_u = .00$)

*2. [a]: Female amateur > professional ($p_a = .03$)

[i,u]: Male amateurs younger < older

Maximum phonation frequency range (MPFR)



$p < .05$

*1. [a]: Female amateurs younger > older ($p = .00$)

(Baken & Orkiloff, 2000)

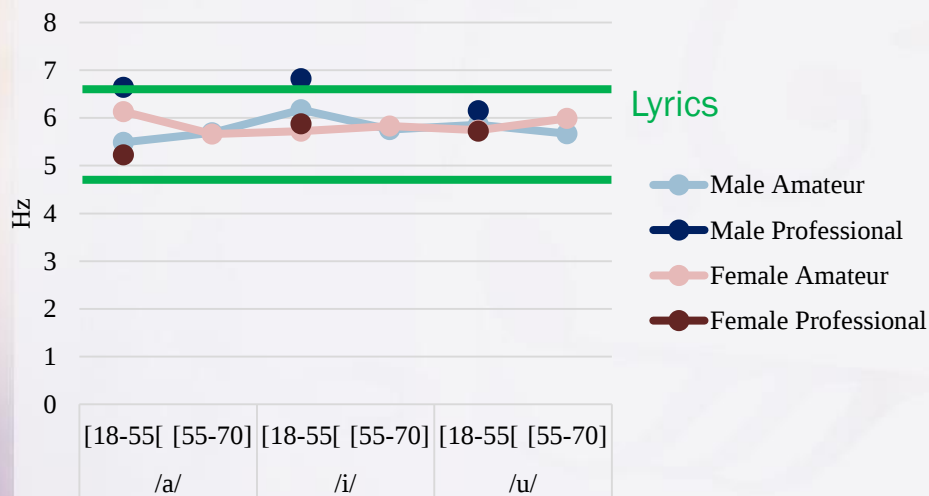
MPFR



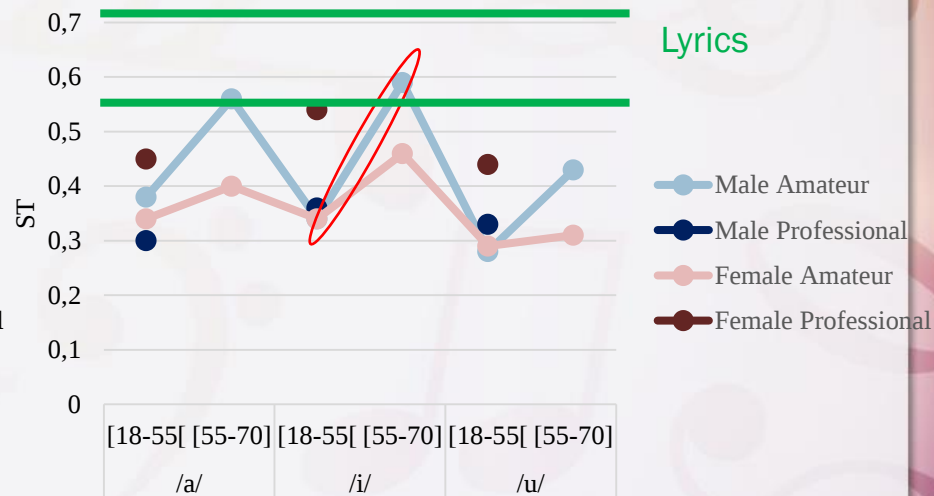
(Baken & Orkloff, 2000 cit. Hollien, Dew and Phillips, 1971)

Vibrato

Frequency



Extent



$p < .05$

*. Extent [i]: Male amateurs younger < older ($p = .01$)

Singer's formant

Classical western singers:

- 2800 Hz - 3500 Hz
- F3 e F4 vowels
- Variation = 3 - 5 dB

	Sex	Age range	Professional experience	N	Frequency (Hz)	Amplitude (dB)
Singer's formant	F	[18-55[	A	2	3122.89	7.20
					3094.97	5.10
			P	3	3122.98	4.27
					2968.93	3.49
					3136.98	4.64
Mean±SD					3089.35±69.02	

F=female; A = amateur; P = professional; SD=standard deviation.

N = 5/104



- Fado singers' formant:
- Formant frequencies: 2969-3137 Hz
- Peak amplitude ranged 3-7 dB

Discussion

Speaking

MPT	Reduced	Inefficient threshold
s/z	Increased	Difficulty in airflow control ?
f_0	Male < Female Amateurs > professionals	Expected
Jitter	Increased	Less control
Shimmer	Reduced	???
NHR	Increased	High variability

Singing

f_0	Male < Female	Expected
Jitter		
Shimmer	Increased	High variability – less control
NHR		
MPFR	Reduced	
Vibrato	Less extended	Less control
Singer's formant	Rare	

Conclusion

Conclusions

- Fado's speaking voice acoustic profile.
 - Reduced temporal measures, spectral as expected, high perturbation measures
- Fado's singing voice acoustic profile.
 - Spectral as expected, very high perturbation measures, reduced MPFT, less or exaggerated vibrato and rare singers' formant
- Differences:
 - Gender: Differences in temporal and spectral measures
 - Age: Differences in temporal, spectral and perturbation measures of speaking and singing voice, as well as vibrato and singers' formant
 - Professional experience: Professional > Amateur in spectral, and perturbation measures,

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THANK YOU!!!
Obrigada!



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Speaking

Singing

Sustaining vowels F ₀ (Hz)		Male	Female		Male	Female	
	/a/	164-187	254-259	/a/	159-168	240-262	
	/i/	171-195	268-286	/i/	159-172	244-264	
	/u/	172-193	272-291	/u/	205-230	319-350	
Jitter (%)	Female				Younger	0.79	
	Male /i/				Older	1.22	
	Younger	Older					
	0.50	0.77		Female /u/	Amateur	0.83	
					Professional	1.21	
Shimmer (%)	/a/	Male	Female	/a/	Male	Younger	1.71 (3.26)
						Older	3.01
					Female		1.60-2.14
	Younger	1.34	1.61	/i/	Male	Younger	1.40 (2.51)
	Older	1.89	2.17			Older	2.21
					Female		1.12-1.41
NHR	Male		Female				
	/a/	0.11 - 0.12	0.10-0.11				
F ₀	Male	Female		Male		Female	
	115-131	193-215		214-234		286-354	
MPT (s)	Male	Female					
	17.78-18.82	14.29-20.07		-			

Vibrato

Male

Female

Amateur

Professional

Amateur

Professional

5.49-6.17
Hz 0.28-
0.59 ST

6.15-6.82
Hz 0.30-
0.36 ST

5.66-6.13
Hz 0.29-
0.46 ST

5.23-5.88
Hz 0.44-
0.54 ST

Speaking

Singing

Sustaining vowels F_0	Male vs female	Male vs. female
Jitter	[a] Female amateur younger vs. older	Male vs female
Shimmer	[a] 1. Male amateur younger vs. older 2. Female amateur younger vs. older	1. [i] male amateur younger vs. older 2. [u] female amateur vs. professional
NHR	[a] Male vs. female	1. [a,i] male vs. female 2. [a] female amateur vs. professional 3. [i,u] male amateur younger vs. older
F_0	Male vs. female	Male vs. female
MPT	Inefficient threshold	-
MPFR	-	[a] Female amateur younger vs. older
Vibrato	-	Extent [i] male amateur younger vs. older
Singer's F	-	Rare

SPEAKING VOICE PROFILE OF FADO'S SINGERS (*_p<.05)

MPT	Sustaining vowels F ₀	Jitter	Shimmer	NHR	Reading F ₀
Female amateurs younger vs. older Female amateurs vs. professionals	Male vs Female	[a] Female amateur younger vs. older	[a] Male amateur younger vs. Older Female amateur younger vs. older	[a] Male vs. female	Male vs. female

MALE

- Frequency
 - 5.49-6.17 Hz
- Extent
 - 0.28-0.59 ST

Amateur

Vibrat

0

Profession
nal

- Frequency
 - 6.15-6.82 Hz
- Extent
 - 0.30-0.36 ST

FEMALE

- Frequency
 - 5.66-6,13 Hz
- Extent
 - 0.29-0.46 ST

Amateur

Profession
nal

- Frequency
 - 5.23-5.88 Hz
- Extent
 - 0.44-0.54 ST

SINGING VOICE (* $p < .05$)

Sustaining vowels F_0	Jitter	Shimmer	NHR	Singing chorus F_0	MPFR	Vibrato	Singer's formant
Male vs female	[i] Male amateur younger vs. older [u] Female amateur vs. professional	[a,i] 1. Male vs. female 2. Male amateur younger vs. older	[a,i] Male vs. female [a] Female amateur vs. professional [i,u] Male amateur younger vs. older	Male vs. female	[a] Female amateur younger vs. older	Extent [i] Male amateur younger vs. older	Rare

1. Speaking voice acoustic profile

Acoustic speaking parameter	Conclusion
MPT	↓
s/z	↑
F ₀	↑ Male ≠ Female Amateurs > Professionals
Jitter	WNL? Older female amateurs > younger female amateurs
Shimmer	WNL? Older amateurs > younger amateurs
NHR	WNL? Males > Females

2. Singing voice acoustic profile

Acoustic singing parameter	Conclusion	
F_0	Male $\neq$ Female	
Jitter	Fado > Lyrics ↑ normative	
Shimmer	Fado > Lyrics ↑ normative Male amateur > female amateur Female professional > Male professional	
NHR	Fado > Lyrics ↑ normative	
MPFR	Highest F_0 mean Fado < Lyrics	
Vibrato	Range Fado 5,49-6,82 Hz 0,28-0,59	Lyrics 4,55-6,25 Hz 0,54-0,95 ST
Singer's formant	Formant frequencies: 2969-3137 Hz Peak amplitude ranged 3-7 dB	

3. Differences in gender, age and professional experience

Speaking acoustic measures		Profile	
MPT	Male>female	Younger>older	Amateur>professional
s/z	Male>female	Younger _{male} >older _{male} Older _{female} >younger _{female}	Professional _{male} >amateur _{male} Amateur _{female} >professional _{female}
F ₀	Female>male	Younger _{male} >older _{male} Older _{female} >younger _{female}	Amateur>professional
Jitter	Female _{amateur} >Male _{amateur} Male _{professional} >Female _{professional}	Older>younger	Professional>amateur
Shimmer	Female>male	Older _{male} >Younger _{male} Younger _{female} >older _{female}	Professional>amateur
NHR	Male>Female	Younger>older	Amateur>professional
F ₀ reading	Female>male	Older _{male} >younger _{male} Younger _{female} >older _{female}	Amateur _{male} >professional _{male} Professional _{female} >amateur _{female}

Singing acoustic measures		Profile	
F ₀	Female>male	Younger _{male} >older _{male} Older _{female} >younger _{female}	Amateur _{male} >Professional _{male} Professional _{female} >Amateur _{female}
Jitter	Male _{amateur} >female _{amateur} Female _{professional} >male _{professional}	older _{male} >younger _{male} Younger _{female} >older _{female}	Professional>amateur
Shimmer	Male>female	Older>younger	Professional _{male} >amateur _{male} Amateur _{female} >professional _{female}
NHR	Male>female	Older>younger	Professional _{male} >amateur _{male} Amateur _{female} >professional _{female}
F ₀ singing	Female>male	Younger>older	Amateur _{male} >Professional _{male} Professional _{female} >Amateur _{female}
MPFR	Male>female	Younger>older	Professional>amateur
Vibrato		See slide 46	
Singer's formant	-	Younger	Professional>amateur