Universidade de Aveiro Departamento de Comunicação e Arte
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Práticas Vocais Performativas de Cantadeiras do Alto Minho

Describing Vocal Performance of Portuguese Cantadeiras of Alto Minho

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Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Música, realizada sob a orientação científica da Doutora Filipa Martins Baptista Lã, Professora Auxiliar Convidada do Departamento de Comunicação e Arte da Universidade de Aveiro

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Dedico este trabalho à minha família e à Terra que me viu nascer e crescer…
…ambas são parte de mim e de ambas me orgulho muito.

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o júri

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palavras-chave Alto Minho, folclore, canto tradicional, performance vocal, função vocal.

resumo

Portugal é um país com fortes tradições musicais perpetuadas ao longo de décadas através das práticas folclóricas. Nos grupos folclóricos da região do Alto Minho, o canto é maioritariamente praticado por *cantadeiras*, cantoras amadoras cuja aprendizagem é feita maioritariamente por tradição oral. As suas características vocais diferenciam-se das de outras regiões do país, embora se desconheçam ainda as razões fisiológicas e acústicas responsáveis por tal distinção.

O presente trabalho propõe investigar a performance vocal das *cantadeiras* do Alto Minho numa perspetiva multidimensional, considerando aspetos sociais, culturais, fisiológicos e acústicos associados à prática deste estilo musical. Assim, os dados recolhidos, qualitativos e quantitativos, procuraram: (i) descrever práticas performativas atuais, (ii) explorar as perceções existentes sobre os traços mais relevantes da voz nesta região, (iii) investigar propriedades fisiológicas e acústicas da voz neste estilo, e (iv) comparar o canto folclórico do Alto Minho com outros estilos de canto tradicional.

Foram envolvidos: 78 grupos, em questionários telefónicos, 13 diretores em questionários de caracterização performativa, 1 cantadeira num estudo piloto, 16 cantadeiras em gravações áudio preliminares, 77 membros de grupos folclóricos em testes perceptuais auditivos e 10 cantadeiras em gravações multicanal, incluindo sinais áudio, ELG, fluxo de ar e pressão intra-oral. A análise de dados incluiu análise temática de conteúdo, estatística descritiva e inferencial, análise hierárquica de componentes principais e modelos de regressão linear multivariada.

As características vocais mais representativas incluem: voz aguda e forte, com timbre estridente, prevalência de registo de peito com nível não-excessivo de esforço, boa inteligibilidade do texto e sotaque da região. Poucas foram as cantadeiras identificadas como detentoras destas características. As que foram apontadas como possuidoras de vozes mais representativas apresentam valores de pressão subglótica e contacto das pregas vocais elevados, predominância de parciais harmónicos superiores e grande intensidade vocal, características que corroboram as associadas a uma fonação “pressionada”. Este padrão vocal, indicativo de esforço fonatório, aproxima-se do descrito em *belting*, utilizado em teatro musical. Quando comparado com outros géneros tradicionais, as cantadeiras do Alto Minho apresentam alguns traços semelhantes aos dos cantores de *country* (EUA) e *ojikanje* (Croácia).

Estratégias que poderão contribuir para a preservação deste estilo vocal e para a saúde vocal das cantadeiras apontam para a formação contínua de grupos existentes, à semelhança do que acontece com outros estilos folclóricos europeus.

keywords Alto Minho, folklore, tradicional singing, voice performance, voice function.

abstract

Portugal has strong musical traditions, which have been perpetrated by decades through folkloristic activities. In folk groups from Alto Minho (north of Portugal), folk singing is mostly performed by *cantadeiras*, amateur female solo singers who learn this style orally. Their vocal characteristics are distinctive when compared with other regions of the country; however, deep understanding of these vocal practices is still missing.

The present work aims at studying Alto Minho *cantadeira's* vocal performance in a multidimensional perspective, envisioning social, cultural and physiological understanding of this musical style. Thus, qualitative and quantitative data analyses were carried out, to: (i) describe current performance practices, (ii) explore existent perceptions about most relevant voice features in this region, (iii) investigate physiological and acoustic properties of this style, and (iv) compare this style of singing with other non-classical singing styles of other countries.

Dataset gathered involved: 78 groups whose members were telephone interviewed, 13 directors who were asked to fill in a questionnaire on performance practices, 1 *cantadeira* in a pilot study, 16 *cantadeiras* in preliminary voice recordings, 77 folk group members in listening tests, and 10 *cantadeiras* in multichannel recordings, including audio, ELG, air flow and intra-oral pressure signals. Data were analysed through thematic content analysis, descriptive and inferential statistics, hierarchical principal components, and multivariate linear regression models.

Most representative voices have a high pitched and loud voice, with a bright timbre, predominance of chest register without excessive effort, and good text intelligibility with regional accent. High representativeness levels were obtained by few *cantadeiras*; these sing with high levels of subglottal pressure and vocal fold contact quotient, predominance of high spectrum energy and vocal loudness, corroborating indications of prevalence of pressed phonation. These vocal characteristics resemble *belting* in musical theatre and share similarities with *country* (USA) and *ojikanje* (Croatia) singing.

Strategies that may contribute to the preservation of this type of singing and the vocal health of current *cantadeiras* are discussed, pointing at the direction of continuous education among folk groups, following practices that are already adopted elsewhere in Europe.

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LIST OF ABBREVIATIONS

Alpha	Ratio between the sound energy above and below 1kHz
AM	*Alto Minho* (Higher Minho)
AMVC	*Academia de Música de Viana do Castelo* (Viana do Castelo Music Academy)
BM	*Baixo Minho* (Lower Minho)
CAx	Amplitude perturbation (measured from an electroglottogram)
CFx	Frequency perturbation (measured from an electroglottogram)
CTP	Collision threshold pressure
EGG	Electroglotography
ELG	Electrolaryngography
F0	Fundamental frequency
FFP	*Federação de Folclore Português* (Federation of Portuguese Folklore)
FFT	Fast Fourier Transform
FG	Folk group(s)
Fx	Fundamental frequency (measured from Lx)
H1-H2	Level difference between the 1st and 2nd voice source spectrum partials (measured from a flow glottogram)
$(H1-H2)_{LTAS}$	Estimated level difference between the 1st and 2nd voice source spectrum partials (measured from LTAS)
HCA	Hierarchical cluster analysis
HNR	Harmonic-to-noise ratio
INATEL	*Instituto Nacional para o Aproveitamento do Tempos Livres dos Trabalhadores* (National Institute for the Workers Leisure)
INET-MD	*Instituto de Etnomusicologia - Centro de Estudos em Música e Dança* (Ethnomusicology Institute – Centre for Studies in Music and Art)
IQ	Interquartile Range
Jitter	Cicle-to-cicle frequency perturbation
Leq	Equivalent sound level
LT	Listening test
Lx	Electrolaryngographic wave form
MFDR	Maximum flow declination rate
MFT	Maximum phonation time
MPFR	Maximum phonation frequency range
NAQ	Normalised amplitude quotient

PCA	Principal component analysis
Psub	Subglottal pressure
PTP	Phonation threshold pressure
Q_{closed}	Closed quotient (measured from a flow glottogram)
$Q_{contact}$	Contact quotient (measured from an electroglottogram)
R_g	Glottal resistance
SD	Standard deviation
Shimmer	Cicle-to-cicle amplitude perturbation
SNR	Signal-to-noise ratio
SPL	Sound pressure level
ST	Semitone
TMG	Traditional Music Group
VAS	Visual analogic scale
SOR	Self-to-other ratio

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1. THE SINGING VOICE

A MUSICAL INSTRUMENT USED IN VARIOUS PERFORMANCE PRACTICES

> *When the speaking voice is extended into song it becomes the supreme articulator of human desires, emotions and aspirations; almost every individual (or group of individuals) has the potential to use this resource in whatever way is appropriate. Every utterance we make, from the first scream or grunt onwards, is conditioned by our own past and that of the society we live in, and most of the time neither singer or listener is conscious of this ideological baggage that we all carry with us. (Potter, 1998, p. 1)*

Singing is a form of human expression, accessible to everyone and transversal to all cultures. It results from the use of the human voice as a musical instrument (Vennard, 1967). However, unlike other musical instruments, its constituting elements are hidden (Miller, 1996). Thus, making music using the human voice is a unique kind of activity, especially when one takes into consideration that singing also reflects individual personalities, socio-cultural features, and psychological and emotional intentionalities of a group or a person (Proctor, 1980). Thus, it is commonly related to other forms of human expression. In most non Western cultures, for example, singing involves active group engagement, dance and it is present in ritual practices (Cross, 2009). Singing is one of the most ancient forms of musical communication (Fitch, 2005). However, exact deductions on the origins an characteristics of the singing voice as a way of communication are particularly problematic: the self-limiting orality of singing was only recently overcome with the appearance of sound recordings, after the invention of the gramophone (in the last quarter of 19th century) and all subsequent sound recording methods (Potter, 1998).

Although the technological tools to study the singing voice have been developed considerably after gramophone invention up to nowadays (Lã, 2012), both financial and technical difficulties of recording a great number of voices while performing together has constituted a drawback in carrying out more investigations concerning group singing (Jers & Ternström, 2005). Thus, on the contrary, solo singing has been more widely studied over the past forty years (Sten Ternström & Sundberg, 1988). In addition, performance studies concerning solo singing have been greater for particular singing styles. For example, taking into consideration Western music, classical singing has been

extensively studied when compared with other forms of singing (Björkner, 2008). Perhaps, the particular interest for this style of singing lays on the fact that, although the term “classical singing” has been adopted mostly since the nineteenth century onwards - referring to a type of singing specific to certain periods of music history - the ideology behind it goes back to classical antiquity (Proctor, 1980). Also, “classical singing” has been connected to a mode of singing that requires fine control of the human voice, as compared to other forms of singing (Dayme, 2005).

More recently, other non-formally learnt styles of singing (although also benefiting from an oral-literary interaction) have been described in the literature, the so-called non-classical styles (Creech et al., 2008). Musical theatre, pop, rock and jazz constitute some examples (Bunch & Chapman, 2000). Perhaps, a contributing factor for the growing interest in understanding performance practices of these styles (including voice function) is that, at least during the last three decades, non-classical styles gained a great number of audiences and originated one of the most profitable genres in music industry (Bartleet, Bennett, & Bridgstock, 2012).

Another form of non-classical singing style that has been increasingly described in the singing literature is folk (Cohen, 2006). Despite less commercial, this form of singing involves a great number of practitioners. The need to describe a country’s singing culture might have emerged with both romanticism and nationalism movements (Carvalho, 1996). Considering Portugal as an example, the performance of folk music was highly encouraged as the main musical activity by the political regimen governing from 1932 until 1974. During this “folklorization” process (Castelo-Branco & Branco, 2003), folk music, initially performed and learnt orally only in the rural fields, evolved to a more organised form of performance, leading to the creation of “grupos folclóricos” - folk groups (FGs). These started to perform this music and singing style not exclusively in rural contexts, but more often in urban areas (Castelo-Branco & Branco, 2003). Naturally, this increased the interest of many to describe this new (old) form of performance and its associated practices, i.e. their origins, constituting elements, social relationships, traditional instruments, costumes, dancing and choreographies, song lyrics, and repertoire performance (Castelo-Branco & Toscano, 1988).

Despite the increasing numbers of studies concerning the numerous manifestations of different singing styles all-over the world, one might argue that few are those that have been focused on contextualising voice function with its associated performance practices. There have been studies centred on how the voice functions, what repertoire is sung, who are the singers and what are their musical and social group

engagements, or even on how the voice sounds. However, no studies have described a singing style combining all these perspectives. Indeed, music has "floating intentionalities" (Blacking, 1995, p. 237), that is, both definition and meaning of music are likely to change according to the context in which music is experienced. Hence, defining a singing style requires contextualization of its performance practices, how the voice becomes a musical instrument; in other words, what specific vocal behaviours are required. Singing changes according to the needs of the singer, the audience and performance contexts (Potter, 1998); thus, describing a singing style taking into consideration only one of these three elements offers a rather incomplete portray.

The closest attempt reported in the literature to describe traditional singing styles using these three elements perspective was carried out by Alan Lomax (1915-2002), an important ethnomusicologist, responsible for the development of *Cantometrics*. According to Lomax (1976) "*singing is viewed as an act of communicative behaviour that must conform to a culture's standard of performance if it is to achieve its social ends*" (Lomax, 1976, p. 11). This definition constituted the rational for the creation of *Cantometrics*, a computer based system of describing, categorising and comparing vocal behaviour within different cultural music styles (Lomax, 1976). This system contained 37 qualitative dimensions of song elements, classified on a gradient scale, taking into account both musical elements (e.g. voice dynamics, timbre, vocal onset) and ethnographic analytical parameters (e.g. social complexity, musical function, working activities, social stratification) (Araújo, Fucks, Amaral, & Pinto, 2003). The aim was to describe music behaviours (including singing), rather than describing songs among different traditional singing cultures, applying methods based on crossing subjective descriptions with other aspects of cultural and social behaviours (Feld, 1984). Although initially well accepted among scholars, this model became gradually criticised and controversial: the effort to group and to quantify the above described elements using perceptual analysis and qualitative descriptions was viewed as a rather simplistic and idiosyncratic categorization of the ethnographic complexity of folk singing and of its singing events. In addition, the simplistic attempts made to describe acoustical vocal events also constituted a strong criticism to this work (Araújo, et al., 2003; Cross, 2003).

Although some spectrographic measures were included in Lomax work, voice analysis were mainly based on perceptual (subjective) assessments made by the human ear. Only eleven of the thirty-seven items used in the singing analysis were directly related to

voice production, namely: volume of singing, glissando[1], melisma[2], *tremolo*[3], glottal shake[4], register(s), vocal width[5], nasality, *raspiness*[6], accent[7] and consonant enunciation (Lomax, 1962, 2009). Finally, an additional criticism lays on the fact that Lomax and his team used statistical analysis to disclose possible correlations between all included parameters in a period where technological tools for quantitative research were still quite rudimentary. Summarising, despite the methodological approach quite ahead of its time, several limitations questioned the validity of the analysis carried out on such vast recording database, namely the subjectivity of perceptual-based analysis and the applied statistical tests (Association-for-Cultural-Equity, 2009; McLean, 2006).

1.1. AIMS

The present investigation constitutes an attempt to describe traditional singing from a multi-modal perspective, taking as inspiration *Cantometrics*' music definition. In the particular case of this research, the main aim is to describe the physiological and acoustical characteristics of the female solo folk singing from Alto Minho, contextualising them within performance practices of this style and audiences' perceptions.

In Portugal, although clear frontiers separating geographically distinguishable regions do not exist, each region is known and recognised by its specific cultural and musical characteristics. Figure 1 represents the Portuguese ethno-musical map provided by the Camões Foundation (Pereira, Oliva, & Nobre, no date), showing how regions are divided according to its own cultural background, musical repertoire, musical instruments, traditional clothing, and traditional dance choreographies. This representation, however, must be considered cautiously, as no strong evidences exist of such straight distribution of cultural elements in Portuguese teritory.

[1] Glissando - «the effect created when voice slides from one tone to another, passing through the intermediate pitch levels» (Lomax, 2009: p. 69)
[2] Melisma - «the same syllable sung to two or more basic notes of the melody» (Lomax, 2009: p. 69)
[3] Tremolo - «a quavering or shaking in the voice that is heard as undulation between two closely adjacent pitches or tone colours» (Lomax, 2009: p. 69)
[4] Glottal shake - «glottal stops, glottal trills, considerable amounts of glottal articulation, forceful glottal articulation, glottal stroke, and strongly emphasized, wide vibrato from deep in the throat» (Lomax, 2009: p. 70)
[5] Vocal width – Ranging scale measuring «from a very pinched, narrow, squeezed voice to very wide and open-throated singing» (Lomax, 2009: p. 71)
[6] Raspiness – General term used to define hoarseness, harshness and other rough voice qualities. (Lomax, 2009, p. 73)
[7] Accent - «the strength of the attack on sung vowels in a given sample» (Lomax, 2009, p. 74)

Minho is a traditional province (since 1936 to 1976), with no administrative autonomy. As shown in the maps, it is situated in the northwest region of Portugal, with the sea on its west, Spain on its north, *Trás-os-Montes* on its east side and *Douro Litoral* on its south. Minho has an area of 4 838 km^2 and a population of 650 000 inhabitants. Its landscape is mostly mountainous, with flatter areas along the coast, and with a rainy and humid climate, with cold winters and moderate summers.

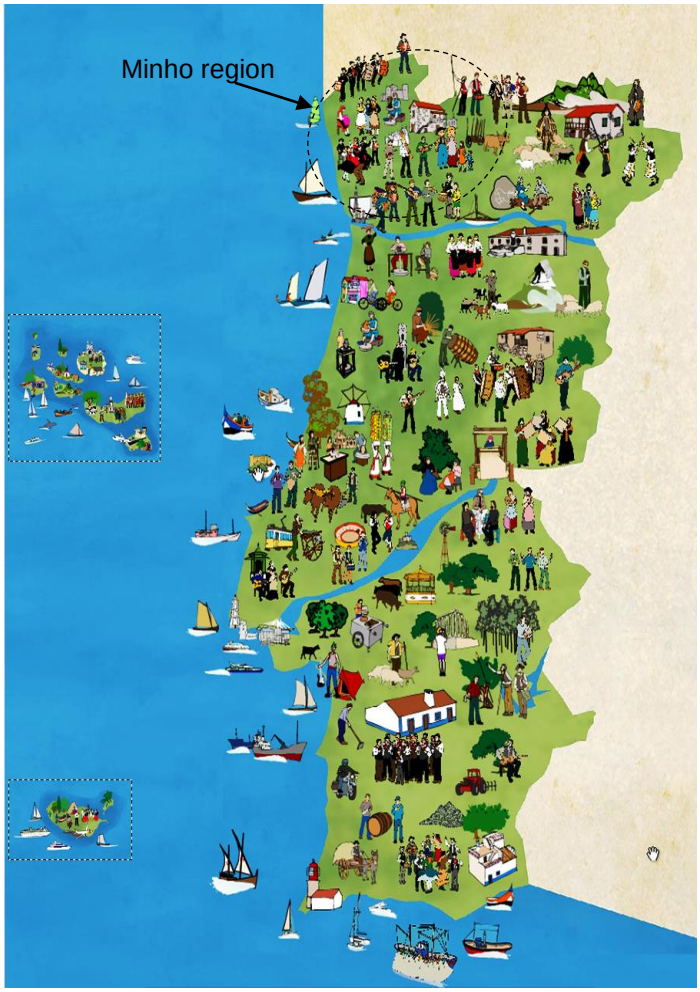

Figure 1. Ethnomusical map showing the iconographic symbols representative of each region that constitute Portugal, including its islands (Azores and Madeira); the dashed circle represents the region of Minho *(adapted from cvc.instituto-camoes.pt, retrieved at 15-01-2014)*.

Minho can be further divided into Braga and Viana do Castelo districts, as these districts have been commonly regarded as two culturally distinct regions: **Alto Minho** (high Minho, district of Viana do Castelo) and **Baixo Minho** (low Minho, district of Braga) (see Figure 2). Although both regions have comparable folklore activities, these are frequently studied separately. For example, the study of the singing repertoire has been

investigated and compiled in separate song books (i.e. *Cancioneiros*) by several authors for each district (Castelo-Branco & Toscano, 1988).

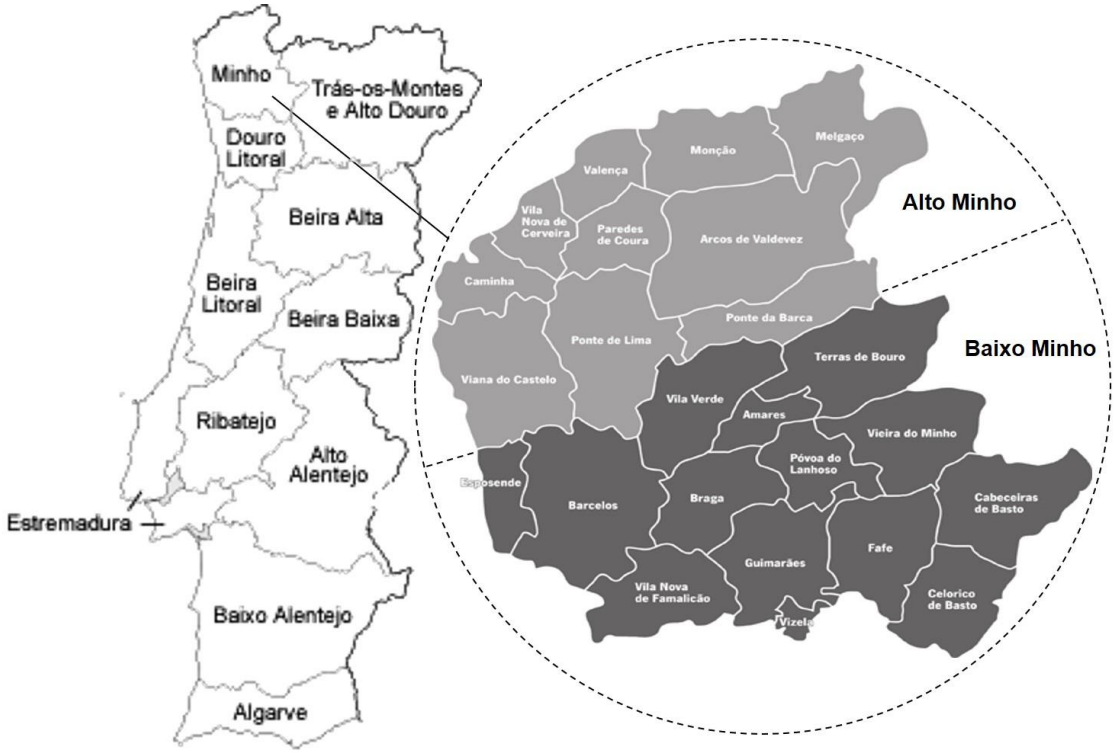

Figure 2. Map of Portugal (the continent only) showing its different constituting administrative regions (left), according with the provinces division used between 1936 and 1976. A detailed representation of the divisions of Minho in Alto and Baixo Minho (districts of Viana do Castelo and Braga respectively) is also provided (right).

1.2. MOTIVATION

For the purposes of the current investigation, Alto Minho (AM) was the selected region, for several reasons. First, although a great number of FGs have regular performance activities in both Alto and Baixo Minho (AM and BM, respectively), AM has the oldest performing FGs in the North of Portugal (performing since 1923) (Castelo-Branco, Neves, & Lima, 2003). Another reason for the selection of this particular region concerns with the fact that the type of solo singing within the groups has been regarded as unique and particularly demanding: the singing of *cantadeiras*. Originally performing polyphonically, this singing style currently involves solo parts, sung by women whose voices have been described as being extremely loud, high pitched and strained. These vocal characteristics, together with their exuberant traditional outfits, have transformed the *cantadeira* in an icon of the folklore of this region. The role of women in folk traditions,

including the *cantadeira*, is represented in many official merchandising materials on regional festivities, especially in Viana do Castelo and Ponte de Lima, and by folk parades, which attract thousands of tourists every year (see Figure 3).

Figure 3. The AM women in traditional outfits as an icon to advertise folklore activities in Alto Minho festivities (Viana do Castelo and Ponte de Lima), being represented in posters, post-stamps and photographs of folk parades.

Although polyphonic singing is no longer the predominant singing expression in AM, these female solo singers – *cantadeiras* - continue to carry the folklore identity of the region (Azevedo, 1997). Their vocal characteristics are recognised and appreciated nationally and abroad, however the role of the female voice in the AM folk identity is still unspecified. Descriptions of voice use and function cannot be found in the literature. If one aims at preserving traditional singing styles that largely depend on orally transmission to be passed over generations (such as this one), it seems natural that one should start by describing aspects of voice production within broad performance practice contexts.

Another reason to carry out such study was related to personal motivations. With family roots both from Braga and Viana do Castelo districts, several cultural ties were developed with the musical traditions of these regions during the childhood and the youth of the author. Although never integrated in a FG, the author was closely in contact with folk music and with FG performances, so that this music style became part of his "musical birthright" and social identity (Welch, Himonides, Saunders, Papageorgi, & Sarazin,

2014). Moved by his interests in music since early years, he studied music at the conservatoire and became acquainted with classical singing. This naturally awakened a great interest on function of the singing voice, which, latter on, made him pursue a professional education in speech and language therapy (the author is a speech and language therapist, SLT) and in speech and hearing sciences. During these years of formal education, the author continued his singing performance activity in non-professional music groups, and developed voice therapy experience with several professional and non-professional singers.

The daily contact with these working environments, including voice therapy with non-professional singers, also *cantadeiras*, impelled him to be interested in deeply understanding voice function of these female singers. Through this experience, the author realised that vocal tasks required by FGs´ repertoire were highly demanding on the voice. This, together with the lack of voice education and vocal technique of these singers seemed to constitute risk factors for developing voice problems within this singing population. Other vocal behaviours, such as those influenced by cultural orally transmitted models, seem to add this risk, as some of these models, according to the working experience of the author as a SLT, include patterns of loud speech and pressed phonation, for example. Thus, a further motivation is to use the results of this investigation as a mean to promote healthy vocal habits in these singers.

1.3. RESEARCH QUESTIONS

As most available literature on voice education and therapy concerns the speaking voice and classical singing, it seems appropriate to understand the voice in non-classical singing contexts, especially in those that have not yet been described. Emerging from personal observations, professional experiences and the literature review, the researcher poises the following questions: (1) what are the perceptual characteristics that identify AM *cantadeiras*' singing; (2) are there common physiological, acoustical and aerodynamic vocal features amongst *cantadeiras* who are perceived as most representative of this style? (3) are these characteristics shared by other traditional singing or non-classical singing styles?

To answer to these questions, a multidimensional study was carried out, aiming at: (1) describing the current performance practices of AM folk singing, including the relationships between FGs' activities and *cantadeiras*' practices; (2) exploring

perceptions of what vocal characteristics most identify *cantadeiras*' singing; (3) developing a voice assessment protocol, particularly designed to study the *cantadeiras*' singing style; (4) investigating if identified features correlate with physiological and acoustical parameters constituting this type of singing; and (5) comparing *cantadeiras*' singing with other non-classical and traditional singing styles.

1.4. STRUCTURE OF THE THESIS

According with the questions and aims presented above, the present work is organised in six chapters (besides this introduction), which reflect all data collection and analysis involved in this multidimensional study. All procedures involved in this study were approved by the Ethic and Deontological Council of Aveiro University (process 4/2014), as presented in Appendix 1. These include telephone questionnaires, handed in surveys, semi-structured interviews, perceptual evaluations of voices (i.e. listening tests), and multichannel voice recordings.

Chapter two presents a contextualization of folk singing, including a definition of this style, its historical evolution in Portugal, a brief review on what physiological and acoustical parameters might be relevant when analysing singing voice, and a systematic literature review of vocal function in non-classical and traditional singing styles.

Chapter three is mainly dedicated to perceptions of AM folk singing practices, inferred from the results of: (1) a telephone questionnaire carried out with a wide sample of FGs; (2) handed in surveys exploring performance practices of a smaller sample of FGs; and (3) semi-structured interviews with FG members, exploring the *cantadeira*'s roles within the groups and voice characteristics found to be as the most representative of this type of singing.

Chapter four consists of a pilot study, where a voice recording protocol was developed and tested to collect voice of traditional singing, particularly AM folk singing. This chapter also explores several voice measures, in order to identify which ones could provide robust information on voice function for this style of singing.

Chapter five includes a Listening Test (LT) carried out to assess the degree of vocal representativeness of a group of *cantadeiras*. The results of this chapter served as the database collected for the subsequent chapter.

Chapter six is focussed on voice function of *cantadeiras*, including acoustical and physiological parameters that can describe both speech and singing. Statistical methods are used (i) to predict perceptual ratings attributed in chapter five, and (ii) to identify which parameters represent the *cantadeiras*' voice. Also, comparisons are made between vocal characteristics of *cantadeiras* and other non-classical and traditional singers.

The last chapter, Chapter seven, presents a general discussion of the results found in all previous chapters. Final considerations are presented, responding to the initial research questions and motivations and pointing at possible research directions in folk singing.

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CHAPTER 2

CONTEXTUALIZATION

2. CONTEXTUALIZATION

2.1. DEFINING FOLKLORE

Folk music, traditional music and popular music, although corresponding to different practices, are terms frequently used in the literature to allude to the same musical style. Thus, a clarification of their definition seems imperative for the purposes of the current investigation and constitutes the starting point of this contextualization chapter.

Folklore was a term originally used in the middle of the 19th century, to refer to "the traditions, customs, and superstitions of the uncultured classes" (McLean, 2006, p. 81). Later it became associated with specific music traditions, thus originating terms such as “folk music” and “folk song”. From a musical point of view, folklore has been understood as old songs without a known composer, or music that has been orally transmitted and orally evolved, or even music performed routinely over a long period of time. During the 20th century, this concept was spread all over Europe and other continents, and begun to be applied to characterise numerous music manifestations; therefore, rather than referring to a consistent and well-defined style, folklore (and folk music) defines a wide number of genres, reflecting the cultural diversity of each region. Today, folklore also includes two other dimensions: (a) the scientific discipline of Folklore Studies; and (b) the cultural representation of the rural traditions, made by FGs in performance activities. This research will focus predominantly on this last dimension, as it concentrates on the activity of *cantadeiras* currently performing in AM FGs.

Other related terms have been introduced as synonymous, such as: traditional music, popular music, and regional music. To avoid misinterpretations of what folklore would be, in the 1980s, the *International Folk Music Council* set the example and changed its denomination to *International Council for Traditional Music*[8]. From then on, traditional music became a wider term, embracing styles such as folk, ethnic, Oriental music (e.g.

[8] International Council for Traditional Music - Is a Non-Governmental Organisation in formal consultative relations with UNESCO. Its aims are to further the study, practice, documentation, preservation and dissemination of traditional music and dance of all countries (http://www.ictmusic.org/).

Chinese opera), and even some urban traditional music styles (e.g. Portuguese *Fado*). Thus, one might say that traditional and folk music are related, but not synonyms.

Popular song also should be considered separate from folk. Although popular song, understood as "a song of people" (Castelo-Branco & R. Cidra, 2010) may have the same roots as folk song, the fact is that popular music, or pop music, is nowadays a totally distinct music genre. It is conceived for mass distribution and produced with essentially commercial purposes. Nevertheless, in some countries (e.g. Portugal), the term "popular" still maintains some connotation with folk or traditional music. The reason for this misconception might be related to the fact that the term popular culture (*cultura popular)* was firstly used as an equivalent to folklore, the authentic patrimony of the rural population. Although the significance of popular music has changed over time, it still is possible to find many references using Portuguese popular music as synonymous of folk or traditional music (Giacometti, 1982). In alternative, the Anglo Saxon meaning of "popular music" progressively evolved to "light music" (*música ligeira*), "modern music" (*música moderna*) or "pop music" (*música pop*), a well-accepted term in today's society (Castelo-Branco & Cidra, 2010).

Taking into account the above definitions, the studies further presented will be identified with the term folk music when describing styles which reflect the cultural diversity of each region only, whereas traditional music will be used in studies referring to all styles that embrace regional, ethnic, Oriental music and urban traditional music styles. Thus, the terms "folklore", "folk music", "folk singing" and "folk style" will be applied to refer to the FGs' music and performance activities. The term "traditional music" will be used to include both folk music and other traditional musical styles, including rural and urban music. The term "popular music" will be avoided in order to prevent misinterpretations. When refering to other modern and commercial styles of music, the term non-classical music or singing will be used. The term classical music or singing will be used only referring to Western classical music.The following section describes the evolution of traditional singing in Portugal, paying special attention to the development of folklore practices.

2.2. HISTORICAL OVERVIEW OF TRADITIONAL SINGING STYLES IN PORTUGAL

In Portugal, like in Europe, folklore has been recognised and studied since the late 19th century, along with the romanticism and nationalism currents. During the 20th century, folk music activity spread out through the whole country, as this style was highly encouraged by the politic regimen of that time (1932 until 1974). During this "folklorization" process, folklore performance accompanied migration flows from rural to urban areas and was gradually transformed into a formal performance activity, mostly practiced by FGs, all over the country (Castelo-Branco & Branco, 2003).

Currently, there is a wide-range of musical traditions in Portugal. Some of the most representative ones are: a) the FGs, constituted by groups of 30 to 50 elements, including singers, traditional instrument players and dancers; b) the *"Cante Alentejano"*, vocal ensembles of the region of Alentejo (south of Portugal) constituted mostly by male singers, singing in several parts; c) female polyvocal singing ensembles, located at different Portuguese regions (e.g. "Cramol do Douro"); d) the *"cantares ao desafio"*, a free singing type of performance where a couple of singers improvise lyrics in a conversational mode; e) the *"grupos de cavaquinhos"*, groups of traditional chordophones (ukuleles); and f) the "Zés-Pereiras", which includes drums' playing in street parades accompanied by concertinas, flutes or bagpipes. Additionally, traditional music expressions also include urban styles, such as *Tunas*, i.e. popular music groups, including instrument playing, with or without singing, and some urban recreational groups (Castelo-Branco & Cidra, 2010; Castelo-Branco, et al., 2003). *Fado* constitutes another example of a traditional urban style, probably the most recognised example of Portuguese music abroad. Although having traditional roots, *Fado* is considered by the discography industry as being part of *world music*. Its origins go back to the early 19th century and the city of Lisbon (Carvalho, 1984). Incorporating music and poetry, it combines local traditional genres of song and dance with other non-Portuguese music that was performed at the busy port of Lisbon (Brito, 1994). *Fado* is currently considered as an urban popular song, recognised by UNESCO as an intangible cultural heritage in 2011 (UNESCO, 2011). Recently (November of 2014), also the *"Cante Alentejano"* obtained the same UNESCO recognition, corroborating the richness of Portuguese singing traditions.

Since the 1870s, many authors have studied Portuguese folklore, mostly from musical, cultural, social and even political perspectives. These studies were developed by musicologists, composers, music teachers, anthropologists, folklorists, folk music

enthusiasts and "local erudites", and the majority include songbooks (*Romanceiros* and *Cancioneiros*) of music from rural areas (Castelo-Branco & Toscano, 1988). Oral-literacy interactions offered an important asset to those interested in understanding performance practices of this style of music, and include: (1) musical transcriptions; (2) harmonised versions of traditional repertoire written for chamber music ensembles, including piano and voice; and (3) adapted versions of traditional melodies for military bands, orchestras and chorus (Castelo-Branco & Toscano, 1988). These works were mostly inspired in the Romanticism movement, a literary current describing genuine roots of Portuguese rural traditions (Carvalho, 1997).

During this period, Portugal was largely a rural country where most population lived in poor economic conditions and had limited access to education. Traditional music was then the major form of representing the country's culture. Predominantly based in vocal polyphonic repertoire, folk music was performed during almost all professional activities.

After the politically instable post-monarchic governance, the first Portuguese Republic (1910-1926), a military dictatorship prevailed (1926-1928), followed by a national dictatorship (1928-1933) that ended with the *Estado Novo* period (1933-1974). During this dictatorship, motivated by the fast disappearance of rural traditions, independent researchers, "local erudites" - many of them catholic priests, ethnographers, anthropologists, composers, music teachers and choral directors - attempted to collect, within the rural areas, information regarding not only the music that was performed, but also its origins. These studies were thus focused on genres assumed to be "authentic" survivals of "archaic" practices (Castelo-Branco & Toscano, 1988).

At this time, folklore was used as a social and cultural mean to convey a nationalist ideology, partially forced by this political dictatorial regime governing the country. A National Propaganda Secretariat (SPN – *Secretariado de Propaganda Nacional*) was created to be responsible for the education of people according to this ideology. To encourage the population on developing this nationalist identity, the political regime organised a number of folklore activities all over the country. Thus, many rural traditions were deliberately performed in urban areas, to serve as iconographic symbols of the genuine Portuguese identity. As a consequence, many folk performance groups were created, adopting a structural organisation that still defines the FGs nowadays (Carvalho, 1996). FGs were invited to perform in local festivities, touristic events and to compete in national and international festivals. A "folklorization" process begun, where the cultural characteristics of regions within the country (*províncias*) were typified.

After 1940, during the *Estado Novo* period, previous documented information on performance practices started to be complemented with audio recordings, and later on (during 1970s), even by video recordings. Some of the most recognised contributes were given by Michel Giacometti (ethnologist, 1929-1990) and Fernando Lopes Graça (composer, 1906-1994), who produced documentary television programs, discography and musical transcriptions of all regions within the country. From then on, many transformations occurred within folk traditions (Castelo-Branco & Toscano, 1988). For example, several where the FGs that modified their practices to fit new performance venues, and to create a show that could include more exuberant costumes, choreographies and music. During the 1960s, the number of FGs increased, partially because they were also created within the community of Portuguese emigrants.

Despite the Carnation Revolution (*Revolução dos Cravos*) of 1974 and consequent significant political changes (the end of the dictatorship regime), the number of FGs continued to grow. Folklore re-gained its importance within cultural activities (Castelo-Branco & Branco, 2003), possibly encouraged by the political changes, the end of the colonial war and the decrease of emigration (Amaral, 2010). In 1977, the Federation of Portuguese Folklore (FFP – *Federação de Folclore Português*) was created to promote and restore FGs' activity, in order to preserve the representativeness of their practices. The national foundation created during the dictatorship regime to support FGs' activities, FNAT (*Fundação Nacional para Alegria no Trabalho)*, was converted into INATEL (*Instituto Nacional para o Aproveitamento do Tempos Livres dos Trabalhadores),* so that it could continue to promote cultural activity of folk and ethnographic groups.

Other traditional music groups also emerged at this time, but now predominantly originated in urban regions. Thus, folk music started to be merged with other more modern music styles. The study of these new and old traditional styles became a focus of interest of many researchers, giving birth to the ethnomusicological research centre - *Instituto de Etnomusicologia* (INET) (1995). This centre was responsible for one of the most important studies on Portuguese traditional music groups (TMG), as, for the first time, it applied quantitative methods to describe specific TMGs' characteristics, including: (i) demographics, (ii) history and origins and (iii) performance activities (Castelo-Branco, et al., 2003). The following paragraphs explore, in more detail, the results of this quantitative study carried out in 1998, organised according to each of the just described categories.

(i) Demographic characterization of Portuguese TMGs

From a total of 2 850 identified TMGs, 74% (n = 2 118) were FGs. About 988 TMGs agreed to take part of this study, which included 703 FGs. The highest number of TMGs was geographically allocated in the Northern coast of Portugal. However, considering the population distribution within the country, both interior part of Portugal (especially the region of Beiras) and Azores islands presented the highest number of TMGs, according with population density. At the time of this study (1998), FGs were predominantly present in urban areas (49%), followed by semi-urban (28%) and rural areas (23%).

In general, there were a total of 93 616 members in FGs all over the country (mean = 44.2 members per group). Thirty five percent of the total number of members (about 32 500) were located in the north region. In the region of Viana do Castelo, there were at least 83 FGs, with an estimated number of 3 670 members. These FGs had a well-balanced gender constitution (53% male vs 47% female), and included all age groups (below 14, 15-17, 18-22, 23-29, 30-39 and 40-59 years) with 12 to 18 members each, except for the age group of “above 60 years old”, with only 7 elements. The reported data clearly showed that FGs were predominantly constituted by children, teenagers and young adults. Furthermore, 24% of the FGs had a separate juvenile group, suggesting that FGs promoted the inheritance of traditions within families. In fact, family relationships within FGs members were quite common (98% of cases).

(ii) History and origins of TMGs

Exploring the history and origins of FGs, the results of INET’s study suggested that the first FGs were created in 1907, in the regions of Coimbra and Aveiro. This contradicts previous reports claiming that the origins of the first FGs were around 1923, in Viana do Castelo (Carvalho, 1997). Thus, although the north region (and particularly Viana do Castelo) is known to be the *niche* of Portuguese folklore, the centre region has a comparable importance concerning FGs’ history. The majority of the responding FGs (42.7%) were founded during 1975-1984, followed by groups created between 1985-1994 (29.2%), 1951-1974 (15.4%), 1995-1998 (7.3%) and previous to 1950 (5.4%).

(iii) Performance activities of TMGs

TMGs’ members may be responsible for activities such as: dancing (46.1% of TMGs members), singing (22.8%), playing an instrument (22.7%), playing an instrument

and singing (12.7%) and organising the performance activities and the institutions' formalities (12.8%).

Comparing with other types of TMGs, FGs were the only groups combining dance with singing and instrument playing in the same performance, using also traditional costumes and accessories. Public presentations were mostly done in outdoor stages followed by show rooms, restaurants, hotels and other spaces.

Many of the FGs' activities and ambitions depended on their legal status: 80% of them were formally constituted as/or integrated in an association, and many were affiliated with funding entities such as INATEL (46%) and FFP (31%). Thus, much of the financial income of the FGs came from governmental support (i.e. local municipalities), but also from INATEL, festivities organization commissions, touristic promotion entities and private companies. Thereby, FGs seemed to be extremely dependent on external entities to support their activities, so they are also easily affected by political and economical oscillations. In fact, the majority of FGs in this study revealed to be paid under 250€ for each performance, which seems rather low taking the amount of people necessary to ensure such type of performance. Thus, one might argue that FG's motivation to perform is not a professional one, but rather connected to related social, cultural and leisure benefits. This corroborates the findings of previous studies, focussed on the social benefits of music (Crozier, 1997). In fact, when asking FGs' directors what were the motivations to keep FGs' activities, they reported to: (a) have their own facilities; (b) preserve and promote their traditions, especially to younger generations; (c) disseminate the repertoire; (d) promote the interaction between members; (e) bring prestige to the region they represent; and (f) travel abroad. The bonds between group members and their family/friends seems to be fundamental to guarantee the continuity of FGs.

2.3. EXPLORING SINGING PRACTICES IN ALTO MINHO FGs

The origins of singing traditions in Portugal remain unclear; however, one might argue that they were certainly related to the interplay between the music from various cultures that coexisted in Portugal and by the influence of catholic religious music (Ramos, 1892). The same applies to the origins of Minho's folk singing. Taking into account the melodic structure of traditional Minho songs, some authors believe that Minho and Galicia (in the north of Spain) musical traditions had their origins in Greek ancestral music (Sampaio, 1937). Contrary to this hypothesis, others considered north-

eastern Portuguese music as part of a larger folk region called "Old Europe", which include regions such as Spain, England and Scandinavia (Alan Lomax, 1959). According to this researcher, *"in this whole area, singing and dancing are basically choral and cooperative; the voice is produced from a relaxed throat and the facial expression is lively and animated, or at least relaxed; (…) blended unison is normal and many forms of polyphony exist"* (Lomax, 1959, p. 936). Additionally, he claims that Celtic influences in Portuguese north-eastern music came from Galicia. Although Minho and Galicia share several cultural and language features, this hypotheses have not yet been tested, as far as we know.

Independently of its origins, singing manifestations were crucial to develop Portuguese folk music during the latter part of the 19th century. Women were central elements in folk Portuguese music activities: polyvocal songs were mainly performed by women, usually accompanying rural work and/or religious activities (Castelo-Branco & Cidra, 2010). The nature of the work and the landscape of mountains seemed to be elements that deeply influenced the singing habits and other vocal manifestations within each region (Lomax, 1959). Perhaps the mountainous topography in AM have impelled ancient people to use loud voice to communicate in far distances, and the existence of group rural works and religious rituals, as pilgrimages, have contributed to the appearance of polyvocal singing manifestations.

Nowadays, it is virtually impossible to listen to the songs sung as they were originally. The earliest repertoire collections of that time currently available are music transcriptions, lacking of descriptions of voice quality of the singing voices. Only from 1960s onwards, one can find several audio recordings of traditional singing. The most known ones were recorded by Giacometti and Lopes Graça (2008).

In those days, Minho was already acknowledged as a Portuguese region where folklore encountered high representativeness; however, on the other hand, it was also a region suffering from great modifications concerning what were claimed to be original traditions, in part due to fast growing numbers of FGs. Nevertheless, Giacometti's recordings are still recognised as representative of a broad singing tradition, as the majority were collected in isolated places within each studied region. Singing was collected during rural or religious activities, and most of the samples had no instrumental accompaniment.

Thus, several polyphonic singing examples are available, most of them performed exclusively by women singing *a cappella*[9].

The complex structure of these vocal compositions was partially studied by Muszkalska (2000), who compared vocal arrangements of the "old style" of singing (the recordings by Giacometti and Lopes-Graça) with those used in modern FGs repertoire. According to the author's field observations, the "old style" of singing was often called as *out of tune* voice (*voz desafinada)*. This perceptual characteristic can be partially related to the intonation strategies used by the folk singers while singing. Instead of memorising the size of the interval, as members of professional choirs do, female singers of traditional Portuguese ensembles sought the target sonority by shifting within the range of micro-tone intervals and listening to the "colour" of the interval. This naturally creates a roughness and *out of tune* perceptual effect, because, for some intervals, the difference between the target and the performed tones exceeds 15Hz. When achieving the target interval and the desired harmony, singers frequently prolong the duration of the chords and increase loudness (Muszkalska, 2000). This author's findings are in accordance with previous descriptions, pointing out that most important voice qualities in those groups were: intonation, sonority and tone sustainability (Sampaio, 1929). The spectrographic-based descriptions of Muszkalska (2000) partially complemented the work of Sampaio (1929) that also described other characteristics of different Minho popular songs. He identified four types of repertoire in Minho, with specific musical and vocal features (Sampaio, 1929): (i) old romance songs (*cantos dos velhos romances*) – performed in one or two voices; (ii) choreographic songs (*cantos coreográficos*) – performed only with voices or together with traditional orchestras (named *rondas*) to accompany dancing; (iii) pilgrimage songs (*modas de romaria*) – performed in pilgrimages or during the rural works, in unison or (the majority) in two voices, using parallel 3rd intervals; and (iv) *terno* songs (*modas de terno*) – performed by vocal ensembles, including mostly women playing four or five different voices: *baixo* (melodic basis), *baixão* (lower voice), *meio* or *desquadro* (middle voice, tuned in thirds or fourths), *guincho* (higher voice, tuned in fifths or sixths) and sobreguincho (top voice in the last phrase, reproducing the *baixo* one octave higher).

Currently, most folklore activities in Minho are performed by FGs. However, only few use an "old style" singing, performing *a cappella* polyvocal songs (see Figure 4 as an example of such FGs).

[9] *A cappella* – Group or solo singing without instrumental accompaniment Holmes, W. C. (Ed.) (2007) Grove Music Online. Oxford Music Online.

Figure 4. AM FG - Cantadeiras do Vale do Neiva - interpreting *a cappella* polyphonic songs *(adapted from www.cantadeirasdovaledoneiva.com/, retrieved in 15-01-2014)*.

The great majority of FGs have followed a choreographic-based performance, and today they exhibit mostly choreographic song repertoire. In these FGs, singing is accompanied by a traditional orchestra, but the core of the performance is occupied by opulent traditional dances, performed by a variable number of male and female dancers. Figure 5 represents one of these performances, and shows the place of the *cantadeiras* in the group.

Figure 5. AM FG - Grupo Etnográfico Danças e Cantares do Minho - interpreting choreographic songs and dances. The *cantadeiras* of this FG are identified by a dashed circle *(adapted from bloguedominho.blogs.sapo.pt, retrieved in 15-01-2014)*.

Minho's folk repertoire includes several songs (*modas*), transcribed in specific songbooks (*cancioneiros*). Most songs have a strophic structure and the poems usually speak about: rural works (i.e. harvests, pasturage or fishery), love and friendship, emigration (i.e. work or war departures), religious themes (e.g. Christmas) and landscape characteristics of the region (i.e. river, mountain or monuments). Within these

songs, according to their musical structure and function, there are several group compositions: *Vira*, *Cana Verde*, *Chula* and *Malhão*. According to Sampaio (1929), this repertoire shows the best of local voices if sung in F major or in D minor tones. No information was found concerning tones recently used.

Vira is a choreographic type of song mostly associated with Minho. It is described as a four-beat rhythmic pattern, where the third beat is divided into a long beat followed by a short one (Figure 6). Most *Viras* are songs accompanied by the usual FG's instruments. Its harmonic structure alternates between the tonic and dominant chords and the most common melodic structures are AABB. The verses are sung alternating between the soloist (*cantadeira* or *cantador*) and the choir, or between both female and male soloists (César & Moura, 2010c).

Cana Verde, *Chula* and *Malhão* are also choreographic songs but not specific from AM. Despite they share a common rhythmic structure they can be found in different and distant Portuguese regions. They all coexist in Minho: *Malhão* is more frequent in BM and *Cana Verde* in AM. These songs have a binary or quaternary metric, and the rhythm pattern, usually marked by a drum, includes two cells: the first consists of three beats, followed by a pause; and the second consists of four beats (one long, two short and one long), followed by another pause (Figure 6). Played in a major mode, the harmonic structure usually alternates between the tonic and the dominant (Batalha, 2010; César & Moura, 2010a, 2010b).

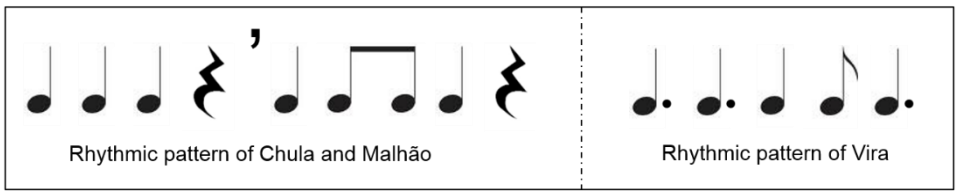

Figure 6. Rhythmic patterns of repertoire performed in AM FGs

Today, singing manifestations in Minho are mostly choreographic songs, where singing is accompanied by loud traditional instrumental playing. Thus, to understand voice function of *cantadeiras* contextualised within the performance practices of these singers, it seems appropriate to describe also the acoustic properties of traditional instruments, especially when the literature is to scarce concerning this matter (Henrique, 1987).

The most frequent traditional instruments played in FGs are: concertinas, accordions, classic and traditional guitars (*violas*), *cavaquinhos* (ukuleles), *bombos* (drums), *reque-*

reques and *ferrinhos* (see Figures 7 and 8). Other traditional instruments that became less popular include the *rabeca* (a kind of violin) and the clarinet (Sampaio, 1929).

The rhythm of folk music is evidenced by percussion instruments, which include membranophones and idiophones (examples of these instruments are presented in Figure 7). The *bombo* is a bimembranophone of direct percussion, similar to a drum, constituted by a cylindrical resonance wood box, covered by two leather membranes. It is usually played by men using wood drumsticks (Carvalho, 2010; Oling & Wallisch, 2004). The idiophones' category include: (a) *ferrinhos*, a cylindrical metal stick of a triangle shape of about 1.5 centimetres thick. The instrumentalist plays it with a metal stick in the sides creating a tinkling effect (Oling & Wallisch, 2004); (b) *reque-reque*, a dented wood-stick (or reed) with about 70 cm long, on which the player rubs at the desired rhythm another stick or cracked cane, and (c) *castanholas*, or castanets, a pair of concave shells, traditionally made of hardwood, and joined on one edge by a string. They are held in the hand and used to produce clicks for rhythmic accents or a ripping or rattling sound consisting of a rapid series of clicks (Oling & Wallisch, 2004).

Figure 7. Percussion instruments used in FGs: *bombo* (first from left), *ferrinhos* (second from left), *reque-reque* (third from left) and *castanholas* (fourth from left) *(adapted from www.gfvv.pt, retrieved at 15-01-2014).*

The melody and harmony are both played by other instruments. The *concertina* (see Figure 8), also named melodeon or diatonic accordion (Oling & Wallisch, 2004), is a box-shaped aerophone, and one of the most dominant instruments in the AM region. It has two or three rows of buttons under the right hand, producing melodies, and 6, 8, 12 or 16 buttons under the left hand, producing the bass line and chords. It was introduced in Portugal in the beginning of the 20th century, possibly after World War I, but because of its tuning limitations was progressively substituted by the chromatic accordion during the second half of 20th century. At the end of the century, the *concertina* was largely promoted all over the country, but specially in AM, and today it is widely used again in

FGs and other traditional music contexts (Raposeira & Castelo-Branco, 2010). The chromatic accordion, composed by buttons or keys, is more versatile considering tuning and repertoire adaptation. Although it still exists in several Portuguese FGs, it is considered non-traditional and less-adequate for folk music purposes, as it did not exist in Portuguese rural contexts at the beginning of the 20th century (Raposeira & Castelo-Branco, 2010).

Another group of traditional instruments represented in AM are the chordophones, composed by a resonance box (with an "eight" shape) and an arm (or neck) with strings fixed in the headstock and in the bridge. They may take a melodic or harmonic musical role, and although they may be played in different ways, Portuguese traditional string instruments are usually played using a plucking method. They include several types of guitars, traditionally named *violas*, with numerous regional variants. The most common is the *violão* (also known as French *viola* or classic guitar), an acoustical wooden guitar with six strings. A variant of this instrument is the *viola baixo*, or bass guitar, a larger instrument with only four metal strings, used to play the bass (Artiaga, 2010). The most relevant regional variant in Minho is the *viola Braguesa*. It has five double steel strings (10 strings) and it may be tuned according with particular regions, singers, groups or repertoires (César, 2010). Examples of these instruments can be observed in Figure 8.

Figure 8. Representation of melodic and harmonic instruments used in FGs: *concertina* (left), *cavaquinho* (midle-up), *violão* (midle-down) and *viola braguesa* (right) *(adapted from www.gfvv.pt, retrieved at 15-01-2014).*

Two other important chordophones in Minho are *bandolim* and *cavaquinho* (see Figure 8). A *bandolim* (Portuguese name for mandolin) is a pear-shaped guitar with origins in

the 15th century, consisting of four double chords, G-D-A-E tuned, and usually plucked with a plectrum or 'pick' (Tyler & Paul, 1996).

The *cavaquinho*, similar to a ukulele, is a small chordophone, used in Portugal since the 18th century. It has four metal simple strings that, in FGs, are usually tuned in D3-G3-B3-D4, A3-A3-C#4-E4, or G3-G3-B3-D4, thus making a harmonic function in the music accompaniment (Morais, 2010).

Traditionally, music playing was considered a more masculine task while singing was expected to be more feminine. Currently, there are female *cantadeiras* but also men soloists, *cantadores*, and women also may play an instrument side by side with men. However, *cantadeiras* of Minho still preserve a fundamental role as representative members of folk music.

Besides music (including repertoire, instruments and voices), there are also other important aspects that define a FG: its costumes and choreographies. All elements, including *cantadeiras*, wear traditional outfits for the performing events, representing the costumes used in daily life activities by different social strata. Dancing is executed in groups of couples, displaying traditional eye-catching choreographies which most times are the central visual element of the show (Dias, 1970; Fernandes, 2000).

As a summary of most important information concerning folk traditions in Portugal, one may say that significant transformations occurred in Minho during the 20th century. As a consequence of folklorization, polyvocal *a cappella* singing tended to disappear, being replaced by FGs. During this period, singing was integrated in pre-organised performances including musical accompaniment, and lately, also sound amplification. Naturally, these transformations may have had some impact on vocal practices of *cantadeiras,* the female solo singers, which still hold a relevant role in representing the traditional singing culture of this region.

Costumes, musical instruments, repertoire, choreographies and *cantadeiras*' voices contribute to differentiate FGs within a region in Portugal. Although women have always had a relevant role in the FG's singing traditions, today this function is shared with male soloists (*cantadores*). However, female voice characteristics seem to remain prevalent in the FG's identity, despite few references refer directly to the *cantadeiras*' voices (most of them concern repertoire and musical considerations). A deep understanding and more

complete description of *cantadeira*'s voice function within performance practices is needed if one wants to contribute to the preservation of this form of singing.

2.4. PHYSIOLOGICAL PARAMETERS RELEVANT TO SINGING

Up-to-now, information on Portuguese folk performance practices has been discussed. The natural following step would be to describe voice function in folklore, especially in AM folklore, as this constitutes one of the main goals of this research. However, before doing so, the following section presents the physiological and acoustical parameters of voice production. The rationale for this previous anticipatory section is the necessity to understand the phenomena underlying the use of voice, as a musical instrument, in a specific music style.

Physiologically, voice is produced by the interaction of several systems, including: (i) breathing, (ii) phonation (or voice source), and (iii) articulation (or resonance, or filter) (Sundberg, 1987). Breathing acts as a compressor, providing overpressured air to the vocal system. Phonation is produced in the vocal folds (larynx), which act as an oscillator, converting the transglottal air column to a sequence of air pulses, corresponding to the voice source. Resonance is the process of modelling the source sound by articulating the constituting elements of the vocal tract (resulting in different formant frequencies), including all structures and cavities between the glottis and the lips.

When studying voice function, each of these components can be quantified (metrics) and qualified (interpreted). Bio-signals are often used to describe voice production in activities as speech and singing, but also in clinical settings (Lã, 2012). Examples of technology applied to study voice function include: radiological imaging (e.g. radiography, fluoroscopy, ultrasound, and magnetic resonance imaging), plethysmography, video-fibroscopy, video-stroboscopy, video-kimography, electromyography (surface or intramuscular), electroglottografy (EGG) or electrolaryngography (ELG), airflow and pressure analysis, and acoustic analysis (Ma & Yiu, 2011).

Interpreting the signals provided by such technology is a complex task for researchers and voice practitioners (i.e. voice teachers, singing teachers, speech and language therapists). Thus, the following sections constitute an attempt to simplify the information that can be extracted from these signals, explaining most frequent measures of voice

function in singing, and presenting some of the most relevant breathing, voice source, and resonance/articulation measures currently in use in voice research.

Breathing is a fundamental element in voice production, as it controls the airflow at the level of the glottis. Lung volumes are important to estimate singer's lung capacity and percentage of air use for a specific vocal task. For instance, air volumes required for singing or for loud speech are usually higher than those in conversational speech (Sundberg, 1987). Spirometers can be used to directly measure lung volumes. However, not only lung volumes, but also breathing patterns are important to understand, as these influence airflow control. Systems as plethysmography measure chest wall movements, providing detailed information on respiratory applied strategies, as rib cage and abdominal wall movements are measured independently. In classical singing several studies exist analysing breathing strategies (Collyer, Thorpe, Callaghan, & Davis, 2008; Pettersen, 2005; Sonninen, Laukkanen, Karma, & Hurme, 2005), but in non-classical singing studies are almost inexistent.

A great interdependence exists between breathing and voice source; for example subglottal pressure (Psub) is influenced by both airflow (controlled by respiratory muscles) and glottal resistance (controlled by intrinsic laryngeal muscles). Therefore, both airflow and subglottal pressure are important components for voice measuring: together they provide information about voice function.

Airflow is defined as the amount of air that flows through the glottis during phonation. It can be measured by a pneumotachograph (Ma, 2011a). In the case of voice and speech studies, the most common unit is *litres per second* (L/s). Airflow evaluation requires that all the air to be measured (an only that) passes through the flow transducers. To achieve this, a face mask that doesn't leak air around the edges is needed (Baken & Orlikoff, 2000). The Rothenberg mask (by Glottal Enterprises, Inc.) is probably the most known and used device for this purpose. It also includes an intraoral pressure transducer, allowing simultaneous measurements of airflow and oral pressure (Solomon, 2011). An example of such mask may be seen in Figure 9.

Figure 9. Rothemberg mask (in the left), used for measuring oral flow and intra-oral pressure pressure transducer (in the right) *(adapted from www.glottal.com/, consulted in 10-01-2014).*

Psub is the driving force beneath the adducted vocal folds during phonation (Colton, Casper, & Leonard, 2006). Although the pressure measurement unit is usually *pascal* (Pa), in speech research the chosen unit is *centimetres of water column* (cm H_2O), originally measured using a U-tube manometer (Baken & Orlikoff, 2000). There are different methods to measure Psub, but all of them are considered invasive. Alternatively, non-invasive methods were developed as the one included in the Rothenberg mask: an estimation of Psub is obtained by measuring the intraoral pressure peaks obtained at the release of a bilabial plosive, usually the voiceless [p] (Ma, 2011a), by means of a small tube inserted in the corner of the mouth, at one end, and to a pressure transducer, at the other end (see Figure 9, in the right).

Psub is considered the main physiological parameter for controlling vocal loudness[10] (Björkner, Sundberg, Cleveland, & Stone, 2006). It has also been demonstrated to influence fundamental frequency (Titze, 1989), and to correlate with other voice source measures (Björkner, Sundberg, & Alku, 2006), namely maximum flow declination rate (MFDR), normalised amplitude quotient (NAQ), the level of the fundamental (H1-H2) and closed quotient (Q_{closed}) (Sundberg, Fahlstedt, & Morell, 2005). All these parameters will be explained later in this chapter. An example of the flow and oral pressure recording outputs is presented in Figure 10.

[10] Loudness - A listener's auditory impression of the strength of a sound. Baken, R. J., & Orlikoff, R. F. (2000). *Clinical Measurement of Speech and Voice* (2 ed.). San Diego: Singular Publishing.

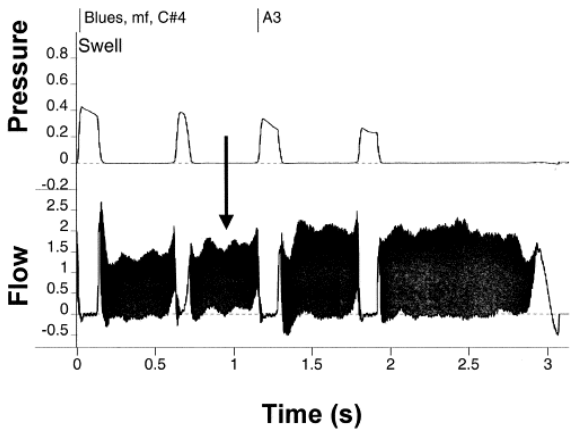

Figure 10. Simultaneous recording of oral pressure and airflow signals during the production of the syllable [pæ] in tones C#4 and A3 in Blues singing style *(adapted from Siupsinskiene & Lycke, 2011, p.180)*.

Voice source activity is mainly dependent on three factors: (i) Psub, controlled by respiratory muscles; (ii) glottal adduction, controlled by lateral cricoarytenoid and interarytenoid muscles; and (iii) vocal fold length, tension and vibrating mass, controlled by the contraction of cricothyroid and thyroarytenoid muscles (Sundberg, 1987). Describing voice source function is important for singing as it influences pitch, loudness and timbre characteristics. These may be objectively described as fundamental frequency, amplitude and spectrum, respectively, measures usually taken from audio signals.

Audio signals are representations of the sound, usually captured by a transducer such as a microphone, which convert the sound pressure signal to an electric signal with similar characteristics. Audio signals usually have frequencies in the frequency range between 20 to 20 000 Hz (nearly the limits of human hearing) (Howard & Murphy, 2008; Svec & Granqvist, 2010).

Fundamental frequency (F0) is a measure of periodicity, representing the rate at which a waveform is repeated per unit of time. Its unit is *hertz* (Hz) corresponding to the number of cycles per second (Baken & Orlikoff, 2000). Perceptually, F0 has a non-linear correlation with pitch: while F0 is an objective, scientific concept, pitch is a subjective auditory sensation. Psychoacoustic scales exist to grade pitch, the most common being the musical semitone (ST) scale, a logarithmic transformation of the physical Hertz scale. In this scale, frequently used to represent the singing voice, each musical octave is divided into 12 ST, easily visualised as the white and black notes on the piano (Nolan, 2003).

Tonal variations are often analysed with F0 related measures. Statistical options as mean F0, F0's standard deviation (SD), maximum F0 and minimum F0 may help to quantify voice dynamics within a specific period of time (Baken & Orlikoff, 2000). To measure speech function, both spontaneous speech and reading tasks may be recorded. In singing activities, tonal variation is largely dependent on the repertoire, so task selection is of paramount importance. F0 measures will vary according to age, gender, voice training and other health related factors (Baken & Orlikoff, 2000; Guimarães, 2007).

Depending on the vocal task/behaviour, F0 related measures may also contribute to determine physiological limits of voice production, as it happens in the voice range profile (or phonetogram). This is a two-dimension graphic display of a person's minimum and maximum intensity vocal levels all over his/her total phonation frequency range. Similar complementary displays can be achieved in speech related tasks (from conversational speech to shouting) obtaining a 'speech range profile' (Ma, 2011b). Examples of voice range and speech range profiles are provided in Figure 11 and 12, respectively. One can see that the first figure (voice range profile) represents the overall voice limits, including maximum-to-minimum intensity range and frequency range, while the second figure (speech range profile) presents the speaking intensity range and tone range, plotted inside the area obtained in voice range profile. Table 1 displays detailed information on normative data for both male and female voices, for both voice and speech range profiles (Siupsinskiene & Lycke, 2011). Both Figures 11 and 12 and also Table 1 show how limited the spoken voice is when compared with all possible voice sounds. Also, singers seem to possess wider frequency and dynamic when compared with non-singers. Thus, training seems to impact on the ability to explore one's voice limits (Ibid.).

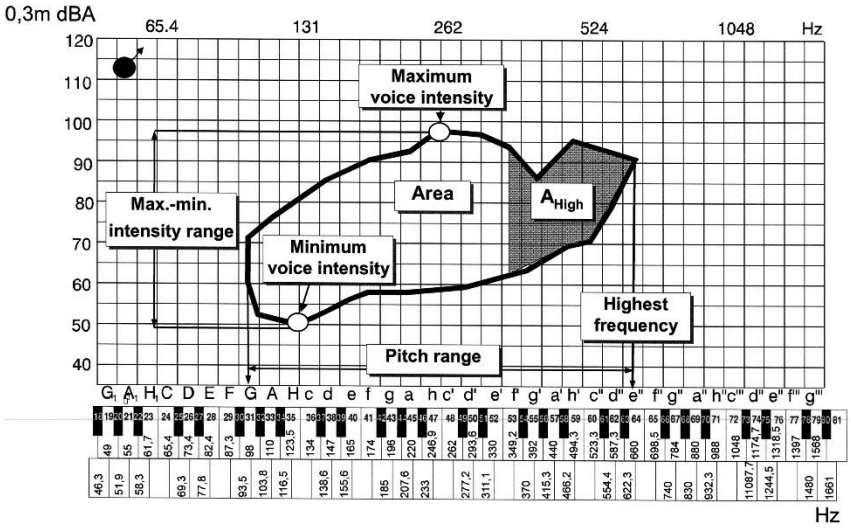

Figure 11. Visual representation and measures of the voice range profile of a healthy woman, including maximum-to-minimum intensity range, frequency range, and area of voice dynamics *(adapted from Siupsinskiene & Lycke, 2011, p. 179)*.

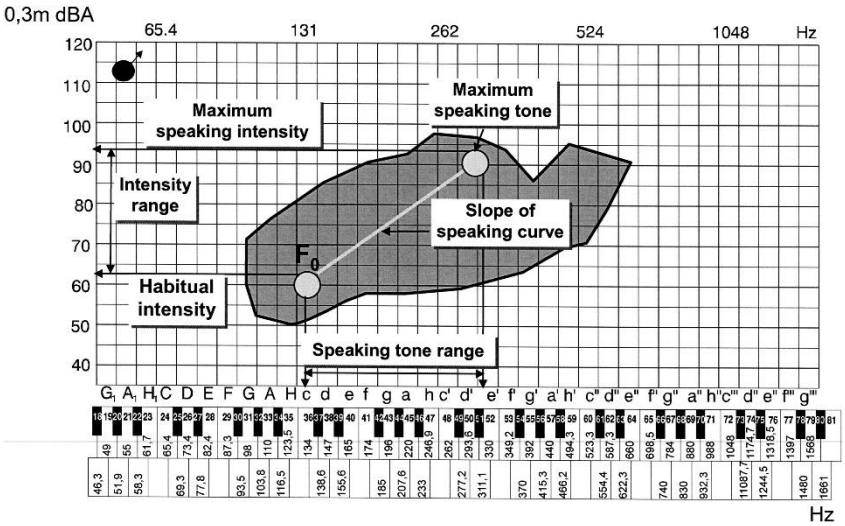

Figure 12. Visual representation and measures of the speech range profile of a healthy woman, including speaking intensity range, speaking frequency range, and slope speaking curve *(adapted from Siupsinskiene & Lycke, 2011, p. 180)*.

Table 1. Voice range profile and speech range profile for singers and non-singers *(adapted from Siupsinskiene & Lycke, 2011, pp. 181-182)*.

	Male		**Female**	
	Singers	**Non-singers**	**Singers**	**Non-singers**
Sample (N)	21	38	59	89
Voice Range Profile				
Total F0 range (semitones)	***37.7***	***34.2***	***34.4***	***29.5***
Total intensity range (dB)	47.5	46.6	***51.7***	***43.4***
Speech Range Profile				
Mean F0 (Hz)	***130.5***	***112.4***	***223.6***	***212.4***
Mean Intensity (dB)	61.2	62.1	61.0	62.1
Speaking F0 range (semitones)	***12.5***	***14.5***	9.9	10.7
Speaking intensity range (dB)	30.6	30.2	***29.9***	***28.1***
Location of mean *F*0 within VRP F0 range (%)	***20.3***	***14.5***	***22.3***	***20.0***

F0 based measures have been used to characterise specific voice source parameters in singing, as registers and vibrato. 'Register' is «(…) a phonation frequency range in which all tones are perceived as being produced in a similar way and which possess a similar voice timbre» (Sundberg, 1987, p. 49). Although the terminology on registers is rather divergent, male voices are generally considered to have three natural registers: *pulse* (or *vocal fry*), *modal* and *falsetto* registers. Female voices are usually classified considering *pulse*, *chest*, *middle* and *head* registers. Registers are mainly controlled by Psub and vocal fold mass configuration (i.e. physiologically controlled by thyroarytenoid muscles), but also the vocal tract has been shown to have a relevant contribution (Henrich, 2006; Tokuda, Zemke, Kob, & Herzel, 2010). Registers are important elements for timbre qualities, and may be used according to the expected voice quality for a given singing style, or as an aesthetic individual effect. While styles, as *classic,* develop source

and resonance strategies to merge registers in order to obtain an homogeneous quality among all singing range, other styles limit voice use to a specific register (e.g. *country* style uses mainly chest register), or use register breaks (e.g. *yodelling*) as the main register (Echternach & Richter, 2010; Titze, 1996).

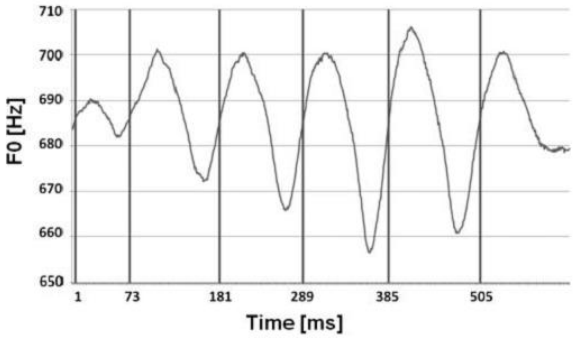

Figure 13. Example of vibrato mean F0, rate and extent calculations *(adapted from Filipa Martins Baptista Lã & Sundberg, 2012, p. 250)*.

Vibrato is «the regular moderate modulation of F0 rate and extent, for which the perceived pitch corresponds to the mean F0 variation» (Lã, 2014, p. 5). The regularity of vibrato constitutes a good indicator of skillful singing (Sundberg, 1987). It can be calculated using the mean F0 of the vibrato curve (Lã, Sundberg, Howard, Sa-Couto, & Freitas, 2012). Vibrato is characterised by its amount of pitch variation ("extent of vibrato") and the speed of which pitch is varied ("rate of vibrato"). Perceptually a rate slower than 5 undulations per second sounds excessively slow, while a rate exceeding 8 undulations per second may sound too “nervous”. Also, voice tends to sound non-normal when a vibrato extent exceeds a 2 ST range (Sundberg, 1994). As presented in Figure 13, vibrato may be measured using the following procedures: a) calculation of the mean F0 of the vibrato curve; b) identification of where the rising parts of the vibrato curve cross the mean F0; c) measurement of the time intervals between the crossings (Lã, et al., 2012).

Intensity is another important element for characterising voice function. Measuring sound energy is a rather complex achievement, and several different measures have been developed to achieve it. By definition, intensity level is a ratio of acoustic power, expressed on a logarithmic scale, as a way to reflect loudness perception (Howard & Murphy, 2008). An alternative measure with direct relation to intensity level is sound pressure level (SPL), calculated as $SPL = 20\log_{10}\frac{P}{P_0}dB$, where P_0 is the standard

reference pressure of $20\ \mu Pa$ (Titze, 1994). The measurement of sound amplitude will have different results depending on the distance from the sound source to the microphone, as sound tends to reduce its energy in space. Because of this, when analysing voice intensity, special care must be taken to normalise the recording conditions and to calibrate instruments (Howard, 1998; Svec & Granqvist, 2010).

Intensity level variations are not perceived by the human ear in a proportional scale; thus, it is important to distinguish between intensity level (or sound level) and loudness (or loudness of phonation) (Sundberg, 1987). Loudness is the subjective psychological perception of intensity (Borden, Harris, & Raphael, 2003). In music, loudness variations are commonly mentioned in an analogue perceptual scale varying between *piano* and *forte* (Kinoshita, Furuya, Aoki, & Altenmuller, 2007). In speech, loudness variations are perceptually known as normal/comfortable, soft and loud voice (Baker, Ramig, Sapir, Luschei, & Smith, 2001). Maximum and minimum vocal intensities are also essential to describe voice dynamics (Siupsinskiene & Lycke, 2011).

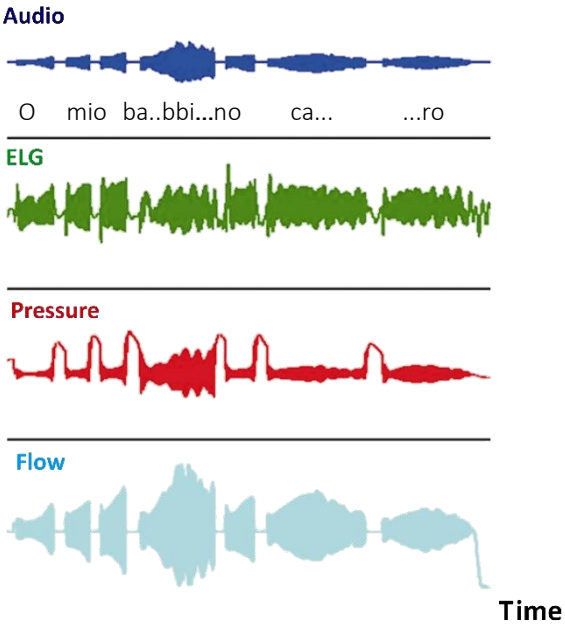

Figure 14. Audio, electrolaryngographic (ELG), intra-oral pressure and airflow signals, recorded simultaneously using SpeechStudio software (Laryngograph, UK), during the performance of the first four bars of the aria "O mio babbino caro", from Gianni Schicchi, by G. Puccini *(adapted from Lã, 2012, p. 93)*.

Phonation is a complex physiologic, aerodynamic and acoustic phenomenon, which can be monitored by displaying audio, electroglottographic (or electrolaryngographic), intra-oral pressure (as an estimative of subglottal pressure) and airflow signals (Lã, 2012).

Figure 14 presents an example of these four signals, recorded simultaneously using a hybrid system, combining a Laryngograph microprocessor (Laryngograph, UK) and a MS-110 transducer (Glottal Enterprises, USA). This hybrid system allows the study of aerodynamic, physiological and acoustic properties of voice production. A schematic representation of such equipment is presented in Figure 15.

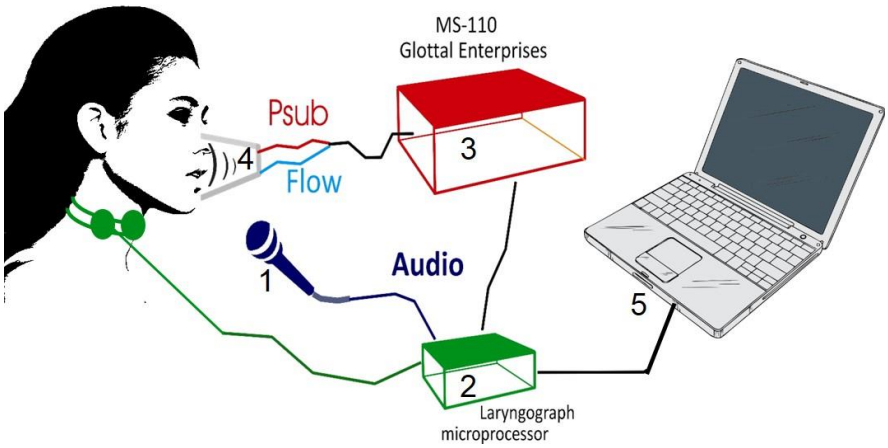

Figure 15. Representation of the hybrid system and its set up for data collection and storage: (1) omnidirectional microphone; (2) Laryngograph microprocessor (Laryngograph, UK) and respective electrodes placed externally around the larynx; (3) MS-110 microprocessor (Glottal enterprises, USA); (4) pneumotach mask and pressures and airflow transducers (Glottal enterprises, USA); (5) portable computer to data storage *(adapted from Lã, 2012, p. 92)*.

EGG and ELG are equivalent non-invasive methods commonly used to evaluate vocal fold contact during phonation across time (Epstein, 2011). EGG was first reported by Fabre (1957) and several improvements occurred over the decades in order to achieve a system able to provide feasible information about the glottal vibratory cycle, mostly in clinical settings. Today there are different varieties of electroglottographs with different devices and signal treatment processes, producing measures and outputs which are not always comparable between them (Baken & Orlikoff, 2000).

EGG is based on the concept that the human tissue is a moderately good conductor of electricity. Using a small high-frequency alternating current in the larynx region, it is possible to measure the tissue's compliance and to estimate an electroglottogram, produced by the opening and closing movements of the vocal folds when vibrating. The system is totally non-invasive and uses two electrodes located in both sides of the larynx to measure the electric conductivity from one electrode to the other (see Figure 16). However, the electric conductivity is produced not only at the glottal level, but also by all the surrounding tissues, which may reduce the reliability of the assessment. It is also

sensitive to vertical larynx movements and neck volume, factors that may affect the signal configuration. Because of this, extra care must be taken when recording, treating and analysing the signal (Baken & Orlikoff, 2000).

Further sections present particular information about the Laryngograph (UK) device developed by Fourcin and Abberton (1971), as this was particularly chosen for data collection in this study. To follow the indications of the hardware and software developers, from now on, ELG and Lx will be used to refer to electrolaryngograph device and electrolaryngographic wave form display, respectively.

Figure 16. ELG device (Laryngograph, UK) on the left *(adapted from http://www.laryngograph.com/, consulted in 10-01-2014)*, and on the right a representation of the placement of the electrodes in the neck of a *cantadeira.*

Lx represents contact and de-contacting events during the vocal folds vibratory cycle. Figure 17 displays an example of a representative Lx, describing the corresponding events in the vibratory cycle: the base of the curve (segment 1) represents the maximum separation phase, followed by a rising curve representing the contact of the lower margins (segment 2 a-b) and upper margins (segment 2 b-c) of the vocal folds. Segment 3 represents the maximum contact followed by the opening phase of the lower margins (segment 4 d-e) and the upper margins (segment 4 e-f). The cycle ends in a new maximum separation phase and repeats in the subsequent vibratory cycles (Baken & Orlikoff, 2000).

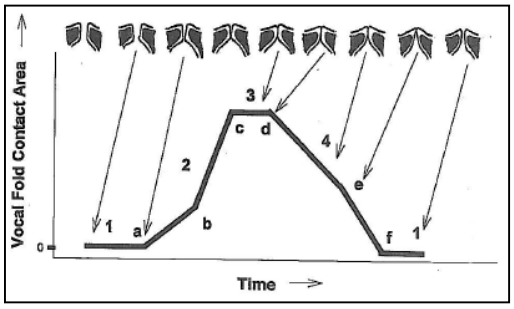

Figure 17. Left: Graphic representation of the ELG glottogram relating with the vocal folds' vibratory cycle *(adapted from Baken & Orlikoff, 2000, p. 419)*.

Lx is affected by glottal vibratory patterns, including voice registers and phonation types. These may affect the duration of the segments, the wave's amplitude and the slope of the ascending (closing) and descending (opening) segments. Figure 18 represents some possible patterns: (A) modal voice, (B) breathy voice, (C) falsetto voice and (D) creaky voice (Howard, 1998).

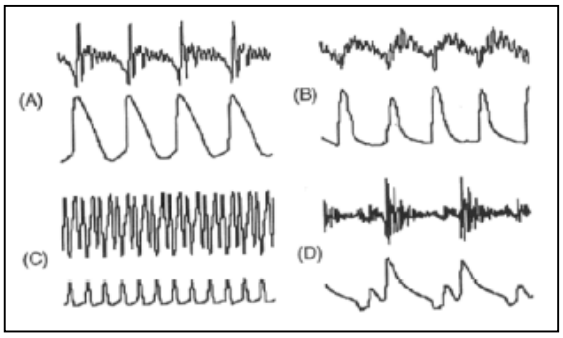

Figure 18. Four characteristic voice patterns (description in the text) represented in audio (top) and ELG (down) waveforms *(adapted from Howard, 1998, p. 343)*.

Quantitative measures are also possible using the ELG method. As an alternative to the acoustic F0, ELG's fundamental frequency (Fx) and other period related measures (minimum Fx, maximum Fx, average Fx, Fx SD) may also be obtained. The waveform amplitude may also be measured, although it does not correspond to an intensity level as it happens in the acoustic signal. Perturbation measures are also available, including ELG's Jitter[11] (CFx) and ELG's Shimmer[12] (CAx), extracted directly from the Lx signal. Because there is no influence of vocal tract (filter) and environmental noise on this signal (Epstein, 2011), many authors find these alternative measures to be more reliable than the audio signal based ones. A normal voice is expected to present values of both CFx and CAx under 6%, as they are justified by prosodic or intonation variations during speech or singing. Only above 10% a voice may be regarded as possibly dysphonic (Fourcin, McGlashan, & Blowes, 2002).

Another common measure is contact quotient ($Q_{contact}$), also represented as CQx. In singing research, $Q_{contact}$ has been used as a common measure to study vocal behaviour on both classical and non-classical singing styles. It is derived from the Lx waveform and

[11] Jitter - Variability of the fundamental frequency from one cycle to the next, reflecting the glottal source voice quality Ibid.
[12] Shimmer - Variability of the amplitude from one cycle to the next, reflecting the glottal source voice quality Ibid.

corresponds to the fraction of time during which vocal folds are in contact. $Q_{contact}$ is slightly higher for male than for female speakers and varies with F0, loudness and type of phonation. For the latter, normal phonation presents values between 0.4 and 0.6, pressed phonation varies between 0.7 and 1.0, and breathy phonation varies in a 0.1-0.3 interval (Baken & Orlikoff, 2000; Epstein, 2011). However, these values must be regarded with caution, because discrepancies in the recording and treatment systems of the EGG/ELG signals may exist among different studies and limit their comparisons. $Q_{contact}$ was first assumed to represent an estimation of the closed phase of the vibratory cycle. Different authors have presented alternative methods for $Q_{contact}$ calculation: a) a 'criterion-level method', which thresholds could vary from 20%-50% of 25% of the peak-to-peak amplitude; or b) a method based on the first derivative of the EGG signal (dEGG). A posterior study comparing several methods confirmed that these methods lead to different results, and $Q_{contact}$ should not be used to represent closed phase. Current recommendations require the identification of the calculation method used in each research, to be able to allow for results comparison (Herbst & Ternström, 2006).

Flow glottograms, obtained by filtering the airflow signal or the audio signal (a procedure named inverse filtering) provide reliable measures of voice source behaviour (Sundberg, et al., 2005). The basic principle of this method is to use a common voice signal (usually a stable vowel), calculate a transfer function corresponding to the combination of formant frequencies and bandwidths, and then filter the input signal with this transfer function inverted. This process eliminates the effects of the vocal tract transfer function from the input signal, obtaining a reconstitution of the original voice source signal (Baken & Orlikoff, 2000; Sundberg, Lã, & Gill, 2011). A representation of the display provided by the costume-made software Decap (by Svante Granqvist, KTH, Sweden) is presented in Figure 19, which allows for the above mentioned inverse filtering process.

Inverse filtering method also has limitations, especially when F0 is higher than at least half of the first formant frequency. For this reason the vowel [æ] is commonly used (it has high first and second formants) and pitches higher than 330 Hz are difficult to analyse (Thalén & Sundberg, 2001). Thus, inverse filtering female voices in high pitches may be a rather demanding, if not impossible task.

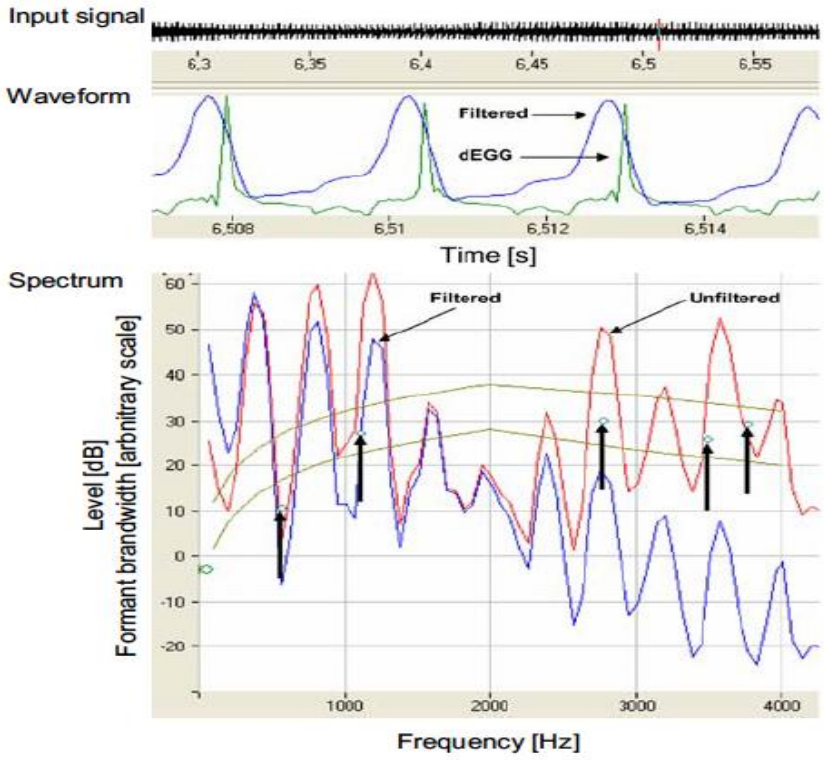

Figure 19. Decap display of inverse filtering. Input signal, the audio signal (top panel), the filtered flow waveform (middle panel), the derivative of the EGG (dEGG) (green), and the spectrum before (red) and after (blue) applying the filters are displayed. Formant frequencies are represented by circles and respective bandwidth limits with arrows *(adapted from Sundberg, et al., 2011, p. 159)*.

The flow glottogram waveform example in Figure 19 (in blue) represents the vibratory pattern of the vocal folds: a) closed phase – flat part of the waveform; b) opening phase – rising curve; c) opened phase – peak; and d) closing phase – falling curve.

Based on a flow glottogram (and the derivative of the EGG/ ELG) it is possible to calculate the duration of the opened and closed phases, obtaining another important measure, the closed quotient (Q_{closed}). It is defined as the relative duration of the closed phase, when the glottis is adducted. Q_{closed} was found to quickly increase with Psub at low pressures and slowly increase at high pressures. Also, for a given Psub value, female voices reach lower values of Q_{closed} than male voices (Sundberg, et al., 2005). Q_{closed} also tends to increase with a decreasing lung volume, while Psub tends to decrease, possibly revealing a glottal adduction force adjustment (Iwarsson, Thomasson, & Sundberg, 1998).

It is important to highlight that $Q_{contact}$ and Q_{closed}, although related, are not the same measure. As Q_{closed} can only be obtained by flow glottograms and not by

electroglottograms (Lã & Sundberg, 2014; Lã & Sundberg, 2009; Sapienza, Stathopoulos, & Dromey, 1998), it is always smaller than $Q_{Contact}$.

Several other flow glottogram related measures have been described; however, for the purposes of this investigation, the focus will remain on the following four measures: a) maximum flow declination rate (MFDR); b) normalised amplitude quotient (NAQ); and c) the level difference between the first and second voice source spectrum partials (H1-H2).

MFDR is the maximum negative peak measured from the first derivative of the flow glottogram (see Figure 20) (Sundberg, et al., 2005). MFDR is strongly related with acoustic excitation of the vocal tract, in the sense that a quick shut of airflow by a quick closure of the glottis will excite the vocal tract without compromising the level of vocal effort required. In other words, a high MFDR results from converting mechanical energy into acoustical energy at low cost of vocal effort (Titze, 2006).

MFDR was found to increase linearly with Psub, although a given Psub produced lower MFDR values for female than for male voices (Sundberg, et al., 2005). For similar F0 and Psub values, MFDR was also shown to be a discriminative measure between chest (higher values) head (lower values) registers (Björkner, Sundberg, Cleveland, et al., 2006).

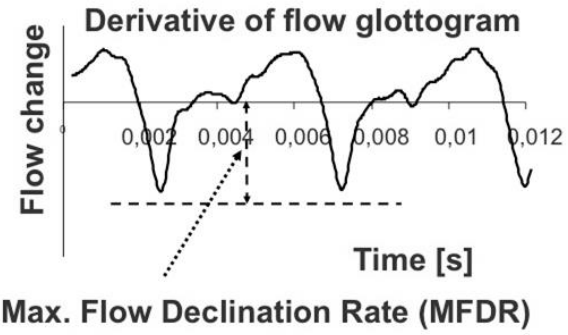

Figure 20. Representation of MFDR calculation as the negative peak amplitude of the differentiated glottogram *(adapted from Sundberg, et al., 2005, p. 881).*

NAQ is the ratio between the pulse amplitude, also named peak-to-peak flow (P-t-P Flow) and the product of MFDR and the period. This parameter can give an estimation of glottal abduction/adduction and thus the degree of hypofunction/hyperfunction (Sundberg, Thalén, Alku, & Vilkman, 2004). Although some studies failed to show NAQ

as a differentiating measure between vocal styles (Borch & Sundberg, 2011; Sundberg, Thalén, & Popeil, 2012), other studies found that NAQ differs between singing styles, types of phonation and voice registers (Sundberg, et al., 2004). Analysing female musical theatre singers, NAQ was also found to be lower for chest than for head voice registers (Björkner, Sundberg, Cleveland, et al., 2006). Regarding types of phonation, NAQ seems to inversely reflect the degree of phonatory pressedness, a relevant factor for vocal health (Sundberg, et al., 2004), as voice effort is frequently associated with muscle tension dysphonia and other hyper functional voice disorders (Stemple, Glaze, & Klaben, 2010).

H1-H2 is measured from a Fast Fourier Transform (FFT) spectrum of the flow glottogram (see Figure 21) and provides a good estimative of the dominance of the fundamental. H1–H2 has been found to be linearly related to Q_{closed}: a high value of Q_{closed} is associated with a weaker fundamental, producing lower H1-H2 values (Sundberg, Andersson, & Hultqvist, 1999). Another study showed that H1-H2 is a robust measure to distinguish musical theatre from opera singers: for a given Psub, opera singers produce a stronger fundamental (i.e. higher H1-H2 values) (Björkner, 2008).

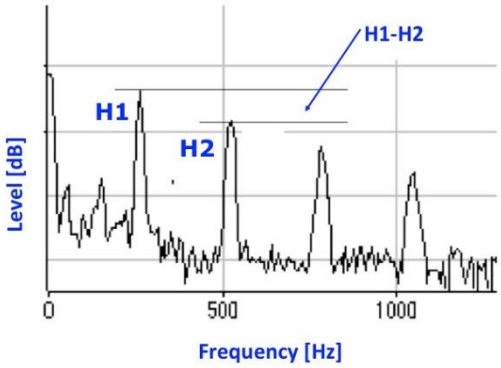

Figure 21. Spectrum representation of the level difference between the first and the second harmonic partials of the voice source. This difference level (H1-H2) provides an estimative of fundamental frequency dominance *(adapted from Sundberg, et al., 2005, p. 881).*

A final relevant measure extracted from oral airflow signals is glottal resistance (R_g), also known as laryngeal airway resistance. R_g is defined as the ratio of translaryngeal pressure to the translaryngeal airflow, and represents the level of resistence produced by the vocal folds to the airflow during the vibratory process (Baken & Orlikoff, 2000). Accordingly, higher adduction patterns (pressed phonation type) will produce higher R_g, while lower adduction patterns (including breathy phonation type) will have lower R_g values (Sundberg, 1987). Also, R_g is influenced by the individual laryngeal morphology:

females are expected to have higher R_g values than males. R_g is expressed in cmH_2O/LPS or kPa/l/s units, and should be measured using a /pV/ syllable repetition task to allow reliable Psub measurement (Baken & Orlikoff, 2000). Although there are not normative data of this voice parameter, several studies report specific values. Accordingly, a study involving 11 sopranos presented R_g around 1.36-5.09 kPa/l/s for Eb4, and 4.41-22.34 kPa/l/s for Db5 (Cláudio, 2012).

Other two voice source measures are also relevant for the purposes of evaluating voice function in singing (an in clinical settings), namely phonation and collision threshold pressures (PTP and CTP, respectively). Both derived from Psub (measured as an estimate of intraoral pressure during the [p] occlusion), they reflect vocal fold´s motility (Lã & Sundberg, 2012).

PTP "is the minimum lung pressure required to initiate vocal fold oscillation" (without vocal fold collision) (Titze, 2009, p. 1062). Thus, it corresponds to the smallest amount of air pressure needed to initiate the softest phonation possible. It is a parameter of phonatory function (Solomon & DiMattia, 2000), clinically relevant: a lower PTP can be assumed to reflect greater vocal fold motility, which indicates lower levels of phonatory effort (Chang & Karnell, 2004), whereas in cases of, for example, voice fatigue, PTP is usually higher. It has also been related with physical properties of the vocal folds and the vocal tract: it decreases with vocal fold thickness and supraglottal vocal tract inertance; it increases with vocal fold abduction, glottal convergence, supraglottal resistance, tissue viscosity and mucosal wave velocity (Titze, 2009).

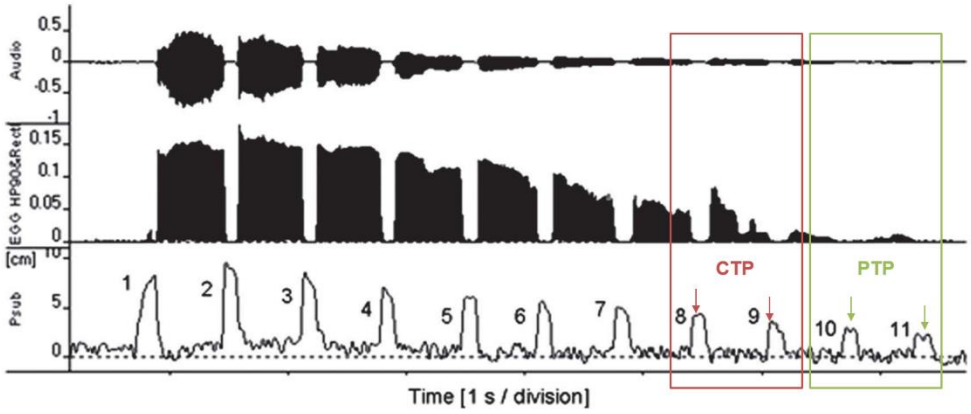

Figure 22. Soundswell software (Hitchec, Sweden) displaying three simultaneous channels (audio, EGG, and intraoral pressure), recorded while performing a diminuendo task using the syllable [pae], and the Rothenberg mask. The mean pressure peaks used to determine PTP and CTP are represented with green and red boxes, respectively *(adapted from Enflo & Sundberg, 2009, p. 212).*

PTP may be calculated as the mean between the lowest pressure that caused phonation and the highest pressure that did not produce phonation, as evidenced by the flow signal (see Figure 22) (Lã & Sundberg, 2012; Solomon, 2011).

PTP calculations are based on the initiation of vocal folds vibration, a phenomenon that does not necessarily involve vocal folds collision. Thus, PTP measures might be difficult to extract, as the vocal task required is to sing as soft as possible a given pitch. This is certainly a difficult task for those who are not professional singers. An alternative measure is the collision threshold pressure (CTP). This is a similar measure but uses as reference the moment collision of the vocal folds, which may be given by the EGG/ELG signal (see Figure 22). CTP constitutes an easier alternative to PTP, as the vocal task to allow CTP measurements does not require the production of the softest voice phonation. Both PTP and CTP are strongly related (CTP = 1.3857 * PTP + 0.5, R^2 = 0.945), CTP presenting higher values than PTP (Enflo & Sundberg, 2009; Lã & Sundberg, 2012).

The most common representation of the sound consists of spectrographic analyses of the audio signal. Thus, spectrograms allow the analysis of both source (glottal) and filter (vocal tract) contributions in speech and singing. By applying a mathematical formula – FFT analysis – the data collected by means of a microphone converted from an electric sound to a digital signal is then plotted in a graphic displayed on a computer screen (Howard & Murphy, 2008). The result is either a spectrum or a spectrogram. Thus, for the observation of specific aspects, several parameters must be adjusted when generating a spectrogram. For example, the sampling rate of the digital recording should be around 220% of the higher frequency planned to be analysed (i.e. speech sounds may achieve up to 10 kHz, so the recommended sampling rate is at least 22 050 Hz, or higher) (Baken & Orlikoff, 2000).

The result of spectrographic analysis can be: (a) a two dimensional plot of frequency (x axis) against intensity (y axis) in a singular moment in time – power spectrum; (b) a similar spectrum averaged across time – a long term average spectrum (LTAS); or (c) a three dimensional graphic including the display of time (x axis), frequency (y axis) and intensity (colour variation) in a variable duration sound signal – a spectrogram (also known as sonogram) (Howard & Murphy, 2008).

Power spectrums show sound components during a single moment in time (some milliseconds) and are useful to estimate resonance strategies applied by singers. Although it cannot show the location of formants, if a given harmonic partial in the signal

is boosted, one might predict that a partial is in the vicinity of a formant (see Figure 23) (Lã, 2012).

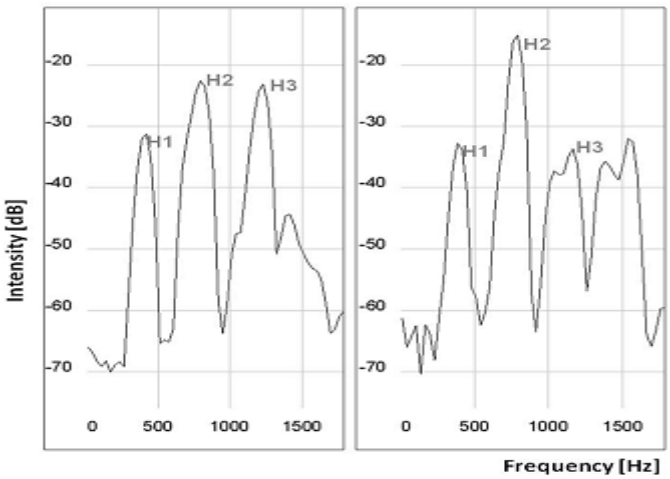

Figure 23. Spectrum analysis comparing H1, H2 and H3 distribution in two outputs. The output in the right shows a higher energy in H2 partial, which may be boosted by a formant in the same region *(adapted from Lã, 2012, p. 106)*.

LTAS displays sound components during several cycles of vibration; it is therefore an average of the acoustic output. It requires vocal tasks longer than 40 seconds as this is typically the time needed for the spectrographic representation to stabilise. LTAS reflects quite clearly quasi-constant characteristics such as a singer's formant. Although it is rather insensitive to the exact linguistic content of the speech material, the use of standard material is sometimes recommended (Nordenberg & Sundberg, 2004). In Figure 24, the voices of different singers – soprano, alto, tenor, baritone and bass – are represented, evidencing different frequency peaks. Sopranos and tenors seem to have the frequency peak corresponding to the F0 above the frequency peak presented by altos, baritones and basses, whereas in the region of 2 kHz to 3 kHz, it seems that male voices present a spectral peak that cannot be observed in females. This spectral peak is known as the singer's formant cluster, resulting from a cluster of the third, fourth and fifth formants (Sundberg, 1987).

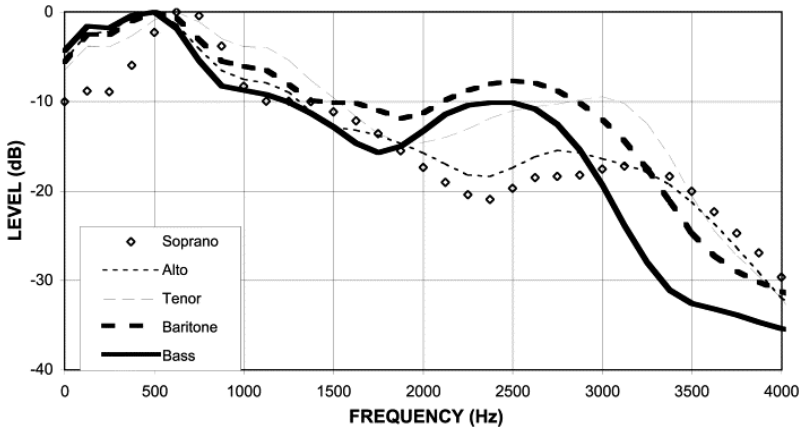

Figure 24. LTAS representation of classical singing voice, displaying spectral differences between different singer classifications (lines represent 4 soprano, 4 alto, 4 tenor, 4 baritone and 4 bass singers) *(adapted from Sundberg, 2001, p. 184)*.

This cluster of formants gives a boost in the energy of the spectrum where the human ear is most sensible, becoming an excellent strategy to make the voice audible against the background of a loud orchestral accompaniment (Sundberg, 1987). Figure 25 plots the LTAS of an orchestra, of speech and of the orchestral and singing of a male singer. The singer's formant constitutes the major difference between the orchestra with and without the singer soloist. Speech sound (without singer's formant) is shown to be almost totally covered by the orchestra.

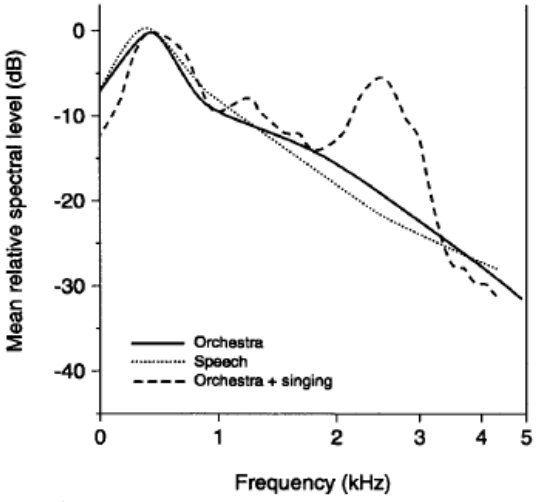

Figure 25. LTAS representation for the sound of a symphony orchestra with and without a singer soloist (solid and dotted curves) and for normal speech (dashed curves) *(adapted from Sundberg 1987, 123)*.

LTAS allows the quantification of four other measures: equivalent sound level (Leq), alpha ratio (also represented by α), spectral slope, and the estimate of dominance of the fundamental $(H1\text{-}H2)_{LTAS}$. Leq in dB is an intensity measure representing «the constant sound pressure level, which is equivalent to the varying sound level over the measurement period» (Howard & Angus, 2009, p.96). It is defined as: $L_{eq(total)} = \sqrt{L_{eq1}^2 + L_{eq2}^2 + \cdots + L_{eqn}^2}$, where $L_{eq(1-n)}$ is the individual short time measurements (Howard & Angus, 2009). Alpha is defined as the ratio between the sound energy above and below 1kHz (represented in Figure 26) and it is particularly important in understanding loudness variations and its relations with phonation modes (Sundberg & Nordenberg, 2006). These can be further studied by looking at the spectral slope (or spectral tilt), which corresponds to the average drop-off intensity per unit of frequency (Tamarit, Goudbeek, & Scherer, 2008). Previous research suggested that normal voice productions in comfortable loudness have high energy below 1 kHz, produce high alpha, and steep spectral slopes. In contrast, louder voices, especially when produced with pressed phonation[13], will naturally produce higher Leq values, and higher energy above 1 kHz, creating lower alpha and flatter spectral slopes (Master, De Biase, Pedrosa, & Chiari, 2006).

$(H1\text{-}H2)_{LTAS}$ explores the level difference between the first and the second voice source spectrum partials in a LTAS. This must not be confounded with H1-H2, the already described measure taken directly from an inverse filtered glottogram. Relevant information can be taken from $(H1\text{-}H2)_{LTAS}$, especially considering the relationship between the first and second partials, which partially reflects phonation types. Neutral phonation is expected to have a stronger first partial – higher $(H1\text{-}H2)_{LTAS}$ – while a pressed phonation will produce a weaker first partial – lower $(H1\text{-}H2)_{LTAS}$ (Lã & Sundberg, 2012).

[13] Pressed phonation – Vibration pattern of the vocal folds produced by high adduction levels and high Psub, producing a weaker fundamental Sundberg, J. (1994). Acoustic and psychoacoustic aspects of vocal vibrato *STL-QPSR, 38*(2-3), 45-68..

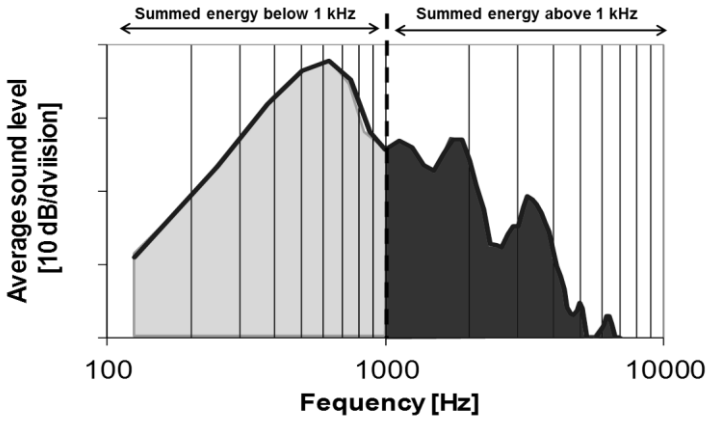

Figure 26. Representation of a long-term average spectrum displaying the energy above and below 1 kHz, the difference of them used to calculate alpha.

The last outputs for voice analysis here presented are spectrograms. Spectrograms can also be represented as narrowband or wideband. Both display frequency, intensity and time, but the analysis window is adjusted either to divide the frequency spectrum into broad swaths – wide band spectrogram (see Figure 27 - left) – or to divide the frequency spectrum into narrow segments – narrow band spectrogram (see Figure 27 - right). The first is useful to display the energy bands corresponding to the formant frequencies, while the second facilitates the visualization of single harmonics (Howard and Murphy, 2008).

In wide band spectrograms it is possible to observe formant frequencies in speech and singing. These formant frequencies have a direct relationship with the vocal tract configuration and thus resonance (Borden, et al., 2003). Formants vary with vowel configurations, but also with pitch and individual vocal characteristics, being particularly important for timbre characterization when describing singing voices (Sundberg, 1987).

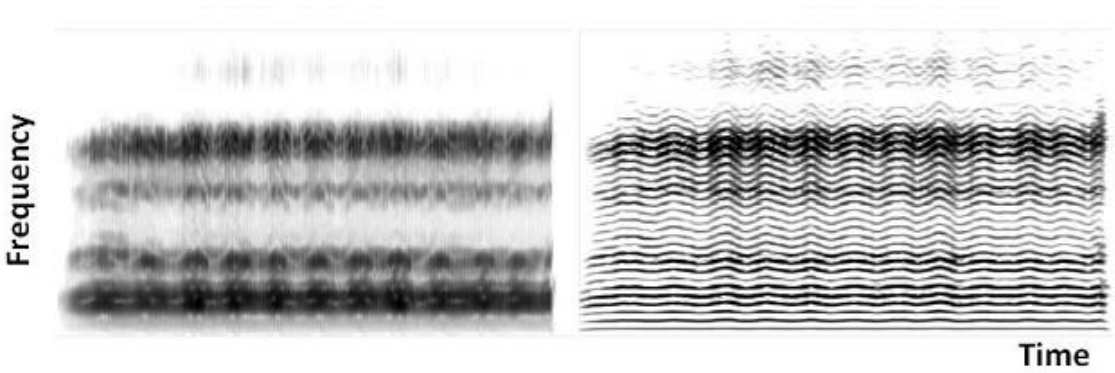

Figure 27. Example of wideband (left) and narrowband (right) spectrograms *(adapted from Lã, 2012, p. 101)*.

Formants can be tuned or detuned to their closest partial. Nowadays, there is an on-going debate on whether classical singers tune their formant frequencies so that vocal tract resonances are adjusted to match a given harmonic frequency, reinforcing the energy within this harmonic frequency band (Titze, 1988). A recent investigation showed that classical singers have different resonance strategies, and thus do not share common strategies, as previously has been suggested in the literature (Henrich, Smith et al. 2011). For example, it has been claimed that altos (female singers) used inconsistent strategies, varying between F1:H1 (in lower F1 vowels) and F1:H2 in the lower part of their range. Tenors and baritones (male singers) used F1:H2 and F1:H3 tunings over at least part of their range (Henrich, Smith, & Wolfe, 2011). The acoustical boost of single harmonic partial depends only on whether it is on the vicinity of the formant. In other words, to get a boost, the formant might be just above, just below or right on the partial (Sundberg, Lã et al., 2011). Contrary to classical singing, the placement of a formant on its closest partial has been consistently found in non-classical styles using *belting* quality (Bestebreurtje & Schutte, 2000), and also in some traditional singing styles (Boersma & Kovacic, 2006; Henrich, Kiek, Smith, & Wolfe, 2007). In classical singing, the resonance strategy that seems to be consistently applied is the one used by female singers. Sopranos approximate the second formant to the first partial (F2:H1) in the higher part of their range. The strategy of F2:H2 can also be found in part of their range.

2.5. REVIEWING VOICE FUNCTION IN NON-CLASSICAL AND TRADITIONAL SINGING STYLES

As mentioned before, the major goal of this research study is to describe, for the first time, voice use in AM female folk singing, contextualising it within its musical practices. Bearing in mind that research on folk singing has been under-represented within the broad context of performance science studies in singing, it seemed important to review the methods and associated results of previous studies under the wider scope of non-classical singing styles. By doing so, this investigation will be better acquainted with the most common vocal parameters used to describe and assess voice use in folk singing style. Hence, the following section presents a detailed discussion on the procedures used to carry out a literature review. Studies on non-classical singing styles will be reviewed first, followed by a more narrowed and specific review on traditional singing studies, including voice function in folk music performances.

2.5.1. SEARCH PROCEDURE

The following databases were searched: (i) Web of Science; (ii) Scopus; (iii) Pubmed Science Direct; (iv) Jstore; (v) DOAJ; and (vi) Eric. Studies were considered for review if: (a) published in peer-reviewed journals; (b) published in English or Portuguese languages; and (c) reported data on non-classical or traditional singing voice. No restrictions were imposed regarding study design. No filters considering year of publication were used. The search was performed during January 2013, using the following keywords: (i) “folk” AND “singing”; (ii) “traditional” AND “singing”; and (iii) “non-classical” AND “singing”. Every time more than 100 results were obtained, complementary keywords were used to refine the search, such as (…) AND “voice” AND “acoustic” AND “singing voice”.

A total of 679 potential articles were identified in the initial search. From those, 222 were excluded because: were duplicated articles, were not peer-reviewed, and were not written in English or Portuguese. Afterwards, 357 citations were considered non-relevant after a tittle analysis. The remaining 100 citations were submitted to an abstract and keyword analysis; 55 were considered non-relevant. The final list included 21 articles divided into two groups: non-classical singing styles (n=13) and traditional singing styles (n=8).

This review was complemented by a selective analysis of the references provided by the selected articles (thus called indirect references). Fourteen extra articles fall within the inclusive criteria for this review and were added, including PhD thesis and research reports. Figure 28 represents the flow chart summarising the procedure for this literature review.

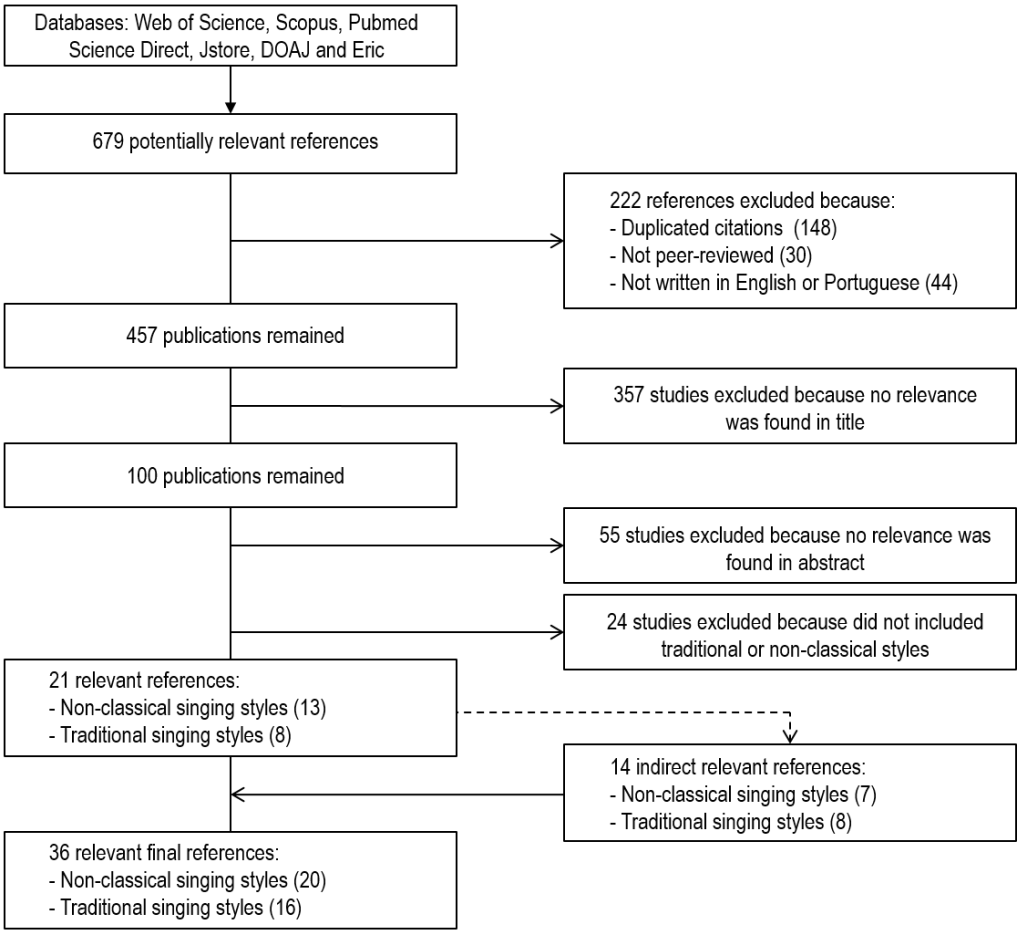

Figure 28. Flow chart of study selection for the systematic review carried out during this investigation.

2.5.2. SEARCH RESULTS

At the end of the search, a total of 20 articles on non-classical and 16 on traditional singing were considered for further analysis. Authors and titles of these articles are listed on Tables 2 and 3, respectively, for non-classical and traditional singing.

Table 2. Selected articles referring to voice production in non-classical singing styles, listed by author and title. Articles found by direct review method are presented in grey (n=13) and those found by indirect review method are presented in white (n=7).

Author | Year	Title
Schutte and Miller (1993)	Belting and pop, nonclassical approaches to the female middle voice: Some preliminary considerations.
Sundberg, Gramming, et al. (1993)	Comparisons of pharynx, source, formant, and pressure characteristics in operatic and musical theatre singing.
Koufman, Radomski, et al. (1996)	Laryngeal biomechanics of the singing voice.
Bestebreurtje and Schutte (2000)	Resonance strategies for the belting style: Results of a single female subject study.
Thalén and Sundberg (2001)	Describing different styles of singing: A comparison of a female singer's voice source in ''Classical'', ''Pop'', ''Jazz'' and ''Blues''.
Borch and Sundberg (2002)	Spectral distribution of solo voice and accompaniment in pop music.
Stone, Cleveland, et al. (2002)	Aerodynamic and acoustical measures of speech, operatic, and Broadway vocal styles in a professional female singer.
Borch, Sundberg, et al. (2004)	Vocal fold vibration and voice source aperiodicity in 'dist' tones: a study of a timbral ornament in rock singing.
Sundberg, Thalén, et al. (2004)	Estimating perceived phonatory pressedness in singing from flow glottograms.
Björkner, et al. (2006)	Voice source differences between registers in female musical theatre singers.
Björkner (2008)	Musical Theater and Opera Singing—Why So Different? A Study of Subglottal Pressure, Voice Source, and Formant Frequency Characteristics.
Butte, Zhang, et al. (2009)	Perturbation and Nonlinear Dynamic Analysis of Different Singing Styles.
Sundberg and Romedahl (2009)	Text Intelligibility and the Singer's Formant—A Relationship?
Barlow and LoVetri (2010)	Closed Quotient and Spectral Measures of Female Adolescent Singers in Different Singing Styles.
LeBorgne, Lee, et al. (2010)	Perceptual Findings on the Broadway Belt Voice.
Sundberg and Thalén (2010)	What is “Twang”?
Lebowitz and Baken (2011)	Correlates of the Belt Voice: A Broader Examination.
Borch and Sundberg (2011)	Some Phonatory and Resonatory Characteristics of the Rock, Pop, Soul, and Swedish Dance Band Styles of Singing.
Kochis-Jennings, Finnegan, et al. (2012)	Laryngeal Muscle Activity and Vocal Fold Adduction During Chest, Chestmix, Headmix, and Head Registers in Females.
Sundberg, Thalén, et al. (2012)	Substyles of Belting: Phonatory and Resonatory Characteristics.

Table 3. Selected articles referring to voice production in traditional singing styles, listed by author and title. Articles found by direct review method are presented in grey (n=8) and those found by indirect review method are presented in white (n=8).

Author | Year	Title
Johnson (1984)	Voice Physiology and Ethnomusicology: Physiological and Acoustical Studies of the Swedish Herding Song
Ross (1992)	Formant frequencies in Estonian folk singing
Doskov, Ivanov, et al. (1995)	Comparative Analysis of Singer's High Formant in Different Type of Singing Voices
Hoit, Jenks, et al. (1996)	Respiratory function during speaking and singing in professional country singers
Ross and Lehiste (1996)	Trade-off between Quantity and Stress in Estonian Folksong Performance?
Cleveland, Stone Jr, et al. (1997)	Estimated subglottal pressure in six professional country singers
Stone, Cleveland, et al. (1999)	Formant Frequencies in Country Singers' Speech and Singing
Cleveland, Sundberg, et al. (2001)	Long-Term-Average Spectrum Characteristics of Country Singers During Speaking and Singing
Lindestad, Södersten, et al. (2001)	Voice Source Characteristics in Mongolian "Throat Singing" Studied with High-Speed Imaging Technique, Acoustic Spectra, and Inverse Filtering
Kovačić, Boersma, et al. (2003)	Long-term Average Spectra in Professional Folk Singin Voices: a comparison of the Klapa and Dozivacki Styles
Boersma and Kovacic (2006)	Spectral characteristics of three styles of Croatian folk singing
Henrich, Kiek, et al. (2007)	Resonance strategies used in Bulgarian women's singing style: A pilot study
Bezerra, Cukier-Blaj, et al. (2009)	The Characterization of the Vibrato in Lyric and Sertanejo Singing Styles: Acoustic and Perceptual Auditory Aspects
Erickson (2012)	The Traditional/Acoustic Music Project: A Study of Vocal Demands and Vocal Health
Yoshinaga and Kong (2012)	Laryngeal vibratory behavior in traditional Noh singing
Mendes, Rodrigues, et al. (2013)	Acoustic and Phonatory Characterization of the Fado Voice

The following sections explore the methods and results found by each of the articles listed in both Tables 2 and 3.

2.5.3. VOICE FUNCTION STUDIES IN NON-CLASSICAL SINGING

Voice characteristics in non-classical styles often present similarities with those in traditional singing. Indeed, some traditional styles have been transformed by the music industry into commercial non-classical styles, as it was the case of *country* (Peterson, 1997). Moreover, in many *world music* styles, singers manifest influences of traditional styles in their musical compositions, to create a unique vocal/musical identity (McLean, 2006). In the literature review concerning non-classical singing, not only voice function descriptions were considered, but also methods applied. A summary of such information is listed on Table 4.

Musical theatre, alternatively named *Broadway* by some authors, was the style with highest number of articles dedicated to it (Barlow & LoVetri, 2010; Björkner, 2008; Björkner, Sundberg, Cleveland, et al., 2006; Butte, Zhang, Song, & Jiang, 2009; Koufman, Radomski, Joharji, Russell, & Pillsbury, 1996; LeBorgne, Lee, Stemple, & Bush, 2010; Stone, Cleveland, Sundberg, & Prokop, 2002; Sundberg, Gramming, & Lovetri, 1993; Sundberg & Romedahl, 2009).

Two of these studies were focused on a particular voice technique, *belting*, frequently used in *musical theatre,* but also in other styles (LeBorgne, et al., 2010; Sundberg, et al., 1993). This voice quality will be treated separately later on in this chapter. Most studies explored female voices: only one was dedicated to male voices (Björkner, 2008). In these studies, different voice qualities have been explored, namely *belting*, *legit*, mixed voice, and chest/head registers. Comparisons have been made with classical singing (i.e. Opera), speech produced at different loudness levels, and other non-classical singing styles. Perceptual tests with expert listeners were also carried out in three of these studies to rate representativeness of: a) Operatic vs Broadway style (Stone, et al., 2002), and b) chest vs head register use (Björkner, Sundberg, Cleveland, et al., 2006). Intelligibility of consonants in singing was also perceptually evaluated (Sundberg & Romedahl, 2009).

Table 4. List of publications, organised according to the style of non-classical singing, summarising principal observations (this table continues up to page 59).

Author | Year	Style(s)	Participant(s)	Methods | Measures	Results | Observations
Schutte and Miller (1993)	Belting Pop (legit)	Undetermined	- Audio, EGG signals: F0, formant analysis and Q_{closed}* ($Q_{contact}$).	- Belting: Chest register ($Q_{contact}$ > 50%); high to very high larynx position; high Psub; middle frequency range; F1:H2 strategy for open vowels - Legit: Falsetto register ($Q_{contact}$ < 40%); low to intermediate larynx position; moderate Psub; middle to high frequency range
Sundberg, Gramming, et al. (1993)	Musical Theatre (Belting) *(vs 'Mixed' and Classical)*	1 professional female singer	- Experiment 1 – Audio, flow and oral pressure signals: F0, SPL,Psub and spectrogram analysis - Experiment 2 – Transnasal fiberoptic laryngoscopy: video description by 5 experts	Belting: high Psub (2.3-3.1 kPa), weak fundamental (great glottal adductive forces), high SPL (85-92 dB at 0.5m), and wide jaw opening and an elevated larynx (suggested by formant frequencies). Laryngoscopic data show high larynx position, advanced side walls and the small sinus piriformes in many vowels.
Koufman, Radomski, et al. (1996)	Jazz/Pop Belting/Musical Theatre Country Rock/Gospel *(vs Choral and Classical and Art Song)*	100 healthy singers 39 male / 61 female 48 professionals / 52 amateurs	Transnasal fiberoptic laryngoscopy: graduation of each sample in four levels of muscle tension (muscle tension patterns)	- Lowest muscle tension scores in female professional singers. - Highest muscle tension scores in amateur female singers. - Muscle tension scores higher in nonclassical singers: choral music (41%), art song (47%), and opera (57%), and the highest being seen in those singing jazz/pop (65%), musical theater (74%), bluegrass/country and western (86%), and rock/gospel (94%)
Bestebreurtje and Schutte (2000)	Belting *(vs Speech)*	1 female singer	- Audio signal: F0, and formants analysis - EGG signal: Q_{closed}* ($Q_{contact}$)	Belting has $Q_{contact}$ values above 52% (higher than speech), apparently associated with specific resonance tuning strategies according to different vowels: /a/ requires no adjustment; /ɛ/ presents F2-H5 tuning; and /u/ presents F2-H3 tuning.
Thalén and Sundberg (2001)	Pop, Jazz and Blues *(vs Classical)* *(vs pressed, neutral, flow and breathy phonation types)*	1 female singer (experience in different styles)	- Audio, flow and oral pressure signals: Psub, larynx height, Q_{closed}, glottal compliance and H1-H2. - Perceptual pressedness rate by a LT with 10 trained listeners	- Blues is close to a pressed phonation type. - Jazz and Pop are close to a neutral phonation type. - Classical is close to a flow phonation type.
Borch and Sundberg (2002)	Pop	1 Pop male singer 1 Classical male singer Commercial music recordings	- Audio signal and LTAS extraction of: Pop singer's solo voice; Classical singer's solo voice; Pop music orchestra; classical orchestra	- Pop singers do not present a singer's formant. - LTAS of the Pop and Classical orchestras are similar. - Adaptations in the amplification of the frequency range 3–4 kHz in the monitor sound may prevent pop singers' difficulties to hear their own voices during the performances.

Author | Year	Style(s)	Participant(s)	Methods | Measures	Results | Observations
Stone, Cleveland, et al. (2002)	Broadway *(vs Speech and Classical)*	1 professional female singer (experience in both styles)	- Audio, flow and oral pressure signals: F0, Psub, SPL, pulse amplitude, glottal leakage, Q_{closed}, glottal compliance, H1-H2, vibrato rate and LTAS, formant analysis - Perceptual Operatic-Broadway rate by a LT with 5 trained listeners	Broadway style presents (as compared with classical singing): - similar voice source characteristics (Psub and H1-H2) as those found in loud speech; - stronger adduction than in Classical singing; - weaker fundamental; - higher formant frequencies; - stronger partials in the 0.8 to 1.6 kHz range; - faster vibrato rate and smaller vibrato extent.
Borch, Sundberg, et al. (2004)	Rock ("dist" singing)	1 professional male singer	- Experiment 1 - Audio, flow and oral pressure signals: F0, SPL and Psub. - Experiment 2 - audio and a high-speed imaging recording	'Dist" tones are loud tones, produced with relatively high Psub (20-45 cmH_2O). They seem characterised by a periodic vocal fold vibration combined with periodic or aperiodic vibration of supraglottal mucosa.
Sundberg, Thalén, et al. (2004)	Pop, Jazz and Blues *(vs Classical)* *(vs pressed, neutral, flow and breathy phonation types)*	1 professional female singer	- Audio, flow and oral pressure signals: F0, Psub, Q_{closed}, glottal compliance, H1-H2 and NAQ. - Perceptual pressedness rate by a LT with 10 trained listeners.	- Classical singing is near to a breathy/flow phonation type. - Pop and Jazz are near a neutral phonation type. - Blues is near to a pressed phonation type.
Björkner, et al. (2006)	Musical Theatre *(chest vs head registers)*	7 professional female singers	- Audio, flow and oral pressure signals: SPL, Psub, Q_{closed}, Up-t-p, MFDR and NAQ - Perceptual Chest-Head register rate by a LT with 3 experts.	- In chest register Psub, MFDR, and Q_{closed} are higher, whereas NAQ is lower than in head register. - Register differences are perceptually clearer in loud than in soft phonation.
Björkner (2008)	Musical Theatre (Belting) *(vs Classical)*	10 professional male singers (5 classical and 5 MT)	- Audio, EGG, flow and oral pressure signals: F0, SPL, Psub, Q_{closed}, Up-t-p, MFDR, AQ, NAQ, H1-H2 and formants.	Comparing with Classical singers, musical theatre singers have: - Slightly higher Psub values for the same F0; - Similar NAQ and AQ values (equivalent phonation modes); - Higher values of MFDR, Up-t-p, and Q_{closed} (higher adduction); - Lower values of H1–H2 (a weaker fundamental); - Higher formant frequencies; - Absence of the clustering of F3, F4, and F5 (singer's formant).

Author | Year	Style(s)	Participant(s)	Methods | Measures	Results | Observations
Butte, Zhang, et al. (2009)	Country Musical Theatre (Belting) Jazz Soul Pop *(vs Classical)*	26 songs from from an online music database	- Perturbation measures: Jitter, Shimmer, Signal-to-Noise Ratio (SNR). - Nonlinear dynamic analysis (NDA): correlation dimension (D_2)	- Jitter (0.28-1,13): MT < Country < Soul < Jazz < Opera <Pop - Shimmer (2.34-7.72): Jazz < MT < Country < Soul < Pop < Opera - SNR (12.3-24.4): Pop < Soul < Opera < Country < MT < Jazz - D_2 (2.14-6.19): Country < Jazz < Pop < MT < Soul < Opera
Sundberg and Romedahl (2009)	Musical Theatre (Legit) *(vs Classical)*	4 professional male singers: - 2 MT singers - 2 opera singers	Intelligibility rate of consonants in singing in different noise levels, measured by LT (10 listeners)	- The singer's formant does not represent a sufficient condition for good text intelligibility. - MT singers were slightly more successful than the OP singers. - Formant transitions in consonants were much quicker in Opera singers than those of the MT singers.
Barlow and LoVetri (2010)	Musical Theatre *(vs Classical)*	20 adolescent female singers aged 12–17 years	Audio and ELG signals: Q_{closed}* ($Q_{contact}$), average vowel spectra (AVS) and long-term average spectra (LTAS)	- MT singing uses change in resonance strategy rather than raised vocal tension to achieve the tonal changes associated with the genre. - 2^{nd} to 5^{th} harmonics were stronger in the MT style than in classical. - $Q_{contact}$ was higher in the MT style than in classical style.
LeBorgne, Lee, et al. (2010)	Broadway / Belting	20 female singers (18-25 years)	Perceptual rating of belting voice (3 expert judges). Perceptual parameters (loudness, vibrato, ring, timbre, focus, nasality, and registration breaks). Correlation and linear regression analysis (elite vs average Belters).	- Elite belters' voices are correlated to the perceptual ratings of vibrato and ring. - Vibrato and ring are highly correlated with perceived loudness.
Sundberg and Thalén (2010)	Twang quality *(vs neutral)*	1 professional female singer	- Audio, ELG, flow and oral pressure signals: LTAS, Psub, SPL, MFDR, Q_{closed}, H1-H2, NAQ, Formants (F1-F5) - Perceptual "twanginess" rate by a LT with 6 expert listeners - Multiple regression analysis	- Comparing to neutral voice, twang quality has: higher Psub, SLP, Q_{closed}, F1 and F2; lower H1-H2, NAQ, F3 and F5. - F1, H1-H2, and Q_{closed} are particularly important factors for the perception of "twanginess". - Formant differences are more important than the source difference for the perception of "twanginess".

Author | Year	Style(s)	Participant(s)	Methods | Measures	Results | Observations
Lebowitz and Baken (2011)	Belting *(vs Legit)*	20 professional female singers	- Audio and EGG signals: Q_{closed}* ($Q_{contact}$), Q_{speed}, LTAS, harmonic ratio (H1/H2).	Comparing with Legit, Belting: - did not vary significantly $Q_{contact}$ values (46-48%); - had higher Q_{speed} values (2.3>1.4); - had weaker H1 than H2 in 25% of the cases.
Borch and Sundberg (2011)	Rock Pop Soul Swedish Dance Band (SDB)	1 professional male singer	- Audio, ELG, flow and oral pressure signals: Leq, F0, Psub, Q_{closed}, pulse amplitude, MFDR, NAQ, H1-H2 and LTAS - Perceptual assessment of the singing substyles by a LT with 8 expert listeners	- Rock produced the highest and SDB the lowest curve of LTAS. Pop and Soul had intermediate configurations. - F1 and F2 were lowest in Soul. F1 was high in Pop and Rock. - Rock and Swedish Dance Band (SDB) have opposite Psub and F0 configurations (SDB < Psub and F0 < Rock) - Rock presents low NAQ values (close to pressed phonation) and neutral phonation in all other styles.
Kochis-Jennings, Finnegan, et al. (2012)	Non-classical singers	7 female non-classical singers *(vs 7 female classical singers)*	- Laryngeal EMG, nasoendoscoscopy and audio signal. - Perceptual "twanginess" rate by a LT with 6 expert listeners	- Commercial training singers failed to produce headmix register, whereas classical singers failed to produce chestmix register. - Classical trained singers had smaller ranges of TA muscle activity (25–38% of maximum), whereas commercial singers had a greater range of TA muscle activity (5–75% of maximum)
Sundberg, Thalén, et al. (2012)	Belting (heavy, brassy, ringy, nasal, and speechlike) *(vs Classical)*	1 professional female singer	- Audio, ELG, flow and oral pressure signals: Leq, F0, Q_{closed}, pulse amplitude, MFDR, NAQ, H1-H2 and LTAS - Perceptual assessment of the singing styles by a LT with 7 expert listeners	Differences between the belting substyles are mainly concerned the voice source: - Dominant voice source fundamental in Classical and much weaker in the other styles, especially Heavy Belting. - Clear differences in subglottal pressure and other flow glottogram related parameters between the substyles and classical. - Reduced differences in the formant frequencies between the substyles, but clearly separated from the classical style with regard to the first formant.

Legend: * Although the measure indicated in the article is Q_{closed}, the correct measure is $Q_{contact}$ as it was based in EGG signals

At least four of these studies carried out voice analysis based on audio, EGG, flow and oral pressure signals (Björkner, 2008; Björkner, Sundberg, Cleveland, et al., 2006; Stone, et al., 2002; Sundberg, et al., 2012). Most applied measures were: F0, SPL, Q_{closed}, Psub, Up-t-p, MFDR, NAQ, pulse amplitude, glottal leakage[14], glottal compliance[15], H1-H2, LTAS, vibrato rate and extent, and formant frequencies analysis. Results describe *musical theatre* type of singing closer to loud speech than to classic singing: a) high Psub; b) high SPL; c) weak fundamental (i.e. H1-H2); d) high adduction level, evidenced by high MFDR, Up-t-p, and Q_{closed} values; e) strong 2nd to 5th harmonics and absence of singer's formant; and f) vibrato rate of 6.1 Hz and extent of ±78 cents (in adolescent female singers).

Also transnasal fiberoptic laryngoscopy was used to investigate this style (Koufman, et al., 1996; Sundberg, et al., 1993): the first study reported *belting*, and the second was non-specific concerning the performance of *musical theatre* as compared with other singing styles. *Musical theatre* singers revealed a high larynx position, advanced side walls, smaller sinus piriformes in many vowels, and one of the highest muscle tension scores (74%).

Belting was specifically described by six studies (Bestebreurtje & Schutte, 2000; LeBorgne, et al., 2010; Lebowitz & Baken, 2011; Schutte & Miller, 1993; Sundberg, et al., 1993; Sundberg, et al., 2012), although the first definitions on this technique have been provided by Lawrence (1979), Estill et al. (1985), Yanagisawa et al. (1989), and Miles & Hollien (1990) (in Sundberg, et al., 1993). Most authors define belting as speech-like, yell-like, or shouting-like type of vocal quality (LeBorgne, et al., 2010; Schutte & Miller, 1993; Sundberg, et al., 2012). This type of singing has raised a great interest among researchers, moved by the following: a) *belting* vocal characteristics are many times perceived as being produced under physiological limits; b) voice disorders are reported as frequent in singers who belt; c) it is possible to use *belting* in many styles besides *musical theatre* (e.g. *pop*, *rock*, *R&B*, *jazz*, *country*, and *world music*); d) there is the need for a standardised definition of the term *"belting"* and its perceptual qualities; and e) pedagogical approaches are needed to train *belting* in a safe and healthy way (Lebowitz & Baken, 2011).

[14] Glottal leakage – «the mean of the flow values appearing during the quasi-closed phase [of the vocal folds' vibration]» Iwarsson, J., Thomasson, M., & Sundberg, J. (1998). Effects of lung volume on the glottal voice source. *Journal of Voice, 12*(4), 424-433.

[15] Glottal compliance - «the ratio between the air volume contained in the glottal pulse and Psub»; it is «related to the degree of glottal adduction; the greater the adduction, the lower the compliance» Thalén, M., & Sundberg, J. (2001). Describing different styles of singing: A comparison of a female singer's voice source in "Classical", "Pop", "Jazz" and "Blues". [Article]. *Logopedics Phoniatrics Vocology, 26*(2), 82-93.

Two studies used perceptual assessments with expert listeners to rate different *belting* substyles (heavy, brassy, ringy, nasal and speechlike) (Sundberg, et al., 2012) and voice qualities as loudness, vibrato, ring, timbre, nasality, and register breaks (LeBorgne, et al., 2010), respectively. The results of the latter revealed ring and vibrato as the most perceived features that characterise belt. Loudness obtained a strong correlation with ring and vibrato, contributing to the overall perception of belt, while timbre, nasality and registration were not found to be correlated with *belting* quality (LeBorgne, et al., 2010).

The remaining studies reported on the literature mainly used audio and EGG signals to study *belting* (Lebowitz & Baken, 2011), and only two used flow and oral pressure signals (Björkner, 2008; Sundberg, et al., 2012). Most common voice measures were: F0, $Q_{contact}$, Leq, speed quotient[16] (Q_{speed}), Q_{closed}, Psub, pulse amplitude, MFDR, NAQ, H1-H2 and LTAS. All studies were done with female voices. Most relevant results revealed: a) $Q_{contact}$ above 52% (Bestebreurtje & Schutte, 2000) or between 47.6% and 49.1% (Lebowitz & Baken, 2011); b) Q_{closed}, varying among substyles – ringy around 32%, and heavy and brassy around 50% (Sundberg, et al., 2012); c) Q_{speed} around 2.3 (Lebowitz & Baken, 2011); d) Leq, varying among substyles – ringy around 92 dB, brassy around 93 dB and heavy around 95 dB (Sundberg, et al., 2012); e) Psub varying among substyles – ringy with 15 to 20 cmH_2O, brassy with 18 to 21 cmH_2O and heavy with 25 to 30 cmH_2O (Sundberg, et al., 2012); f) weak voice fundamental, given by a low H1-H2, especially in heavy belting (Lebowitz & Baken, 2011; Sundberg, et al., 2012); and g) low NAQ and high MFDR, especially for heavy belting (Sundberg, et al., 2012). The above data reflect the use of modal (chest) register (high $Q_{contact}$ and Q_{closed}), high degree of perceived pressedness (low NAQ) and strong contribution of the voice source to vocal loudness (high MFDR). The weak fundamental and the predominance of peaks in the 1-1.7 kHz, and 3 kHz regions were also seen in LTAS of *belting* (Sundberg, et al., 2012), as shown in Figure 29.

[16] Speed quotient - «assesses the temporal symmetry of the opening and closing motions during the time the glottis is open» Lebowitz, A., & Baken, R. J. (2011). Correlates of the Belt Voice: A Broader Examination. *Journal of Voice, 25*(2), 159-165.

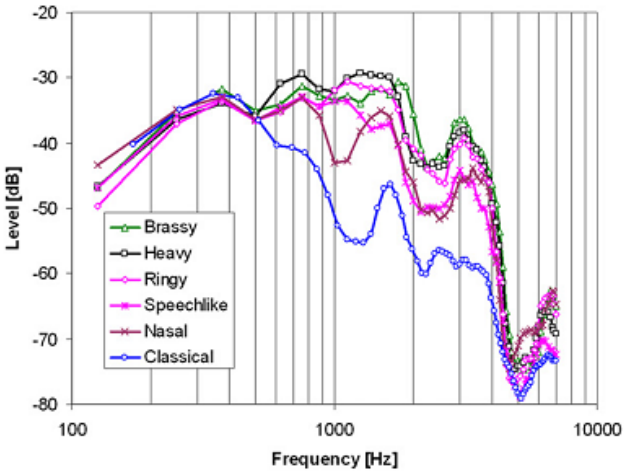

Figure 29. LTAS representation of different belt qualities (e.g. brassy, heavy, ringy, speechlike and nasal) compared with *classical* singing. Data was recorded from a single singer *(adapted from Sundberg, et al., 2012, p. 48)*

Summarising, the results of these different studies, suggest that *belting* is produced with: high Psub levels; chest/modal register in high F0 regions (high $Q_{contact}$ and Q_{closed}); high adduction (suggested by low NAQ values); weak fundamental (shown by H1-H2); and high vocal intensity (high Leq). A possible formant tuning strategy consists of raising the energy of H2 and H5 (demonstrated by LTAS and inverse filtering). *Belting* is also perceptively related with a good text intelligibility level (Björkner, 2008; Barlow and LoVetri, 2010; Lebowitz and Baken, 2011; Sundberg, Thalén, et al., 2012).

Several studies have been focused on *pop* style (Borch & Sundberg, 2002; Borch & Sundberg, 2011; Butte, et al., 2009; Koufman, et al., 1996; Schutte & Miller, 1993; Sundberg, et al., 2004; Thalén & Sundberg, 2001). The only study using transnasal fiberoptic laryngoscopy found evidence of muscle tension: scores around 65% for pop and jazz singers (Koufman, et al., 1996). Other studies used audio, ELG/EGG, flow and oral pressure signals to record voices and extracted LTAS and inverse filtering measures. As demonstrated in Figure 30, *pop* was found to be close to neutral/flow phonation in a female singer, taking into account NAQ values (Sundberg, et al., 2004; Thalén & Sundberg, 2001). For a male singer study, results for *pop* style revealed: a) Psub around 15-25 cmH_2O (at 175-330 Hz), approximately 4*PTP; b) NAQ around 0.15, similar to the one of *soul* and higher to *rock*; c) LTAS with peaks at 1-1.8, 2.7, 4 and 5 kHz, similar to those found in *soul*; and d) high F1 values, similar to those found in *rock* and pressed phonation (Borch & Sundberg, 2011).

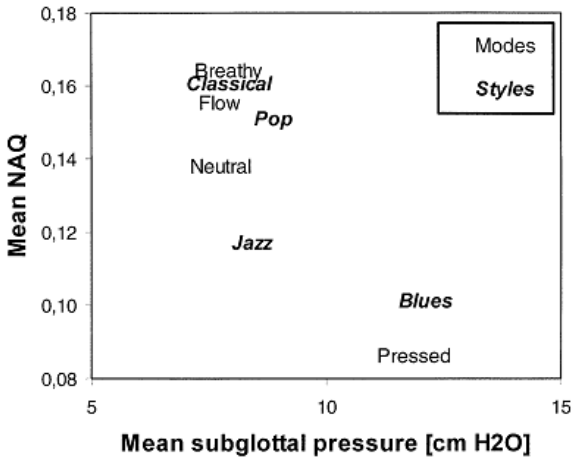

Figure 30. Mean NAQ as function of mean Psub, representing different voice modes in pressedeness scale (breathy, flow, neutral and pressed), and different singing styles (*classical*, *pop*, *jazz* and *blues*). Data recorded from a single singer study *(adapted from Sundberg, et al., 2004, p. 61)*

Another researched non-classical singing style was rock, (Borch & Sundberg, 2011; Borch, Sundberg, Lindestad, & Thalén, 2004; Koufman, et al., 1996). Transnasal fiberoptic laryngoscopy data described rock as presenting the highest muscle tension of all non-classical styles, scores around 94%, together with *gospel* style (Koufman, et al., 1996). Borch and Sundberg (2011) used audio, ELG, flow and oral pressure signals to describe *rock* in a professional male singer, and showed that: a) *rock* produced the highest curve of LTAS; b) F1 was as high in *rock* as in *pop*; c) *rock* presented NAQ values around 0.13; d) Psub was high, around 30-50 cmH_2O (at 311-466 Hz). Much of presented results revealed a pressed phonation pattern. Analysing the production of 'dist' tones, «a particular timbral ornament frequently used in *rock* music styles, such as *heavy rock* and *heavy metal*» (Borch, et al., 2004, p. 147), the same methods were used, complemented by audio and a high-speed imaging recording. 'Dist" tones were described as loud voice (90-96 dB @ 30 cm), produced with relatively high Psub (20-45 cmH2O). Their production was achieved by a periodic vocal fold vibration combined with periodic or aperiodic vibration of supraglottal mucosa (Borch, et al., 2004).

Jazz, *blues*, *soul* and *gospel* were described by a more reduced number of studies (Borch & Sundberg, 2011; Butte, et al., 2009; Koufman, et al., 1996; Sundberg, et al., 2004; Thalén & Sundberg, 2001). In transnasal fiberoptic laryngoscopy analysis, scores of 65% and 94% of muscle tension were obtained for *jazz* (and *pop*) and *gospel* (and *rock*), respectively, high levels when compared with classical singing styles (41-57%) (Koufman, et al., 1996). According with voice source measures (e.g. Psub and NAQ), *blues* was found to be close to pressed phonation, while *jazz* was closer to neutral

phonation (Sundberg, et al., 2004; Thalén & Sundberg, 2001). Psub varied between 10 and 30 cm H_2O (at 185-370 Hz) for *soul*, NAQ was around 0.15 (close to neutral phonation), and a similar LTAS of the one of *pop* style was found, with peaks at 1-1.8, 2.7, 4 and 5 kHz (Borch & Sundberg, 2011).

Commercial recordings of several non-classical styles, namely *country*, *musical theatre*, *jazz*, *soul* and *pop*, and also classical singing were compared (Butte, et al., 2009). Perturbation measures as jitter, shimmer and signal-to-noise ratio (SNR)[17] were extracted in sustained vowels with no accompaniment for each recording. Although these measures largely contribute to the assessment of voice disorders in voice clinics, they are barely used in singing voice research, as demonstrated in this review. In this particular study, as no control existed in the recording and signal treatment process, results should be regarded carefully. Median jitter increases in the following order: *musical theatre* (0.28%), *soul* (0.43%), jazz (0.44%), and *pop* (1.13%). Median shimmer raises in the following order: *jazz* (2.35%), *musical theatre* (2.8%), *soul* (6.42%) and *pop* (6.78%). Median SNR increases in the following order: *pop* (12.3 dB), *soul* (17.1 dB), *musical theatre* (23.3 dB) and *jazz* (24.4 dB) (Butte, et al., 2009).

The majority of the literature concerning non-classical singing used voice function in classical singing as reference for comparison: 60% (n=12); only two studies (10%) used the speech-like voice as reference. This is possibly explained by the fact that most singers in these studies were professional or formally trained, allowing them to sing more than one style. *Choral*, *art song* (Koufman, et al., 1996) and *mixed voice* (claimed to be a variant of *belting*) (Sundberg, et al., 1993) were occasionally used as a reference for comparison. “Phonation types” was the voice function event most reflected in these studies: *pressed*, *neutral*, *flow* and *breathy* (Borch & Sundberg, 2011; Sundberg, et al., 2004; Thalén & Sundberg, 2001). They allow the mapping of other styles according to several voice source measures and to perceived degree of pressedness. Different modes within the same style were also explored, particularly in *musical theatre*: a) chest vs head registers (Björkner, Sundberg, Cleveland, et al., 2006); b) *legit* vs *belting* qualities (Lebowitz & Baken, 2011); and c) *heavy* vs *brassy* vs *ringy* vs *nasal* vs *speech-like* substyles of *belting* (Sundberg, et al., 2012).

[17] Signal-to-noise ratio - Mean amplitude of the average wave divided by the mean amplitude of the isolated noise components of the sound Baken, R. J., & Orlikoff, R. F. (2000). *Clinical Measurement of Speech and Voice* (2 ed.). San Diego: Singular Publishing.

Considering the singers' sample constitution, most studies researched female voices (n=12; 60%) and used a single case study design (n=9; 45%). The majority of the studies used professional singers, with voice training and sometimes with experience in more than one style. Studies with smaller samples frequently recruited highly differentiated singers (sellected by convenience), while larger sample size studies had more heterogeneous characteristics, allowing for comparisons between, for example female vs male, professional vs amateur, or different styles' singers.

Regarding voice signals, audio was the most common type of signal (n=19; 95%), followed by airflow and oral pressure signals (n=10; 50%), and by ELG or EGG signals (n=9; 45%). The most frequent measures were Psub and perceptive related measures (n=10; 50% studies for both). Nine of the studies (45%) also used F0, intensity and LTAS related measures, all extracted from the audio signal. Also common were air flow related measures obtained by inverse filtering (n=8; 40%). Few studies used inverse filtering to extract formants, in alternative to spectrographic methods. ELG/EGG measures and spectrogram analysis were less commonly used (n=5; 25% and n=2; 10%, respectively). Some studies used EGG signal exclusively to obtain dEGG, as means to carry out the inverse filtering.

Finally, considering vocal tasks recorded, most studies (n=9; 45%) used reference songs, and few researchers (n=3; 15%) asked for sustained vowels in certain segments of a song to allow the extraction of specific measures. Songs were frequently tuned in pre-established reference tones and performed without a musical accompaniment. The most frequent adaptation was performing songs substituting the lyrics by the syllable [pæ] (n=10; 50%), to allow the recording of flow and oral pressure signals. The voice dynamics of each singer was also studied in diminuendos (n=4; 20%) and triads (n=3; 15%), common exercises especially for trained singers. Few studies (n=2; 10%) included speech based tasks (e.g. reading the song's lyrics and producing sequences of [pæ] with the prosodic variation typical of speech) and simple sustained vowels (n=2; 10%).

Summarising, many non-classical singing styles have already been studied, although with different depth. *Musical theatre*, including *belting*, was the most studied non-classical singing style. Several results coming from these styles, including voice source, resonance and perceptual measures, may be useful to understand traditional styles. Although voice and singer's representativeness may vary between studies, special cautions were identified to increase their validity (e.g. LTs) and should be considered in further research. Indeed, the most important difficulty when carrying out a literature review aiming at understanding what type of voice analysis could be more

informative resides on the differences found in the recording protocols and on the rationale for voice measures selected for each study.

2.5.4. VOICE FUNCTION STUDIES IN TRADITIONAL SINGING STYLES

Studies concerning voice function in traditional singing are scarce. Furthermore, the variety of methods used and measures extracted prevent comparative studies to be carried out between different traditional singing styles; thus, voice characteristics of traditional singing were frequently compared with classical singing.

The following studies (summarised in Table 5) mostly aimed at characterising particular small numbers of singers (between one and 15), varying between amateur and professional, depending on the styles. They included the following countries: Bulgaria, Brazil, Croatia, Estonia, Mongolia, United States of America (USA) and Portugal. Traditional singing of Siberia (Russia) (in Kovačić, Boersma, & Domitrović, 2003), Persian *avaz* (Iran) (Biglari & Sundberg, 2011), and Mongolian long song during trills (Mongolia) (Pillot-Loiseau et al., 2011) were also found; however, these were excluded as they did not meet the systematic review criteria, namely being published as articles during the period of this review.

The next sections discuss the results summarised on Table 5 in more detail, using the following order: (i) studies concerning only female singers (as Minho singing is mostly performed by females), (ii) studies on male voices and (iii) non gender specific research.

(i) Studies on female voices

The first traditional style to be described from a voice function point of view of was *Kulning*, from Sweden (Johnson, 1984). *Kulning* was originally sung only by females in the mountains of Scandinavia to call, lead and keep the cattle together, to scare off wild beasts and to communicate with other humans at great distances. The research was carried out in the 1980's, when the technological means to study the singing voice were much more limited than today. This constitutes one of few examples of studies that use relevant methods to collect voice samples while singing – audio and oral pressure recordings, vocal tract radiographs and a three dimensional acoustical model constructed by Fant (1960), complemented by a depth ethnomusicological review of the style.

Although the author assumes several limitations related with sample size and vocal measures, great caution was taken when selecting the singer (an experienced singer, with near 70 years, which lived in a rural context and learned *kulning* orally when she was a child). The singing tasks included “ordinary” folk songs and *kulning* phrases chosen by the singer (Johnson, 1984).

Differences between *Kulning* and other Swedish folk singing styles were found for SPL, Psub, larynx hight, jaw opening, tongue position, pharynx constriction and formant distribution, including formant tuning analysis. *Kulning* revealed (i) higher F0, Psub (60 cmH2O) and SPL levels (between 85 and 105 dB at 1 m); (ii) higher larynx (almost 40 mm rising) and tongue positions, pharyngeal constriction, and jaw opening. A formant tuning F1:H1 strategy (i.e. an approximation between the first formant (F1) and the first harmonic partial (H1)) was found for *Kulning*, pointed out as one of the main explanations for such loud voice production (Johnson, 1984).

Posteriorly, among the female traditional singing styles, Estonian folk singing has also been investigated. The authors compared formant frequencies in singing with data of spoken Estonian vowels and diphthongs. The research used a more than 50-year-old studio recording of an Estonian swing song, performed by two elderly women. The audio signals were digitally inverse filtered, in order to estimate the first three formant frequencies (F1, F2 and F3) of the sung vowels [a], [e], [i] and [u]. A LTAS of 50 seconds showed fairly flat decay of the spectral envelope above 1.5 kHz, with a slope of 5-10 dB/kHz (Ross, 1992). There was a tendency to cluster F1 to F2 in sung vowels (between 200 to 300 Hz frequency range), a different strategy when compared with F1:H2 tuning posteriorly described in Bulgarian singing (Henrich, et al., 2007). As expected in female singers, no evidence of a "singer's formant" was found (Ross, 1992).

Although this constitutes the first attempt to describe Estonian female traditional singing, caution must be taken when looking at the results, because an old studio recording was used for analysis, and thus the original data may have been modified by sound engineering studio artefacts.

Table 5. List of publications, organised according to the style of singing (in this case traditional), summarising their principal observations.

Origin	Style(s)	Author / Year	Participant(s)	Methods | Measures	Results | Observations
Sweden	Kulning *(vs common folk singing)*	(Johnson, 1984)	1 female singer	Voice source measures: Psub Acoustic measures: F0 and SPL Articulatory measures (by radiographs): larynx height, jaw opening, tongue position, pharynx position and formant estimation (F1, F2, F3, F4)	In Kulning: a) Psub achieves 60 cmH_2O in higher tones (1200 Hz); b) SPL achieves 105 dB (at 100 cm) in higher tones; c) larynx rises almost 40 mm; d) jaw opening has positive correlation with F0; e) tongue position adapts to F0; f) pharynx constriction is higher in higher tones; g) there is a formant tuning (F1:H1) for the entire F0 range; h) other formants (F2, F3, F4) are stable in frequency distribution.
Estonia	-	(Ross, 1992)	2 female singers (50 year old recording)	Audio signal: inverse filtering (F1, F2, F3) and LTAS	Singing F0 between 200 and 300 Hz. Tendency to cluster or approximate F1 and F2 in sung vowels. Absence of singer's formant.
Bulgaria	Teshka & Leka	(Henrich, et al., 2007) (Henrich, Kiek, Smith, & Wolfe, 2011)	1 female singer (professional)	Audio signal (injecting a synthesised, broad-band acoustic current): resonance tuning analysis EGG: Q_{closed}* ($Q_{contact}$)	Formant tuning (F1:H2) for most of the vowels. No relevant resonance factors between Teshka (loud and projected voice) and Leka (gentler, more lyrical voice). Higher $Q_{contact}$ in Teshka than in Leka, but both in modal register.
USA	Country	(Hoit, Jenks, Watson, & Cleveland, 1996) (Cleveland, Stone Jr, Sundberg, & Iwarsson, 1997) (Stone, Cleveland, & Sundberg, 1999) (Sundberg, Cleveland, Stone, & Iwarsson, 1999) (Cleveland, Sundberg, & Stone, 2001)	6 male singers (professional)	Audio, flow, oral pressure and respiratory bands signals: respiratory behaviour, Psub, flow inverse filtering (Q_{closed} and glottal compliance), SPL, F0, LTAS and formant frequencies (F1-F4)	Low pulmonary volumes with predominant chest wall movements; High subglottal pressures (35<50 cm H2O); Higher level of pressed phonation when singing high pitches; Very high closed quotient values (0.5 to 0.6 or even higher) in loud singing at high pitches; No specific resonant strategies including F1, F2 and F3; speaker's formant (3<4 kHz).

Origin	Style(s)	Author / Year	Participant(s)	Methods | Measures	Results | Observations
Mongolia	Kargyraa	(Lindestad, Södersten, Merker, & Granqvist, 2001)	1 male singer	Audio, flow and kymography signals: flow inverse filtering, acoustic spectral analysis	Low F0 (70 < 100 Hz); Combination of vocal fold and ventricular fold vibrations; Extremely- low pitch sound (a half of the modal register voice); Very dense spectrum of overtones suitable for overtone singing
Croatia	Klapa, Ojkanje & Tarankanje	(Kovačić, et al., 2003) (Boersma & Kovacic, 2006)	12 male singers (professional)	Audio signal: LTAS	Klapa: speech-like voice; lowest vocal intensity; steepest LTAS slope; spectral peaks at 0.6 and 1.1 kHz. Ojkanje: shouting voice; higher intensity; medium LTAS slope; spectral peaks at 0.6 and 1.1 kHz; speaker's formant (2.2<3.8 kHz); formant tuning (F1:H2). Tarankanje: pressed voice; nasal quality; extreme flat LTAS slope; spectral peaks at 0.7 and 1.5 kHz
Brazil	Sertanejo	(Bezerra, Cukier-Blaj, Duprat, Camargo, & Granato, 2009)	10 male singers	Audio signal: vibrato analysis (extension and rate)	Vibrato rate between 5.0<6.56 Hz; Vibrato extent between 0.54<0.95 semitones (no statistical differences comparing with classical style of singing); No regularity in the spectrogram in terms of frequency oscillation
Japan	Noh	(Yoshinaga & Kong, 2012)	4 singers (male and female)	Audio and EGG signals: F0, EGG open quotient (OQ_{EGG}), speed quotient (SQ_{EGG}), spectral analysis	Low pitch sounds are produced with medium F0 combined with subharmonics produced by the ventricular and ariepiglotic folds oscillating at a *F0/2* frequency. Opened phase is higher in *growl* quality, followed by *pressed* quality and lower in *vocal-ventricular mode* quality.
Portugal	Fado	(Mendes, Rodrigues, & Guerreiro, 2013)	15 singers (male and female)	Audio signal: maximum phonation time (MPT), s/z ratio, jitter, shimmer, harmonic-to noise ratio (HNR), F0, maximum phonational frequency range (MPFR), vibrato analysis (extension and rate) and formant frequencies	Speech: MPT and s/z ratio near the inefficient physiological threshold; high jitter and shimmer; normal HNR Singing: high jitter; low shimmer; low frequency range profile; vibrato (frequency of 5.72 Hz and extent values of 2.39 ST); absence of singer's formant cluster

Legend: * Although the measure indicated in the article is Q_{closed}, the correct measure is $Q_{contact}$ as it was based in EGG signals

Bulgarian traditional female singing was also studied (Henrich, et al., 2007). This folk style has its origins in rural activities and festivities, thus originally being performed outdoors. It can be sung by soloists but also by an ensemble and modern choral groups (Henrich, Kiek, et al., 2011). It is sung by women usually accompanied by instruments played by men. The typical tessitura for many traditional Bulgarian songs is limited at the frequency range around C4-C5 (for soprano voices) or A3-A4 (for alto voices), which usually includes an octave, especially for solo singing compositions (Henrich, et al., 2007).

Bulgarian voices are known for their loud and unique timbre. There are two major ways of singing: *Teshka* and *Leka*. *Teshka* (meaning heavy) is a loud and projected sound typically used in slower, sadder songs, while *Leka* (meaning light) is gentler and more lyrical sound (Henrich, et al., 2007).

In this study, the same singer subject was asked to perform sustained vowels in different pitches, in *Teshka*, *Leka* and head classical singing voices. Methods of voice analysis included: i) EGG, to analyse glottal period and $Q_{contact}$, and ii) resonance impedance, a technique that excites the singer's vocal tract at the mouth while singing, applying a synthesised broad band acoustic current. This technique was developed to investigate formant tuning strategies (Henrich, Kiek, et al., 2011). The analysis of six Bulgarian vowels in different pitches showed that there was a F1:H2 resonant tuning strategy for most vowels (except for [i] and [u]), contributing to the known predominance of H2 in the voice spectrum of this folk singing style. The author claimed that this phenomenon was possibly explained by the generally low pitch range used in this singing (Henrich, et al., 2007). There were no relevant distinguishable resonance strategies between *Teshka* and *Leka* and both were produced in modal register (while classical head voice was produced in a falsetto register); however *Teshka* had a longer $Q_{contact}$, a sign of higher glottal adduction (Henrich, Kiek, et al., 2011).

(ii) Studies on male voices

Croatian folk singing was studied (Boersma & Kovacic, 2006; Kovačić, et al., 2003), describing three different kinds of singing[18]: a) *klappa*, b) *ojkanje* (or *dozivacki*) and c) *tarankanje*.

[18] A website where several samples of Klappa, Ojkanje (or Dozivacki) and Tarankanje Croatian Folk Singing is available for listening (http://www.fon.hum.uva.nl/paul/CroatianFolkSinging/).

Klappa is described to be usually performed a cappella in a choir of five to eight men and is based in a harmonically (Western-like) musical scale. Perceptually is considered a pleasant and beautiful singing. *Ojkanje* is characterised by great loudness, uses non-Western intervals and is perceived as shouting. Is usually sung before and/or after a loud short text and was traditionally used to communicate over a great physical distance in sparsely settled mountain areas. *Tarankanje* uses a non-equal-tempered scale, the Istrian scale, which has six narrowly spaced tones and is impossible to transcribe in the Western musical notation system. It is performed as an accompaniment to dance and the vocalizations try to imitate wind instruments (Boersma & Kovacic, 2006).

This study, based on 12 professional male singers from a national folk group, chose a LTAS with a pitch-corrected method to characterise the different singing types. Sound level, spectral slopes, location and regularity of spectral peaks were investigated. In this study, LTAS was regarded as a valid method to characterise and compare singing folk styles, using the same singer subject to perform different vocal tasks (Boersma & Kovacic, 2006).

Results showed clear differences between the three singing types. Evidences were found that *Klappa* had a lower vocal intensity (when compared with the others), the steepest slope (with a difference of 20 dB between the low- and high-frequency regions) and spectral peaks at 0.6 and 1.1 kHz. These are features that make this style to be considered near speech. *Ojkanje* showed a higher level of intensity, about 10 dB higher amplitude at the 0.6 kHz peak, comparing with the other singing types. A spectral slope with a low-high difference of 15 dB was also found. These data were consistent with the perceptual descriptions corresponding to loud speech or shouting. As in *klappa*, the spectral peaks were at 0.6 and 1.1 kHz, showing a speech pattern more than a singing one. There was also found a prominent broad plateau between 2.2 and 3.8 kHz, suggesting the existence of a resonance phenomenon, claimed to be a *speaker's formant*. Lastly, there was evidence of a F1:H2 formant tuning strategy, present in all the singing range used in the performance (220 to 320 Hz). Finally, *tarankanje* showed an extreme flatness in the LTAS, with a spectral slope with a low-high difference of 10 dB. The low alpha ratio (measured comparing 0-2 kHz and 2-4 kHz regions) suggests the presence of pressed phonation. The first and second spectral peaks were at 0.7 and 1.5 kHz, in higher regions than the other singing types, and there was a nasal quality evident in all the performance (Boersma & Kovacic, 2006).

In the United States of America (USA) an extensive research was conducted to describe one of the most internationally known traditional singing styles: *country*. One might

even say that, in terms of voice function, *country* is certainly the most complete described folk style. The research was published in five articles, by different authors, between 1996 and 2001, with complementary methods and results, using the same sample and voice recording protocol. Respiratory function (Hoit, et al., 1996), subglottal pressure (Cleveland, et al., 1997), voice source (Sundberg, Cleveland, et al., 1999) and formant frequencies (Stone, et al., 1999) were the analysed parameters. LTAS was also a measure used to acoustically describe this singing style (Cleveland, et al., 2001).

A sample of 5 to 6 male singers (depending on the publication) was studied, all considered professional (i.e. *country* singing activity was their primary source of income). Voice protocol included speaking and singing standard and chosen songs. Respiratory manoeuvres and singing and speaking tasks where the lyrics were substituted by the syllable [pae] were also analysed. Measures included:

a) Respiratory function: percent of ribcage capacity; percent of abdomen capacity; percent of vital capacity; lung volume initiation, termination and excursion; ribcage volume initiation, termination and excursion; abdominal volume initiation, termination and excursion; relative volume contribution of the ribcage (Hoit, et al., 1996);
b) Voice source: F0; SPL; Psub (Cleveland, et al., 1997); perceived phonatory degree of pressednes (by means of a LT); peak-to-peak flow amplitude (P-t-P Flow) (ml/s); glottal leakage (mm/s); duration of the quasi-closed phase (ms); period time (ms); closed quotient; glottal resistance (ml/cm H_2O) (Sundberg, Cleveland, et al., 1999);
c) Formant frequencies: first to fourth formants (F1, F2, F3 and F4) (Stone, et al., 1999);
d) Long-term average spectrum: spectral peaks (Hz) and spectral slope (Cleveland, et al., 2001).

Results suggest that respiratory patterns in *country* singing are similar to those in speech. Chest wall movements were predominantly applied, characterised by larger ribcage volumes and smaller abdomen volumes. The sample was compared with data extracted from previous works, including those involving untrained and classical singers. Like untrained singers, *country* singers use lower pulmonary volumes to sing when compared with classical singers, who thus use greater variations in ribcage and abdominal patterns (Hoit, et al., 1996).

Although usually regarded as loud singing, lower SPL was found for *country* singing as compared to loud speech. However, the authors claim that this result may not be directly associated with the style of singing but rather the data collection method, as the song was recorded without accompaniment. In most subjects, Psub exceeded 35 cm H_2O, reaching in some cases around 50 cm H_2O in the upper part of their pitch range, meaning that they generally used higher Psub than classical singers. For the same Psub, *country* singers reached lower SPL values than operatic singers, a phenomenon related to higher glottal adduction (Cleveland, et al., 1997).

Voice source measures in *country* singing were taken in a subsequent study. Using a LT, the level of perceived pressedness of several voice samples was measured. A positive correlation between perceived pressedness and pitch was found, suggesting that singers used more pressed phonation when singing higher pitches. An inverse relationship was found between perceived pressedness and SPL gain: the smaller the SPL gain, the greater the perceived pressedness. Voice source measures (Q_{closed} and glottal compliance) revealed similar results for both speech and singing, an observation that possibly applies to *country* singers and also to other untrained voices. Another characteristic of *country* singing was high Q_{closed} values (0.5 to 0.6, or even higher) in loud singing at high pitches (Sundberg, Cleveland, et al., 1999).

Regarding resonance strategies, for the same subjects and lyrics, F1, F2, F3 and F4 were found identical in both sung and speech tasks (Stone, et al., 1999). This was further corroborated by an LTAS analysis, which confirmed that speech and singing presented similar acoustical properties, with no singer's formant cluster. A speaker's formant, probably produced by the subjects' fourth and fifth formants, was found between 3 and 4 kHz (Cleveland, et al., 2001).

Traditional style from Brazil, *Sertanejo*, was also found in the literature review (Bezerra, et al., 2009). This is style is original from the western region of Brazil (i.e. Sertão) and it is traditionally performed by male duets, accompanied by guitars. Their voices are perceptually high pitched, often nasal, and sometimes produced in falsetto register. One of the particularities of this singing style is the use of vibrato, and this specific aspect has been focussed in some studies. Vibrato rate and extent were manually compared between 10 male *Sertanejo* singers and 10 male classical singers. A shorter vibrato sustaining time was found for *Sertanejo*. Statistical differences in vibrato rate were also found, but not for vibrato extent.

Mongolian “throat singing” or *kargyraa* (also known as *dzo-ke* in Tibete), usually performed by monks, is characterised by low F0 singing (70 to 100 Hz), with or without emphasising single overtones. Research based on a single case study, using audio, flow and kymography[19] signals, suggested that the bass type of *kargyraa* singing is produced by a combination of vocal fold and ventricular fold vibrations. To be more specific, for every second glottal vibration there was a coinciding vibration of the ventricular folds, producing an extremely-low pitch sound (half of the modal register voice) with a very dense spectrum of overtones suitable for overtone singing (Lindestad, et al., 2001).

(iii) Non-gender specific studies

Japanese *noh* and Portuguese *fado* where reported in the literature as styles that can be sung by both female and male singers.

Noh is an old singing art influenced by Buddhist chants, performed on stage, and involving a small chorus and an orchestra. Phonatory characteristics were investigated for 2 male and 2 female *noh* singers, involving EGG and spectral analysis. Tasks included speech, sustained vowels produced all over the singers’ frequency range (both in *noh* and in speech-like productions) and traditional songs chosen by the singers. Differences between three *noh* singing voice qualities were studied: *growl*, *pressed* and *vocal-ventricular mode* (Yoshinaga & Kong, 2012).

Similar results to those found for Mongolian *kargyraa* were found for *noh* vocal-ventricular mode: ventricular and ariepiglotic folds vibrate at a F0/2 frequency, creating subharmonics in the spectrograms and a perceived low-pitched voice. EGG analysis showed decreased opened quotient (Q_{opened}) and increased speed quotient (Q_{speed}) as compared to speech, which may be indicative of higher glottal adduction in singing. Adduction was found lower for *growl*, followed by *pressed* and *vocal-ventricular mode* (Yoshinaga & Kong, 2012).

Fado is a Portuguese traditional urban style originated in Lisbon under the influence of several singing traditions (Carvalho, 1984; UNESCO, 2011). *Fado* is not considered a folk style since, unlike the previously described European styles and Minho singing, it does not represent a national cultural expression from rural regions. *Fado* is a men or women

[19] Kymography – Method of high-speed video analysis, selecting just a single line from each of the images of the vocal folds to compose a new image representing the vibration of that selected part in time Svec, J. G., & Sram, F. (2011). Videokymographic Examination of Voice. In E. Ma & E. Yiu (Eds.), *Handbook of Voice Assessment* (pp. 129-146). San Diego: Plural Publishing.

type of solo singing, accompanied by a wire-string acoustic guitar and a Portuguese guitar, and usually performed in low noise environments. The mentioned study evaluated voice acoustics of 15 singers (10 male and 5 female), 13 of them amateurs. The assessment included sustained vowels and fricatives, text reading, glissando, singing the Portuguese version of "Happy Birthday" and sustaining vowels in a Fado song. The measures were: maximum phonation time[20] (MPT), s/z ratio[21], jitter, shimmer, harmonic-to-noise ratio[22] (HNR), F0, maximum phonational frequency range[23] (MPFR), vibrato analysis (extension and rate) and formant frequencies calculated from FFT analysis (Mendes, et al., 2013).

Fado singers showed low frequency range profile when compared with classical singers referred in the literature. Vibrato had a frequency of 5.72 Hz and an extent of 2.39 ST and absence of singer's formant (Mendes, et al., 2013). Jitter, shimmer and HNR were compared with values from classical and non-classical styles reported in the literature, namely Butte et al. (2009); jitter was higher compared with *country*, *musical theater*, *soul*, *jazz*, and *classical* singers and lower than *pop* singers; shimmer mean values were lower than *country*, *musical theater*, *pop*, *soul*, and *jazz* singers and higher than *classical* singers; and HNR was similar for *classical* singers. Formant analysis was carried out for segments of sustained vowels [a, i, u] in Happy Birthday song, however, a singers' formant was rarely found. Apparently, not using a *Fado* song in these measures may have limited some of the reported findings.

[20] Maximum phonation time - objective measure of the efficiency of the respiratory mechanism during phonation measuring the ability to maximally sustain a vowel after having taken a maximal inspiration Speyer, R., Bogaardt, H. C., Passos, V. L., Roodenburg, N. P., Zumach, A., Heijnen, M. A., et al. (2010). Maximum phonation time: variability and reliability. *J Voice, 24*(3), 281-284.

[21] S/Z ratio - Standard test of vocal function commonly used in clinical practice, obtained by timing the longest duration that a patient can sustain the individual phonemes [s] and [z]. Under normal circumstances, the ideal S/Z ratio is 1. Disturbances in glottic function are reflected by a decrease in the duration of *z* (as a consequence of inadequate vocal cord closure and subsequent air escape) resulting in an S/Z ratio of more than 1. Gelfer, M. P., & Pazera, J. F. (2006). Maximum duration of sustained /s/ and /z/ and the s/z ratio with controlled intensity. Ibid*., 20*, 369-379.

[22] Harmonic-to-noise ratio – Acoustic spectral measure which quantifies the relative amount of additive noise (in terms of dB) in the voice signal, assessing the dominance of harmonic (periodic) over noise (aperiodic) levels in the voice Ferrand, C. T. (2002). Harmonics-to-noise ratio: an index of vocal aging. Ibid*., 16*(4), 480-487.

[23] Maximum phonational frequency range – Acoustic F0 measure defined as the range of vocal frequencies encompassing both the modal and falsetto registers; its extent is from the lowest tone sustainable in the modal register to the highest in falsetto, inclusive—pulse or fry register is excluded MPFR provides information about basic vocal ability and reflects the physical limits of the phonatory mechanism Baken, R. J., & Orlikoff, R. F. (2000). *Clinical Measurement of Speech and Voice* (2 ed.). San Diego: Singular Publishing.. (MPFR is a part of the voice range profile, already presented in Chapter 2.4.)

Summarising this section concerning the study of traditional singing styles, recording protocols and techniques used to analyse voice function were quite different among studies. The vocal tasks and recording conditions were critical to obtain reliable and comparable results. In different studies, speech was a useful task for intra-subject analysis, as well as, the inclusion of substyles of singing within the same singing style. Although it is difficult to compare all traditional styles described in the literature, some common patterns were found for resonance strategies: a F1:H2 tuning was observed in Croatian (male) and Bulgarian (female) singing. Most studies reported spectral characteristics, and few included source data or resonant strategies.

Considering the pertinence of non-classical styles (presented in previous section) to the study of traditional styles, *belting* quality was considered as particularly relevant. As mentioned previously, traditional styles were originally performed as amateur activities and may carry many characteristics similar to loud speech production. This is the case of *kulning* (from Sweden), *ojkanje* (from Croatia), and *country* (from USA), further presented. In fact, perceived descriptions reveal that *belting* share some similar characteristics with these traditional styles: high loudness, pressed phonation, high level of physical effort (increased laryngeal muscular tension), little to no vibrato, high level of nasality, bright quality, more forward placement than classical singing, brassy, twangy, among other features (LeBorgne, Lee, et al., 2010).

Additionally, *rock* and *gospel* also presented relevant characteristics for comparisons. As shown by Koufman et al. (1996), these are the non-classical styles with higher laryngeal muscle tension scores (94%), followed by *country* singers (86%) and *belting* singers (74%). *'Dist' tones*, a specific voice quality used in *rock* style (Borch, Sundberg, et al., 2004), was described with similar physiological characteristics with the ones shown in Mongolian *kargyraa* (Lindestad, et al., 2001) and in Japanese *noh* (Yoshinaga & Kong, 2012).

Finally, high muscle tension scores shown to exist both in non-classical and traditional styles should be kept in mind when regarding: (i) the need to better understand these styles; (ii) the vocal health of the singers, and (iii) the development of well-designed and grounded actions to respond to their needs (Koufman, Radomski, et al. 1996). Accordingly, these are some of the already mentioned motivations to study Minho folk singing in present research.

2.5.5. REFLECTIONS ON HOW TO STUDY MINHO FOLK SINGING

Having described the results of studies on non-classical and traditional singing styles, it is important to extract from these the most relevant considerations on how to study AM folk singing. The following sections present such information, using the following order: (i) contextualising the singing style, (ii) study design, (iii) singers selection, (iv) voice measures, and (v) recording protocol.

(i) Contextualising the singing style

A brief introduction including information about cultural origins, musical structure, performance contexts and perceptual characteristics of the style should be provided, as it was done in most studies. Despite only few studies have used voice function to respond to specific performance, pedagogical or health issues, the study of AM singing will take these into account, as it happened, for example, in *belting*. This technique has been studied in different ways: characterising voice function; defining the style's perceptual properties; comparing phonatory patterns with other techniques of singing (i.e. mixed voice vs *belting*; *legit* vs *belting*; chest vs head registers); and analysing differences between subtypes of *belting*. As most investigations in Portuguese Minho folk style were developed by ethnomusicology, little information exists on the *cantadeiras* voice use. It is therefore a prior aim of the current investigation to complement this information with knowledge on voice function.

(ii) Study design

Single singer studies and groups of singers with different dimensions have been carried out. Studies, with no control groups, compared their results with other styles and descriptions in the literature, while others included control groups within the same study or used the same singers performing different voice tasks or voice qualities for comparison purposes. Using the singer as his own control seems to be a preferable choice, especially in studies with small sample size. This will be taken into consideration when studying AM folk singing: a group of *cantadeiras* will be studied when performing different vocal tasks.

(iii) Singers selection

Most studies involved a small number of singers. In a considerable number of studies, singers where chosen considering their experience and/or the fact that they were trained in one or more specific singing styles, according with researchers' convenience (some of them were even co-authors themselves). Other studies, instead, have selected singers according with the level of representativeness of their voices, by means of LTs. This seems a method that can increase the reliability of the results, as the relative importance of each voice feature to the overall typical voice quality can be determined.

(vi) Voice measures

Tables 4 and 5 displayed a summary of all reported studies on non-classical and traditional styles. A great diversity of measures is evidenced in these tables, thus not allowing for direct comparisons between voice characteristics of different singing styles. However, it is also observable that some of the most relevant measures were: Psub; F0 and F0 range; SPL and Leq; LTAS and related measures (e.g. alpha); Q_{closed}; flow related measures (e.g. MFDR, and NAQ); and formant frequencies' distribution. Inverse filtering has been shown to be a useful method for voice analysis and enables a reliable extraction of most of the mentioned measures. These measures would allow for extensive voice function comparisons both with other styles and reference phonatory modes (i.e. pressed vs breathy phonation and different voice registers). Looking for specific phenomena, as formant clusters or formant tuning strategies, may also be of particular interest, as they were previously found in other styles.

(v) Recording protocol

Reference song is the most common task among all revised studies. Studies using intra-subject control design ask singers to perform additional voice qualities and voice tasks (e.g. speech, singing, scales, triads, diminuendos). This is obviously an easy option, when singers are professional, vocally trained and acquainted with different singing styles. However, AM *cantadeiras* are typically amateur singers, thus some difficulties are predictable. This is a potential problem also for other traditional singing styles, although none of the reviewed studies assumed it (they also selected professional singers). An appropriate resolution to this situation could be the development and testing of a specific

recording protocol. A pilot study could be useful to identify potential limitations in the protocol and to find specific strategies to overtake them.

Following the considerations made by the analysis of previous investigations, the next chapter concerns the contextualization of the performance practices of singing in this folk style, understood by those who practice it. Only after understanding these performance practices one would be informed enough to design and pilot a recording protocol with a *cantadeira*.

CHAPTER 3

PERCEPTIONS OF ALTO MINHO FOLK SINGING PRACTICES

3. PERCEPTIONS OF ALTO MINHO FOLK SINGING PRACTICES

3.1. INTRODUCTION

This research aims at describing voice function in performance contexts within FGs' activities of Portuguese female solo folk singers, AM's *cantadeiras*. Although previous research on a particular singing style has been focused on voice production only, the author believes that studying voice function disregarding its performance contexts may lead to incomplete visions of that style, particularly concerning the reasons for voice use. Hence, in order to describe a singing style and relate voice function with voice use, it is fundamental to understand also other aspects that might influence voice production, such as: singer's individual characteristics, repertoire, performance venues, number of performances and motivation to perform. After all, the human voice has a multidimensional nature (Berry, 2000). The following section aims at describing demographic characteristics and performance practices of current FGs of Minho region. An additional goal is to be informed on the most important perceptual characteristics that a *cantadeira´s* voice should have to represent a FG from AM. In order to achieve such aims, both quantitative and qualitative information was gathered by means of questionnaires and interviews with FGs' members. The methods of data collection and results of such dataset analysis are described below.

3.2. METHODS

Data was collected carrying out three different methods: (i) telephone questionnaires to obtain demographic information of all FGs existing in AM and the number of their current performances; (ii) a handed in survey carried out with a smaller, yet representative sample of these FGs, to describe current performance practices; and (iii) semi-structured interviews carried out with pre-selected FG members, to understand the *cantadeira*'s roles within FGs and perceptual voice characteristics that are found as being most representative of these singers and singing style. These three methods are separately described in the following sections.

3.2.1. METHOD 1: TELEPHONE QUESTIONNAIRES

Telephone questionnaires were designed to: (a) identify the FGs of AM; (b) characterise these groups according to their constituting members; (c) quantify the approximate number of performances per year; and (d) compare FGs' characteristics and their performance activities. For these purposes, questions were first designed, followed by the identification and selection of participants, phone calls for data collection and data analysis.

(i) Questionnaire design

Taking into account previous mentioned aims, phone questionnaires were designed to include the following questions: (a) foundation year of the group (group age); (b) total number of members; (c) number of members under 18 years old; (d) number of *cantadeiras*, grouped by those who are soloists and those who are choristers; (e) number of *cantadores*; (f) number of performances in the preceding year (i.e. 2010); and (g) number of performances abroad in the same year. Questionnaire was designed taking into account that survey studies constitute a good mean to understand the population under investigation, allowing the collection of a large data with the confidence that the questions possess the same meaning to all respondents as the interviewer may clarify the questions. The phone seemed to be the best way to deliver such questionnaires as the aim was to include, using a simple and straightforward approach, the highest number possible of respondents, spread out in a large geographical area (Robson, 2002).

(ii) Identification and selection of participants

To identify possible respondents, two main sources were used: (a) consulting the official websites for the 10 existing district councils of AM (i.e. Viana do Castelo district); and (b) contacting the Culture Departments of those district councils. The FGs' were listed, identifying a total of 95 groups (see Figure 31 for their geographical distribution), containing groups' identification, directors' identifications, postal addresses and telephone contacts (see Appendix 2). Six groups were excluded because they were constituted predominantly by children and juveniles; thus, a total of 89 groups were considered.

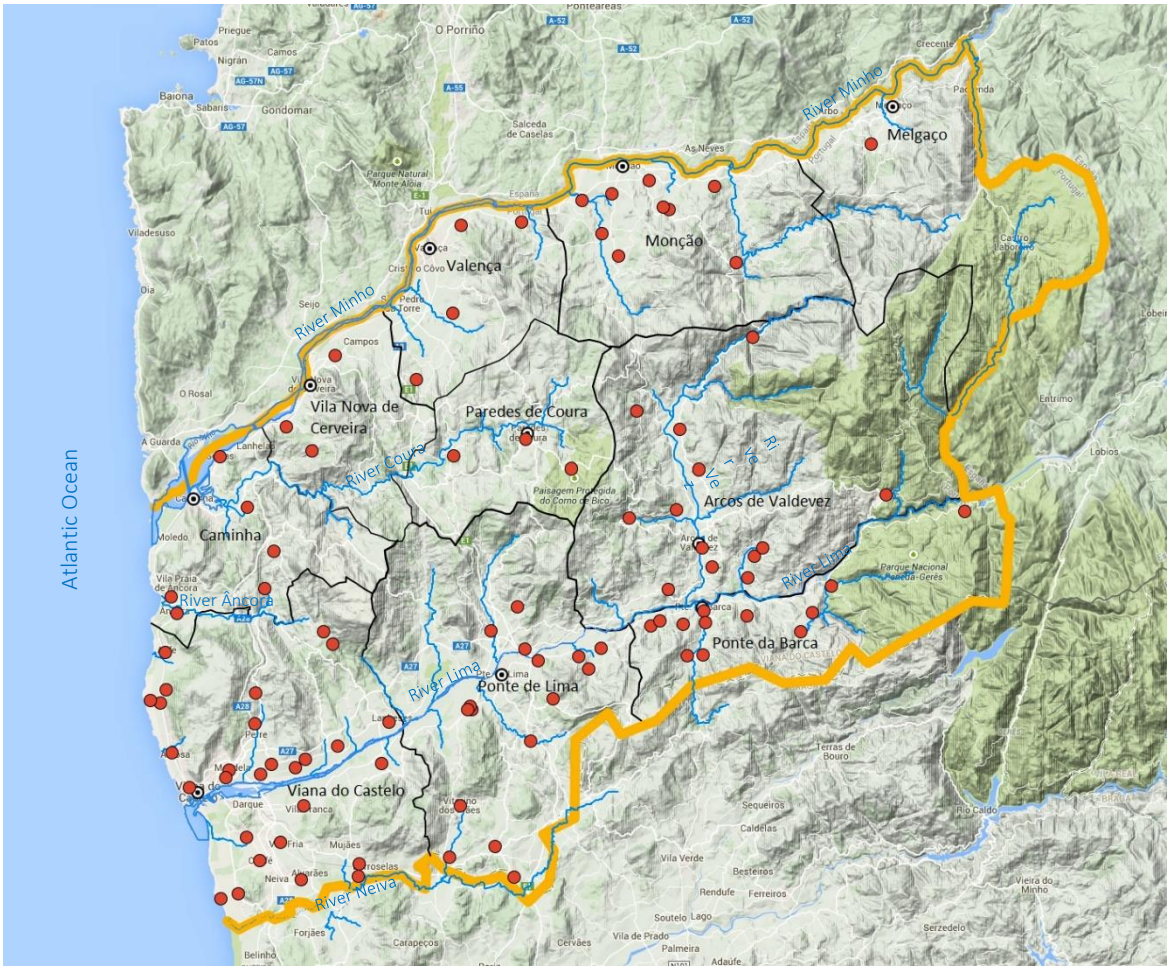

Figure 31. Geographical distribution (red points) of all identified FGs in AM. Black lines represent frontiers between districts within Viana do Castelo region, which is limited by the yellow line.

(iii) Phone calls for data collection

Over a period of approximately two weeks, all groups were contacted by phone. Only 78 actually responded to this survey, giving a response rate of 87.64%. This was a high response rate, suggesting that phone contact was a suitable strategy to recruit participants. Table 6 summarises the procedures used for the identification and selection of participants.

Table 6. Number of FGs and number of actually made contacts, for the 10 districts of AM. From the 95 identified groups, 89 were selected to be contacted, and 78 contacts were successfully achieved.

Districts	Viana do Castelo	Ponte de Lima	Arcos de Valdevez	Ponte da Barca	Monção	Caminha	Valença	Vila Nova de Cerveira	Paredes de Coura	Melgaço	**TOTAL**
Total identified FGs	27	16	13	12	9	7	4	3	3	1	**95**
Juvenile Folk Groups ***(excluded)***	0	2	0	1	1	0	1	1	0	0	**6**
Successfully contacted FGs	26	10	10	11	7	6	2	2	3	1	**78**

(iv) Data analysis

Descriptive and comparative statistics were carried out using the softwares Microsoft Excel (Microsoft® Excel® 2013) and Statistical Package for the Social Sciences (IBM® SPSS® Statistics, Version 21). As data were not normally distributed, median and interquartile rages (IQ), calculated as the difference between percentiles 75 and 25, were used as central tendency and distribution measures, respectively. Comparisons between FGs' characteristics and their performance activities were carried out. In order to make these comparisons, FG's were classified into two categories, according to (i) their age of existence (i.e. experience) and (ii) geographical distribution. The emerging groups falling into FGs' experiences were: (A) FGs with 1 to 20 years (n = 25; 32.1%); (B) FGs with 21 to 40 years (n=34; 43.6%); and (C) more than 41 years (n=19; 24.4%). Concerning geographical distribution, FGs were organised in the following groups: (A') "Coastline / Lima Riverside" (n=35; 44.9%), including Viana do Castelo and Ponte de Lima; (B') "Interior / Lima Riverside" (n=25; 32.1%), including Arcos de Valdevez, Paredes de Coura and Ponte da Barca; and (C') "Border / Minho Riverside" (n=18; 23.1%), including Caminha, Melgaço, Monção, Valença and Vila Nova de Cerveira. These comparisons were carried out using the non-parametric Kruskal-Wallis test. This test was particularly chosen because data were skewed. All tests were made using a confidence level of 0.05 for statistical significance.

3.2.2. METHOD 2: HANDED IN SURVEYS

Handed in surveys constituted the second methodological approach applied to identify FGs' performance practices and *cantadeiras* voice use on a direct and quantifiable manner. A handed in survey was chosen for the same reasons as described before (Robson, 2002). Thus, the aims of this survey were: (a) describing the constitution of FGs; (b) characterising their performance practices (e.g. repertoire, dancing, instrumentation, singing habits, spatial distribution of FGs members); (c) establishing relationships between performance practices and *cantadeiras*' voice use.

The following sections explore: (i) sample selection and recruitment of the participants, (ii) the questionnaire structure, and (iii) data collection and analysis.

(i) Sample selection and recruitment of participants

A total of 23 FGs were invited to participate in this questionnaire. Data collection involved three different procedures: (1) when vising the FGs for recording *cantadeiras* – selected groups were representatives of six districts of AM – the musical directors of these groups were invited to fill in this questionnaire; (2) during a visit to other FGs of the region, aiming at filling in a LT assessing representativeness of *cantadeiras'* voices (see Chapter 5), their musical directors were also asked to fill in this questionnaire; (3) from a last visit to a local folklore festival in AM, the participating FGs (more specifically their musical directors), were also invited to fill in this questionnaire. Participants were exclusively musical and/or executive directors, because they are naturally more acquainted with information on FGs constitution, performance practices and *cantadeiras* voices' characteristics.

From procedures (1), (2) and (3), 6, 5 and 2 musical directors filled in the questionnaire, respectively. Thus, a total of 13 questionnaires were collected and analysed. Table 7 displays the total number of FGs considered for this survey.

Table 7. Summary of total number of participating FGs, distributed accordingly with phase of recruitment and district of origin.

District	Viana do Castelo	Ponte de Lima	Arcos de Valdevez	Ponte da Barca	Monção	Caminha	Valença	Vila Nova de Cerveira	Paredes de Coura	Melgaço	TOTAL
Total number of Folk Groups	27	16	13	12	9	7	4	3	3	1	**95**
Number of selected FGs in procedure 1	3	1	1	1	1	1	0	0	0	0	**8**
Number of selected FGs in procedure 2	1	1	0	1	1	1	1	1	1	0	**8**
Number selected FGs in procedure 3	1	1	1	1	1	1	0	0	0	1	**7**
Total number of respondent FGs/directors	2	2	1	1	3	1	1	1	1	0	**13**

(ii) Questionnaire structure

Taken into account the aims of this survey, questions were designed, emerging from a previous interview with two musical directors of FGs from Braga (Vila Verde) and Viana do Castelo. These interviews were carried out for the identification of relevant questions to achieve the proposed aims of the questionnaire. The questionnaire was piloted with musical directors of three FGs of Braga and Viana do Castelo. This pre-test was done essentially to identify the clarity of the questions and to allow needed modifications. The final version of the survey (presented in Appendix 3) included questions on: (i) number of male and female members; (ii) members' distribution among each performance role (i.e. singing, dancing, playing, among others); (iii) group repertoire; (iv) rehearsal information (e.g. periodicity, duration, number of songs, internal organization); (v) performance information (e.g. periodicity, duration, number of songs, internal organization); (vi) information on traditional orchestra (i.e. amplification, stage disposition, number and type of instruments and instrument players). Questions on specific factors related with the *cantadeiras*' vocal activity were also included, namely: (i) repertoire tuning system; (ii) voice preparation; and (iii) history of voice complaints or limitations in *cantadeiras*. All questions were open so respondents could freely express their perceptions in a written and direct way.

(iii) Data collection and analysis

The questionnaire was presented in paper or digital support, depending on the respondents' preferences. The questionnaires could either be filled in presence of the researcher or by email. Data was stored on Microsoft Excel (Microsoft software) and later analysed applying descriptive statistics.

3.2.3. METHOD 3: SEMI-STRUCTURED INTERVIEWS

To study the *cantadeira's* voice function and acoustical characteristics, and following the principles of the theory of "Context Model" (vanDijk, 2008), a broad view of the *cantadeira*'s voice was needed: from verbalised perception points of view; from an aural perspective, and from a measurement quantifiable angle. The following section concerns the method applied to collect data concerning only the verbalised perceptional points of view. Thus, it seemed rather appropriate to include semi-structure interviews with members of FGs in AM. On the one hand, semi-structured interviews encourage the expression of views and opinions on a given phenomenon that assist in qualitative descriptions of that phenomenon (Robson, 2002), and, on the other, the involvement of those who make part of the research field, allows rich and valid data on how they explain the lived phenomena (Morris, Kwok, Ames, & Lickel, 1999), in this case the *cantadeira*'s unique vocal characteristics.

Semi-structured interviews were particularly chosen because they allow flexibility in the order of questions as well as new questions to be made that were not included in the initial script, adding richness to the final results. The interviews included several questions, the aim of which were: (a) to determine whether there is a uniqueness in *cantadeiras*' voice of AM, and, whenever applied, what characteristics define such uniqueness; (b) characterise the roles that the *cantadeiras* assume within FGs and their relationship with performance practices; (c) identify possible changes in *cantadeiras*' learning and voice use environments over the years; (d) identify social, cultural and musical aspects that may influence the *cantadeiras*' voice use in FGs performances. Before presenting the results of such interviews, the following section provides a brief overview of the (i) recruitment and selection of the participants involved, (ii) the design of the semi-structured interviews and (iii) data collection and analysis.

(i) Participants' selection and recruitment

As the main aim of this interview was to identify vocal characteristics that are considered unique of *cantadeiras* of FGs in AM, a sample of 10 FGs within the 95 FGs identified within this region, was invited to participate, particularly selected to represent the 10 districts in AM. This sample was also selected because of its experience (more than 30 years of existence) and performance activities (more than 20 performances in the year 2010, when this study was initiated. There were two groups (from Arcos de Valdevez and Melgaço) that did not accept to participate; thus, these districts could not be included in this study, and only a total of 8 out of 10 districts were represented.

The interviews were carried out with 35 FG members. The recruitment involved a visit to each FG during a rehearsal and the involvement of the directors to participate and to recruit other members. The participants, all volunteers, vary in number for each FG (see Table 8). They were older than 18 years and had at least 2 years of experience as an active member in the group. There were no exclusion criteria applied.

Table 8. Total number of participants in the semi-structured interviews, distributed according to FG and district.

Districts	Viana do Castelo	Ponte de Lima	Arcos de Valdevez	Ponte da Barca	Monção	Caminha	Valença	Vila Nova de Cerveira	Paredes de Coura	Melgaço	**TOTAL**
Total number of FGs	27	16	13	12	9	7	4	3	3	1	**95**
Selected FGs	1	1	0	1	1	1	1	1	1	0	**8**
Interviewees	2	5	0	4	6	4	5	6	3	0	**35**

(ii) Semi-structured interview design

Semi-structured face-to-face interviews were carried out to explore the participants' opinions and believes on *cantadeira's* role and voice quality. Such type of interview was especially chosen taken into account that, although there are some guidelines towards the questions to be made, the interviewer is free to change the order of questions or even modify them, according with the context of the conversation (Robson, 2002). Given the wide variety of the level of education of the participants, this seemed to be the best manner to collect the data.

Previously to the interview design, informal exploratory interviews have been made with four experts, namely: one ethnomusicologist with experience in Minho folk music, one folklorist from Viana do Castelo, one FG executive director and one FG musical director. After analysing the responses of this previous pilot-interview, the questions of the semi-structured interview carried out for this study were developed, consisting on a group of 5 opened questions exploring: (a) the role of *cantadeira* in the FG; (b) AM *cantadeira's* vocal characteristics; (c) pre-requisites to be a *cantadeira* in an AM FG; (d) the singing learning process of *cantadeiras;* and (e) the evolution of *cantadeira*'s voice over time (past to present). An informed consent was signed by all participants before the interviews.

(iii) Data collection and analysis

The interviews were carried out during scheduled visits to FGs, in a weekend or during FGs' rehearsals. All interviews were made individually, in FG's facilities, in a quiet and relaxed atmosphere, taking between 15 to 30 minutes each.

All interviews were entirely recorded with a digital voice recorder (Olympus model VN-86000PC). After exporting the audio files to a computer, the interviews were transcribed and introduced in the *WebQDA software* (version 1.4.3), suitable for qualitative research analysis. Using this software, a content analysis was carried out, using data codification. The contents were then organised in the following categories, focussing on *cantadeira's*: (i) singing activity; (ii) vocal characteristics; (iii) role within the FG; and (iv) vocal practices over time. For ethical purposes, fake names will be used to address the interviewees' answers.

3.3. RESULTS

The second main section of this chapter concerns the results of the three methods above described, presented separately and following the same order as used before: (1) telephone questionnaires; (2) handed in surveys and (3) semi-structured interviews.

3.3.1. RESULTS 1: TELEPHONE QUESTIONNAIRES

The aims of the telephone questionnaires were to: (a) identify FGs in AM; (b) characterise these groups according to their constituting members; (c) quantify the approximate number of performances per year; and (d) compare FGs' characteristics and their performance activities. Results will be presented below, following this same order.

(a) Identification of the FGs in AM

Table 9 lists a summary of FGs identified in AM grouped by: (a) age; (b) constituting elements, distributed by age and singing role; and (c) number of performances, grouped according to those made in Portugal and those made abroad.

Table 9. General characterization of the Folk Groups (n=78)

Questions	Mean (SD)	Min	Max	Total	Estimation
Folk Group age (years)	30.3 (±18.5)	1	88	-	-
Total number of elements	50.8 (±9.3)	16	75	3 959	4 826
Number of elements under 18 years	15.7 (±7.0)	1	35	1 206	1 491
Total number of female singers	7.6 (±4.2)	3	35	584	722
Number of soloist *cantadeiras*	2.0 (±1.1)	0	8	158	190
Total number of male singers	3.8 (±3.3)	0	25	295	361
Number of male soloists	1.3 (±0.7)	0	3	103	123
Number of performances in 2010	22.8 (±12.2)	1	70	1 758	2 166
Mean number of annual performances abroad	0.6 (±0.6)	0	2	44	57

The majority of the groups are located in the districts of Viana do Castelo (n=25; 32.1%), Ponte de Lima (n=16; 20.5%), Arcos de Valdevez (n=13; 16.7%), and Ponte da Barca (n=12; 15.4%). These are geographically located in the southern region of AM, surrounding the Lima River. The remaining six districts (Caminha, Melgaço, Monção, Paredes de Coura, Valença and Vila Nova de Cerveira) surround the rivers Minho and Coura.

(b) Characterization of FGs according to their constituting members

The mean age of FGs' existence is 30 years old; most groups were created during the 80's (n=24, 30.8%), followed by those created in the 90's (n=14, 17.9%). Fewer were created in the 50's, 70's and in the decade of 2000 (n=10; 12.8% each). A minority was founded before the 50's (n=7, 9.0%), and the 60's (n=3, 3.8%).

The approximate number of constituting elements is 50, with 16 elements (31%) under 18yrs old. Among the elements that are singers (an average of 11.4 elements), females are in higher numbers than males (a ratio of 1 male for 2 females): there were 584 identified female singers and only 295 male singers. Also, observing the number of soloists per group, there were more females (75%) than males (25%). Based in these data, it was possible to estimate the total number of male and female folk singers in the region: 722 female singers, including 190 *cantadeiras*, and 361 male singers, 123 of them *cantadores*.

(c) Quantification of approximate number of performances per year

The average of the FGs' performances per year was around 23, with at least 10 groups having more than 40 performances/year. Concerning performances abroad, most groups (n=31, 39.7%) have one excursion every two or three years, whereas 23 FGs (29.5%) have no performances in a foreign country. Only 17 FGs (21.8%) report one annual excursion and a small minority (n=7, 9.0%) have two performances/year abroad.

(d) Comparisons between FGs' characteristics and their performance activities

As explained above, FGs were clustered into two main groups, according to (i) age of experience and (b) geographical location. Table 10 presents the results of a Kruskal-Wallis test between the three groups for age of experience: (A) 1-20 yrs; (B) 21-40 yrs; and (C) > 41yrs. Older FGs (group C) had a greater number of performances in 2010 compared with the other groups, although not statistically significant. On the other hand, the number of performances abroad was statistically significant to differentiate groups: those having more experience (group C) presented a higher number of performances abroad.

Table 10. Results of a non-parametric Kruskall Wallis test comparing groups A, B and C, distributed according to group experience (A= 1-20 yrs; B=21-40 yrs; C>41yrs). Significant differences between groups were found only for mean number of annual performances abroad.

Statistic Groups	**A. 1 to 20 years**		**B. 21 to 40 years**		**C. > 41 years**		**Kruskall Wallis p-value**
Number of groups (N)	**25**		**34**		**19**		
Dependent variable	**Median**	**IQ range**	**Median**	**IQ range**	**Median**	**IQ range**	
Folk Group age (years)	**11**	**9**	**28**	**6**	**54.5**	**12**	**67.045; p=0.000***
Total number of elements	50	17	50	7	50	11	2.045; p=0.36
Total number of female singers	7	4	7	3	7.5	4	0.661; p=0.71
Number of *cantadeiras*	2	1	2	1	2	1	0.833; p=0.65
Total number of male singers	3	4	3	3	3	2	0.568; p=0.75
Number of male soloists	1	1	1	1	1	1	0.096; p=0.95
Number of performances (2010)	20	10	15.5	21	24.5	16	5.436; p=0.06
Mean number of annual performances abroad	**0.3**	**0.5**	**0.4**	**0.8**	**0.75**	**0.7**	**8.420 p=0.015***

* $p < 0.05$ significant at $\alpha = 0.05$

FGs were also compared taking into account their geographical distribution and, thus, local socio-cultural influences. Three groups emerged: (A') Coastline / Lima Riverside; (B') Interior / Lima Riverside; and (C') Border / Minho Riverside (see Table 11). Based in this geographical distribution, groups A', B' and C' statistically differed concerning: total number of elements, number of *cantadeiras* and number of performances abroad. FGs in Border / Minho Riverside (group C') present fewer elements (median=45.5; IQ=5). The number of *cantadeiras* was found to be statistically different between regions, although the median of 2 *cantadeiras* per FG was found for all statistical groups: the difference resides in the IQ range, which is higher in group B'. FGs from group A' present a high number of annual performances (median=22.5), distinguishing from both other groups (median=20 for group B' and median=18.5 for group C'). However, statistical differences were found only for the performances abroad (median=0.75 for group A' and median=0.3 for groups B' and C').

Table 11. Results of a non-parametric Kruskall Wallis test comparing groups A', B' and C', distributed according to region (A'= Coastline / Lima Riverside; B'= Interior /Lima Riverside; C'= Border/Minho Riverside). Significant differences were found for total number of elements, number of cantadeiras and mean number of performances abroad

Statistic groups	**A'. Coastline / Lima Riverside**		**B'. Interior / Lima Riverside**		**C'. Border / Minho Riverside**		
Districts within each statistic group	Viana do Castelo Ponte de Lima		Arcos de Valdevez Paredes de Coura Ponte da Barca		Caminha Melgaço Monção Valença V. N. Cerveira		
Number of groups (N)	35		25		18		**Kruskall Wallis p-value**
Questions	**Median**	**IQ range**	**Median**	**IQ range**	**Median**	**IQ range**	
Folk Group age (years)	27	25	28	34	27	20	0.666 0.717
Total number of elements	**50**	**12**	**50**	**12**	**45.5**	**5**	**7.457** **0.024***
Total number of female singers	7	3	7	4	6	4	3.038 0.219
Number of *cantadeiras*	**2**	**0**	**2**	**2**	**2**	**1**	**6.891** **0.032***
Total number of male singers	4	3	4	3	2	2	1.378 0.502
Number of male soloists	2	1	1	1	1	1	5.039 0.081
Number of performances (2010)	22.5	23	20	9	18.5	10	2.441 0.295
Mean number of annual performances abroad	**0.75**	**0.8**	**0.3**	**0.4**	**0.3**	**0.4**	**9.798** **0.007***

* $p < 0.05$ significant at $\alpha = 0.05$

3.3.2. RESULTS 2: HANDED IN SURVEYS

The second methodological approach included handed in surveys aiming at: (a) describing the constitution of FGs; (b) characterising their performance practices (e.g. repertoire, dancing, instrumentation, singing habits, spatial distribution of FGs members on stage); and (c) establishing relationships between performance practices and *cantadeiras*' voice use. Results are presented separately, as follows.

(a) Folk Groups' constitution

A total of 23 FGs were invited to participate in this study; however, only 13 have completed the questionnaire properly (4 presented incomplete questionnaires and 6 did not respond). Thus, data analysis and corresponding results concern only 13 questionnaires.

A total of 570 elements were identified within responding FGs (mean=47.5; SD=9.7): 43.9% were male (n=250) and 56.1% (n=320) were female. About 49.5% (n=306) were dancers and 20% (n=125) were instrument players. To sing in choirs was the third most frequent role (n=101; 16%), whereas only 6% (n=39) were soloist singers (including 12 male and 27 female soloists). In average, most FGs had 2 soloist *cantadeiras* and one male soloist singer (*cantador*). Other roles included executive and music direction as well as costume and accessories maker (n=29; 10.1%). Table 12 represent a summary of descriptive statistics on FGs elements, distributed according to their role within the FG.

Table 12. Distribution of the functions of the Folk Groups' elements

Role	Valid answers	Total number	Mean	Standard deviation	%
Dancers	13	306	23.5	8.9	49.5
Instrument players	13	125	9.6	2.5	20.2
Choir singers	13	101	7.8	3.3	16.4
Soloist singers	13	39	3,0	0.8	6.3
Other	6	29	4.8	3.2	10.1

(b) Folk Groups' musical activity

There were between 10 and 40 identified songs being part of each FGs' repertoire (mean=22.6 songs; SD=10.1). To understand which songs best identified each FG's repertoire, the directors were asked about which songs were most known and sung in FGs' region and AM in general. Most responses identified the repertoire according to the associated rhythm or dance denomination, and also according to the song title.

The most mentioned songs representative of AM region were: Vira, Cana Verde, Chula and Malhão. Within each FG's repertoire there were described several varieties of these song, usually reporting to different choreographies, rhythms and lyrics (e.g. *Vira Velho*, *Vira da Terra*, *Vira Cerrado*, *Vira Trespassado*, and *Vira das Sachadas*). Some other less referred songs were: Fandango, Rusga and Gota.

Number of rehearsals and performances vary according to different periods of the year: a) low season, between October and May; and b) high season, between June and September. Some FGs also consider a resting period, corresponding to the months of October and November.

During the low season, FGs usually have one rehearsal, once a week or once in either week. Only one FG (the one with higher number of annual performances) reported to do two rehearsals per week during this period. This is a period where new members are integrated in the FGs and when they learn their roles. During this season, the performances are scarce: five groups reported to have between one to three performances each month, while six groups usually do not have regular performances. This is also the period when some different activities may happen, such as Christmas and New Year street performances (i.e. *Janeiras* and *Reis*).

During the high season, FGs are invited to perform in festivities, festivals and national and international tours. All FGs reported to have one or two performances per week; 2 FGs assumed to have more than three weekly performances during August. Most FGs (n=11) do not rehearse during this period. Two FGs assumed to maintain one rehearsal per week, or to practice only when there is a specific or important performance.

Most FGs assumed to practice during 2 hours, usually during weekend nights (Friday or Saturday). FGs assumed to practice between 5 and 25 songs in each rehearsal (mean=13.5; SD=4.8). Depending on how extensive the groups' repertoire is, in each rehearsal between 25% and 100% of the entire repertoire can be rehearsed (mean=67.4%; SD=28.6%). During the rehearsal, FGs' members usually assume a spatial distribution, similar to the one used during the performances. Also, the songs' are commonly rehearsed in the same order as it would be in a performance. Repetitions are not frequent and usually happen especially when new elements are learning their roles (usually dancing). Two FGs assumed to practice the dancing parts in turns, because the rehearsal area is limited. Only two FGs assumed to practice separately dancing, instrument playing and singing. Most groups (n=11) do not have access to any amplification system to practice.

Performances length and organization vary, depending on the type of presentation. In festivals, the performance may vary between 15 and 30 minutes, while in festivities it may last around 1 hour. In festivals, the songs (4 to 7) are selected to show the most representative repertoire and choreographies of the FG, while in festivities there is time for longer presentations and to show most of the groups' repertoire (at least 10 songs). Most FGs (n=10) have pre-defined performance schemes; only two assumed to select the songs according to the characteristics of the performance; and one assumed to decide the repertoire to be performed only before entering on stage.

Considering spatial distribution of the FGs members, most of the descriptions corresponded to the example presented in Figure 32. Dancers are positioned in front of the singers and instrumentalists, which, in turn, are allocated in a line or half-moon shape with figurants on both ends, followed by cordophones, concertinas and soloists (from left to right of the audience). Behind the front line, and the soloist, there are the other singers and on the other edge the percussion instrumentalists.

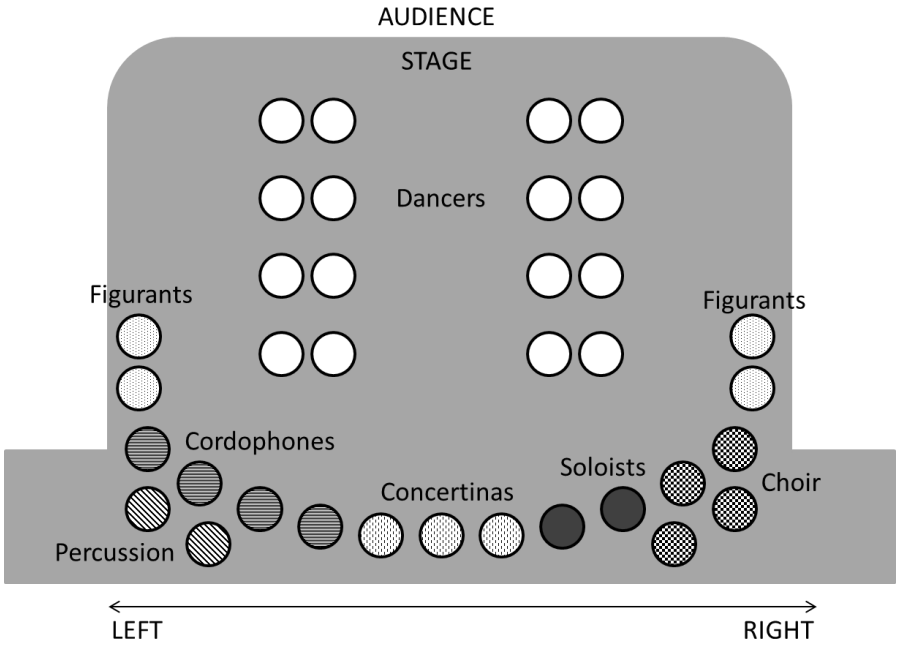

Figure 32. Example of a common stage distribution of FGs members, according with their roles within the FG.

To understand the overall FGs' sonority and the accompaniment playing with the *cantadeiras*, detailed information on what instruments are usually playing was asked. The most commonly reported instruments were the *concertina*, *cavaquinho*, *viola*, *bombo* and *ferrinhos*. Other traditional instruments, such as *reque-reque* and castanets, exist in only half of the FGs (see Table 13). Bandolim, braguesa guitar and bagpipe are played in fewer groups. The accordion, although it may not be considered an AM traditional instrument, was also mentioned to be played in four FGs.

Table 13. FGs instruments, distributed according to their frequency of playing.

Instrument	Instrument group	Frequency of use	Number of instruments			
			Mean	SD	Max.	Min.
Concertina	Aerophone	12	2.8	1.1	5	1
Accordion		4	1.8	1.0	3	1
Gaita de foles (bagpipe)		1	1	-	1	1
Cavaquinho (ukulele)	Chordophone	11	2.6	1.1	5	1
Viola (guitar)		10	1.6	0.8	3	1
Braguesa guitar		3	1.3	0.6	2	1
Bass guitar		1	1	-	1	1
Bandolim (mandolin)		1	1	-	1	1
Bombo (drum)	Membranophone	10	1	0.0	1	1
Ferrinhos (triangle)	Idiophone	10	1	0.0	1	1
Reque-reque (guiro)		6	1	0.0	1	1
Castanholas (castanets)		6	5	2.1	8	2

Rehearsal and acoustic conditions were also explored. Most groups (n=11) have their own rehearsal rooms; only few (n=2) share spaces with other music groups or cultural activities; three FGs have a stage in the rehearsal room. According to the directors' perceptions, rooms can be noisy or offer reverberant conditions (reported by 8 directors). During performances, all FGs use amplification; however, rarely special attention is given to sound equalization between microphones, so some times it may happen that singers need to compete with a considerably louder accompaniment. Moreover, the majority of the directors (n=11) reported not to be concerned with the number, position nor distribution of the microphones. All directors referred to use one or two microphones to amplify voices, so that soloist and choirs must share the microphones. During the rehearsals, only 2 directors reported to use amplification. In performances, habits of check-sound are inexistent (it depends on the event organization) and only two musical directors reported to control the number, position and distribution of microphones.

(c) Cantadeiras' voice use

Considering voice use of *cantadeiras*, the first question concerned whether voice warm-ups are included in the FGs' practicing routines. Only two directors refered to the inclusion of some voice exercises in some rare occasions, performed individually by the singers without any specific guidance. Two directors revealed to begin the rehearsals or performances with the most vocally demanding songs, as at the end, *cantadeiras* would be rather tired to be able to sing them.

All directors mentioned that songs were tuned depending on the tuning used by the concertinas. Three groups had concertinas tuned in different keys to obtain more flexibility in the repertoire's adaptation. The most frequent keys were major D and major F (n=4), followed by major G (n=3), major C (n=2) and major E (n=1), major A# (n=1) and major B (n=1). When questioned if there was any tuning adaptation of the repertoire to the singers' voices, most directors (n=10) assumed that such care was not possible, because of the limitations imposed by the concertinas tuning system. Thus, the singers should adapt their voice to the tunning system applied. Inversely, three directors referred that they would make adaptations considering the singers' voices, whenever there was a song that the singer could not sing properly (usually higher pitches), or when a new *cantadeira* assumed the soloist role in the group. For one FG, in some particular songs, the musical director would exclude the concertina so that a comfortable key could be played for the *cantadeira* by the other instruments. Another option was to substitute the concertina by the accordion.

The last question aimed at understanding whether voice problems could be observed in *cantadeiras*. Although some directors identified voice problems in *cantadeiras* (5 in total for the 13 FGs), these were mainly transitory (at least for 3 *cantadeiras*), with little or no impact on the groups' overall performance quality. Only one *cantadeira* had to follow a period of voice therapy and one *cantadeira* was substituted because of permanent voice damage.

3.3.3. RESULTS 3: SEMI-STRUCTURED INTERVIEWS

Semi-structured interviews were carried out with 35 FGs' members aiming at: (a) determining whether there are voice characteristics that are considered unique in *cantadeiras* of AM, and, whenever applied, what characteristics define such uniqueness; (b) characterising the roles assumed by *cantadeiras* within FGs and their relationship with performance practices; (c) identifying possible changes in *cantadeiras*' learning and voice use over the years; (d) identifying social, cultural and musical aspects that may influence *cantadeiras*' voice use in FG contexts.

Participants' ages varied between 19 and 70 years (mean=46.4; SD=15.1). From a total of 35 respondents, 17 were male and 18 female, and their experience as members of the FG varied between 5 and 60 years of membership (mean=25.5; SD=13.3). Their roles varied between: dancers (n=26), choir singers (n=13), soloist singers (n=6), instrument players (n=6), and other roles (n=18) such as executive director, music director, and logistics. Most participants (n=11) attended up to secondary school (12 years), seven had a Bachelor or

equivalent level, seven attended primary school (4 years), six completed basic school (9 years), three had not finished basic school (6 years) and one never went to a school.

The emergent themes of these interviews included: (i) voice characteristics associated with geographical origins; and (ii) interactions between voice and instruments.

The following sections present the results of content analysis (including those which were emergent themes), organised as: (i) folk singing characteristics in AM; (ii) vocal characteristics of the AM *cantadeiras*; (iii) roles of the *cantadeiras* within the FGs; and iv) changes in vocal practices throughout time.

(i) Folk singing characteristics in Alto Minho

Most respondents (n=26; 74%) revealed that the fundamental attribute of a *cantadeira* is "knowing how to sing" or "having a good voice", concepts often used as synonyms.

> *Having a good voice. Knowing how to sing (…) What I value the most is the person that, while is singing, shows that enjoys what she is singing. (Ana, 34, dancer)*

Some of the interviewees (n=9; 26%) associate "good voice" to a "healthy voice", attributing subjective qualities such as: normal, clean, pleasant, of high quality, with no breaks, with no tremor and effortless. Few were those assuming that the *cantadeira* should also have an educated voice (n=2; 6%).

> *(…) There are people who have a healthy voice - really good and healthy. Others, well, they are sharper, stronger and then they begin to squeal… but that is not singing! (Aurora, 60, cantadeira and dancer)*

> *For me [the most important] is a good voice, but above all, an educated throat. The educated voice is the most important characteristic. (Manuel, 62, cantador)*

Being able to "properly sing the lyrics" was another important feature (n=21; 60%). Diction (understood as lyrics' intelligibility), emerged as an important feature (n=16; 46%), as it was pointed out to be essential to communicate the group's performance intentions with the public. This text eloquence was mentioned as a key factor in assisting the coordination between the *cantadeira'*s voice and the *tocata*, the dancers and the choirs. It seems therefore that, in FGs performances, understanding the lyrics sung by the *cantadeira* is an important guiding line for all actions on stage.

> *I love to understand what they say. Sometimes it becomes difficult to understand. And if you do not realise what they are saying, it makes no sense to be singing. (Maria, 19, dancer)*

The accent used in the lyrics' pronunciation was also found to be important. For about 31% of the interviewees (n=11), *cantadeiras* must keep the old phonetic and linguistic features associated with rural regions of AM, commonly called "hillbilly speaking" (*falar à parolo*).

> *A FG reports to the end of 19th and beginning of 20th century, and in those times the way people spoke was different. There are words which had a different pronunciation (…) and when singing they [cantadeiras] should also use that pronunciation. (Lúcia, 41, dancer)*

The *cantadeiras'* ability to memorise the lyrics was also stressed as an important asset (n=4; 11%). Apparently, this is necessary to carry a confident posture and to prevent mistakes that could jeopardise the coordination of the FG's members during the performance.

> *And above all, they should not have a paper in front. Because many times, when they are reading, they get lost. (Ermelinda, 69, technical assistant)*

Another characteristic pointed to be of paramount importance to a *cantadeira* was "being able to adjust to the FG's repertoire" (n=19; 54%). This "adjustment" includes four major aspects: a) to sing in tune; b) to sing on the beat; c) to get adequate loudness; and d) to have a proper timbre.

> *Surely that the cantadeira must have a voice that is able to follow the group's music… the songs of the group. The group has a repertoire and will not change it because of the cantadeira, don´t you think? (José, 57, dancer and director)*

> *It depends on the music tones which are used in each region, and if she [cantadeira] is able to get those tones in each music (António, 53, singer and director)*

> *The concertina must follow the cantadeira, but she must be able to begin in the proper time. She must know when to start and maintain the rhythm. (Ana, 34, dancer)*

> *Not everyone is able to sing our songs (…) only those possessing good lungs will do it. Our cantadeira has good lungs (Celina, 33, instrument player and dancer)*

> *Not all timbres are equal (…) maybe some [cantadeiras] fit better in one music than in another. (Pedro, 27, instrument player and dancer)*

Intonation was described as fundamental to the singing quality (n=16; 46%), but also as a valuable aspect to the group's image and essential for choosing each group's repertoire. Some respondents even considered this factor to be as important as the voice

quality itself. Quite often, there are FG's members with good voices when singing other styles, or non-accompanied folk songs, but they present great difficulties when interpreting folk repertoire with instrumental accompaniment.

> *To appreciate listening, of course she [the cantadeira] must have a finely tuned voice. It cannot be an out of tune voice, otherwise, we don't enjoy the show. (Joana, 20, dancer)*

Cantadeiras must "sing with a sense of rhythm" (n=16; 46%). The sense of tempo/rhythm is essential to synchronise the voice with the instruments, choir and choreographies. In addition, the *cantadeira* was identified as a key element to coordinate all elements of the group, especially in the faster repertoire that is so common in AM's musical culture.

> *It is also important that a cantadeira is able to start in the right beats. To know where she must begin. Because the cantadeira complements the player, and the player complements the cantadeira. All is a complement. If one fails, others will fail. (Ana, 34, dancer)*

> *She also can introduce some rhythm, some dynamic to the group itself when is dancing (Afonso, 55, dancer and director)*

It is important that the voice should be highlighted as compared with other instruments' sonority (n=10; 29%). Considering that the instruments have an overall high loudness, the *cantadeiras'* voice must compete and be able to achieve high loudness levels too.

> *The voice must be strong, able to hang on without oscillations since the beginning to the end of the song. Because our songs are truly demanding, there is the need for a singer who can handle them. (João, 70, dancer and director)*

Although the term vocal extension has never been applied by the interviewees, it was implied as part of a *cantadeiras*' vocal ability (n=8; 23%). The greater difficulty in adjusting the voice to the repertoire was associated with the "high tone" needed to sing typical songs of AM.

> *If there is a cantadeira that is able to put the voice up, the better… because it is more genuine… ancient female voices were high-pitched and quite sharp. (Isabel, 43, cantadeira and dancer)*

As already mentioned, the *cantadeiras* are expected to "adjust to the FG's repertoire". Related to this, an emergent theme appeared in five interviewees: the interaction with the instruments, especially the *concertinas*, as this may influence the *cantadeiras*' capacity to adapt their voices. In this case, because the concertina is a diatonic instrument which does

not offer possible tuning changes, the *cantadeiras* are required to reach the tones set by this accompaniment at any cost, so eventually they end pushing their voices. Additionally, the excessive number of concertinas in some FGs was pointed as a fact that may jeopardise the sound of other instruments, including the voices.

> *Sometimes I think that there are some groups with too many concertinas. Concertina is in fashion… everyone wants to learn, and then you have five or six concertinas in the same group (…) It covers guitars and voices. (E35)*

> *There are concertinas playing in different tones: in F, in C and in A. And there are cantadeiras who can't handle it, and then they can't sing. (…) When we see that they can't reach the music, the song, then we change [the concertina]. (E40)*

(b) Vocal characteristics of the Alto Minho cantadeiras

Exploring the specific characteristics of the AM *cantadeiras*' voice, the most representative features were vocal range (n=22; 63%), loudness (n=16; 48%) and timbre (n=10; 29%). There was a wide variety of vocabulary used by different respondents, sometimes to describe identical vocal phenomena. There are differences between perceptual descriptions and quantitative voice measures; thus, several studies have called the attention to the high subjectivity of perceptual evaluations of voice qualities (Kreiman & Gerratt, 2011). Terms as "high-pitched" (*aguda*) and "thin" (*fina*), may be related with the *cantadeiras*' voice range, while terms as "high" (*alta*), "strong" (*forte*), "firm" (*firme*), "projected" (*projetada*), "full" (*cheia*) or "vigorous" (*pujante*) may be associated with intensity, and "thin" (*fina*), "thinned" (*afinada*)[24] and "that intones in the ear" (*que entoa no ouvido*) may be related with timbre. Despite the difficulty in categorising and grouping these terms, it is curious to observe that, in fact, there are common voice features that define a typical *cantadeira*'s voice.

> *The high-pitches. There are people who cannot get them (…) but there are songs here from Alto Minho that really ask for a very high pitch… that is quite difficult. (Cândida, 42, dancer)*

[24] The direct translation of the term "*afinada"* would be "tuned". However, the real meaning given by the interviewees is a derivation of the word *"fina"*, which means "thin". In this context, *"fina"* was found to be related with pitch, while *"afinada"* was related with timber, possibly referring to other spectral characteristics beyond the F0.

> *It is high [the voice volume]. Generally people use to say that we don't need microphones. Because women have a strong voice, they have a very projected voice (…) (Ana, 34, dancer)*

> *The cantadeira from Alto Minho is different than the others, because it has a thinner voice, with more timbre (…) It's a voice that stands out over the others… and over the instruments too. (Joaquim, 68, instrument player and director)*

Timbre characteristics were identified as unique to *cantadeiras*, and were related to registers[25] (n=4; 11%). Chest register also defined as "full voice" (*voz cheia*) or "deep voice" (*voz grave*), was identified as the most commonly expected.

> *What I appreciate the most is the singer who can reach high-pitches, but in a full manner. I think that is the most important thing in cantadeira's voice. (Isabel, 43, cantadeira and dancer)*

Other voice characteristics were considered as non-pleasant, such as "over-effort voice" (*voz com esforço excessivo*) (n=21; 60%), also defined as "yelled voice" (*voz gritada*), "squeaky voice" (*voz esganiçada*), "over-sharp voice" (*voz demasiado aguda*) and "ear hurting voice" (*voz que fere o ouvido*). These negative and displeasure descriptions are also partially associated with the perception of vocal problems.

> *Well, they [the cantadeiras] shouldn't spoil their throat nor straining it too hard. However, our songs here in Alto Minho often compel them to make too much effort. (Manuel, 62, cantador and director)*

Apart from excessive effort, and also related with this, the lack of text intelligibility is identified as another non-representative characteristic of this style (n=9; 26%).

> *(…) here in the North [of Portugal] there are many cantadeiras who sing, but you don't understand their words. Because they push their voices to hard, you see? They almost shout. It's a shouting that don't' allow you to understand what they're saying. (Miguel, 38, dancer and director)*

Finally, another non-characteristic aspect in *cantadeiras'* voices is to use head voice to sing high notes (n=3; 9%), also named as "changed voice".

> *I think not all people are able to get that timbre, which is quite difficult because the voices from Alto Minho are very characteristic. Some sing with head voice, which they shouldn't, and others produce a guttural sound, and this is also not desirable. (Cândida, 42, dancer)*

[25] Specific information on voice Registers is provided in section 2.4

According to some testimonies (n=5; 14%), *cantadeiras*' voices may have mild or pronounced differences, depending on their origins. While some participants (n=4; 11%) consistently reported that the most high pitched voices come from districts located in interior and rural regions within AM (e.g. Ponte da Barca and Arcos de Valdevez), at least one participant disagreed, assuming these as characteristics more often found in coast line and urbanised areas (i.e. Viana do Castelo and Ponte de Lima).

> *If you go to Arcos de Valdevez, those voices are more squeaky. But it's fine, it's their voices. It's a genuine voice from there. (E26)*

In summary, according to the interviewees, the *cantadeiras* from AM must be able to sing high-pitched tones, using chest register in order to guarantee a "full voice", but always preserving non-excessive levels of vocal effort, word intelligibility, and the region's accent. The typical timbre of the region, characterised by a "thin voice" that stands out from the instruments even without amplification, is also and expected feature.

(c) Roles of the cantadeiras within the FGs

Although the *cantadeira* apparently assumes a secondary role in AM FGs (dancers being the first, with a higher visual impact in the performance), singing is described as the most important to communicate the FG's identity (n=22; 63%).

> *Let's see, a cantadeira plays a central role. If there isn't a good cantadeira, you can't have a good folk group. (Miguel, 38, dancer and director)*

Currently, the impact of a *cantadeira* on FGs clearly exceeds her vocal skills; the *cantadeira* is often seen as a "coordinating" element (n=19; 54%): despite doing it informally, in most songs she is responsible for the entries of both the choir and the dancers. Therefore, it is assumed that if she fails, it is likely that the entire FG may fail and the whole performance might be jeopardised.

> *The cantadeira also has a role with high responsibility; because she needs to be careful about what is happening around her, isn't it? From the instruments to all the rest. Because of her voice, her singing has a central role, fundamental to coordinate. She is, how can we put it… the coordinator of the group. (Manuel, 62, cantador and director)*

Only a few respondents reported that the *cantadeiras*, although having a differentiated role in the FG (n=6; 17%), have equivalent importance as all remaining members. These opinions were shared mostly by the dancers.

> *I believe that the cantadeira's role is as important as the one of the dancers. Because dancing without music and singing wouldn't make any sense. (Joana, 20, dancer)*

Besides the above mentioned functions, respondents indicated that a *cantadeira* must: (i) be able to communicate the message of the songs, because the repertoire's selection defines the FG's identity (n=13; 37%); (ii) be responsible (n=8; 23%); (iii) be happy (n=7; 20%); (iv) feel comfortable on stage (n=7; 20%); (v) properly wear the costume (n=7; 20%); (vi) look good (n=6; 17%); (vii) have a good body posture (n=6; 17%); (viii) have a strong personal motivation (n=4; 11%); (ix) sing with feeling (n=4; 11%); and (x) be simple and humble (n=1; 3%).

(d) Changes in vocal practices throughout time

The voice of a *cantadeira* nowadays is described as being different from the voice of a *cantadeira* of the past (n=24; 69%). This distinction was clearer and more detailed in the reports of older interviewees (with more than 40 years of experience in FG).

In the past, singing was part of rural activities, to make hard work feel easier, to make the time pass faster or to decompress, especially in physically exhausting activities. It was also a way to coordinate the various participants of a collective activity. Depending on the respondents' origin, these activities were mostly: agriculture (i.e. harvests and maize husking); fishing (i.e. seaweed picking); or pastoral (i.e. cattle grazing). Additionally, across all the regions, singing was also associated with festivities, pilgrimages and dancing balls.

> *Older cantadeiras, without any doubt, come from the working fields: from the maize husking, the root crops, the seed sowings… (Miguel, 38, dancer and director)*

> *In those days people used to sing a lot… usually in the working fields… and in Pilgrimages. They used to go and return always singing. (Susana, 36, dancer and director)*

Singing used to be learned during rural tasks, most times outdoors, in groups (polyphonic), and with the older *cantadeiras* who were family. In fact, the FG's *cantadeiras* were usually descendants from other *cantadeiras* or directly chosen in the fields or pilgrimages and invited to join the group.

> *If the mother sung, probably the daughter would sing too… or the niece. Because singing passed from generations to generations. (Pedro, 27, instrument player and dancer)*

Independently of the learning process, the respondents persistently stressed that singing was a natural behaviour, fully integrated with daily activities and thus practiced during several hours a day.

Currently, folklore is predominantly practiced and widespread in FGs, and mostly presented as a performance activity. Therefore, comparing with the past, the role of the *cantadeira* and her singing acquired totally different dimensions. Considering present as an enlarged period including the last two decades, respondents reported that younger *cantadeiras* commonly learn to sing folk within the FG context (n=19; 54%).

> *She [the young cantadeira] is formed here. It has that inconvenient… I mean, she is coming from zero, it's only beginning. And so, she doesn't bring with her that traditional characteristic, which is so important to us … and which was the key characteristic. (Afonso, 55, dancer and director)*

This learning process is therefore quite different from the past. Many respondents (n=15; 43%) believe that the *cantadeiras*' voice, besides their innate personal nature, also have a learned one. However, the learning process should be done within traditional and rural activities, and not in a FG. Therefore, these interviewees concluded that today is very difficult to find young *cantadeiras* with vocal features compatible with the region's folk identity. The absence of experience in traditional activities and the limitation of their voice training to rehearsals and performance periods are the most frequent explanations (n=14; 40%).

> *Let's see, the cantadeira… there is a natural gift that is born with her. And then, she starts tuning up her voice. The more she sings, the more she tunes her voice. (Fernando, 61, dancer and director)*

> *They [older cantadeiras] had the farming, and they worked and sung at the same time. They had a training that maybe does not exist nowadays. We practice when we come to the rehearsals, but during the day we don't sing as we were used to. (Isabel, 43, cantadeira and dancer)*

Likewise, the similarities between present and past voices were explored, and the majority of the participants (n=23; 66%) agreed that they are different. Some interviewees (n=8; 23%) explained that the voices of old-days' *cantadeiras* were better than the present ones because of their typical features, proper of rural singing.

Currently, group singing is the main activity to prepare voices to sing folklore. Also, in some FGs younger *cantadeiras* listen to old recordings so that they can imitate older *cantadeiras*.

> *For instance (...) at the beginning, when I joined the group, I spent the day singing at home to see if I fitted the songs. Then, listening to music [recordings], I've started to sing along, and sometimes I could actually get my voice up to the high notes. (Sofia, 30, cantadeira)*

Several respondents also mentioned that the modifications in the way of singing were connected to external influences (n=9; 26%), namely: (i) formal teaching of music/singing in schools (n=5; 14%); and (ii) practice of other musical styles (n=4; 11%).

The formal teaching of music and singing is pointed out as something that, unlike in the past, it begins to take place in parallel with folklore activities. However, it is not always seen as a positive contribution to the development of this musical style.

> *The voice today is more educated… some years ago musicians used to play and learn by hear. Not anymore… today they go to music schools and have a formal learning. And also, as all we know, there are singing classes and, certainly, the voice will become more educated. And all that naturally will be reflected [in folk style] (José, 57, dancer and director)*

> *I can assure you that when they get out from those schools they will know less than they did when they came in (…) Because folklore can't be learned in music classes. (Joaquim, 68, instrument player and director)*

Apart from singing in a FG context, some *cantadeiras* also sing (or sung) in other groups, usually church choirs. It is often in this context that they first learnt to sing and were identified as having a good voice.

> *Today the cantadeira's selection is done looking at those who sing in the church. There you can see: if the girl can sing there, it also may sing in the folk group. (Joaquim, 68, instrument player and director)*

Finally, another type of external influence that may had contributed to changes in the way of singing is the practice of different singing styles, which may be closer to the musical identity of the younger *cantadeiras'* social group, including karaoke.

> *Formerly it was just folklore, and they would prepare only for folklore. Not now. Now they have other types of activities. (...) Karaoke, for example. Because of the influence of these other activities, the way of singing changed. (Ricardo, 37, dancer)*

The following section concerns a brief discussion of the results concerning the telephone questionnaires, the handed in surveys and semi-structured interviews.

3.4. DISCUSSION

3.4.1. DISCUSSION 1: TELEPHONE QUESTIONNAIRES

The age of the FGs which responded to the telephone questionnaires seems to corroborate the results of previous studies: the majority of FGs where created after 1974 (Castelo-Branco, et al., 2003); in AM, most FGs (around 65%) were created after 1980, in a period were a great social and economic transformation occurred: many traditional rural activities were abandoned and the lifestyle of populations changed dramatically (Barreto & Pontes, 2007; Rosa & Chitas, 2010). The creation of new FGs in the 80's seems to confirm previous evidence of a high folklore activity in Portugal after the political transition occurred in 1974. The creation of new FGs continued during the 90's, and got even stronger in the decade of 2000. Although information on the number of FGs created after 1998 could not be found in the literature, the results of this investigation suggest that folklore activity in AM continues to grow.

It was interesting to observe that, the number of young members in the FGs (i.e. under 18 years old) is around 31%. This corroborates previous findings where a similar percentage (around 32%) of young participants in folklore activities was also found (Castelo-Branco, et al., 2003). However, considering data from the literature (from 1998) and our own (from 2010), one may see that a large number of elements in the FGs was born after 1980 (over 60%), and many of them in the 1990 and 2000 decades (over 30%). Thus, there is an important age gap between the date of creation of many FGs and the age of their current members. This might have consequences on current performance practices. Previous authors have highlighted the fact that, even before 1974, there was a certain difficulty in keeping performance practices of FGs faithful to the original ones (Vasconcelos, 2001). Nowadays, with the increasing number of younger members, this difficult can even be more relevant, especially concerning voice use. The current influences of urban music styles and the easy free access to different musical genres may lead to unavoidable processes of acculturation, thus modifying traditional practices (Martí, 2004; Nettl, 1955).

The mean number of members in a FG (mean=50.8) was shown to be higher than the one reported previously (mean=44.2) (Castelo-Branco, et al., 2003). Also, the total estimated number of FGs members in AM (n=4 826) is found to be considerably higher than the estimated one, based on the reports of previous research (n=3 670) (see Chapter 2). Coastline / Lima Riverside presented the highest number of elements. This is also the region

where more and older FGs exist. These FGs also present the highest number of performances abroad, demonstrating the external recognition which seem to exist in these particular districts.

Concerning gender distribution, one may estimate the existence of around 700 female singers in AM FGs, including approximately 190 *cantadeiras*. This number (n=722) is comparably higher than the one presented for male singers (n=361), and may be explained by the traditional role of women in singing (Azevedo, 1997; Sampaio, 1929). Male soloist singers also exist (n=125), showing that most FGs also perform repertoire sung by men. This, however, might constitute a recently adopted practice as, according with some reports in the interviews, traditionally men were more often associated with instrument playing rather than with singing[26]. This seems to apply as six FGs reported deliberately not to have male soloists at all. Only one FG (from Viana do Castelo) did not have any soloist *cantadeira*, justifying it with the difficulties in finding singers with vocal abilities to sing in solo.

In summary, one might say that the results of this telephone questionnaires pinpointed three important conclusions regarding FGs characterisation: (1) females still have a major role in singing, although there is a trend for male soloist singers to engage also in this role; (2) increasing numbers of recent FGs were found; (3) young members also joint FGs, and their numbers are also raising, suggesting that folklore activities will continue to be a representative part of Portuguese musical culture.

3.4.2. DISCUSSION 2: HANDED IN SURVEYS

Handed in surveys were carried out with 13 directors of FGs in AM. The aims were: (a) to describe FGs' in terms of constituting members; (b) characterise their performance practices (e.g. repertoire, dancing, instrumentation, singing habits, spatial distribution of FGs members); (c) establishing relationships between performance practices and *cantadeiras*' voice use. Generally speaking, these aims were achieved, and rich and valid information was obtained building up on existing knowledge.

[26] One should also note that today there are several women playing instruments, which used to be a male role, according with the interviews.

FGs in AM are constituted by a higher number of female members as compared with other FGs around the country. The male/female ratio found was of 0.78, which is somewhat inferior to the one found in INET-MD's study: 1.12 (Castelo-Branco, et al., 2003). This result was explained by many directors as being a consequence of decreasing numbers of men and couples in AM region due to recent emigration associated with the present economic situation of the country.

Considering members' roles within FGs, there are slightly more dancers (50%) and considerably fewer singers (16%) when compared with other TMGs around the country (46% and 23%, respectively) (Castelo-Branco, et al., 2003). The number of instrument players and other roles were found to be similar to the ones found for TMGs (20% vs 23%, and 10% vs 13%, respectively). Bearing in mind that the *cantadeira*, besides being a singer, constitutes also an icon of FGs in AM, the results here presented seem to indicate that their number is quite small when compared with other FGs members. This can be related with, on the one hand, the difficult in finding singers with a suitable voice quality to be a *cantadeira*, and, on the other, the growing importance given to dancing, with its varying choreographies and dancers (the same does not apply to *cantadeiras*, who are usually the same for all pieces).

The musical repertoire to be performed mostly represent the choreographic repertoire of AM region, corroborating previous reports (Sampaio, 1929). However, other folk repertoires identified in the literature, as old romance songs, pilgrimage songs and *terno* songs, were not referred in this handed in question. Some of this non-mentioned repertoire may actually exist in some activities carried out in specific occasions (e.g. street performances in the low season, as in Christmas or pilgrimages). However, the survey focussed mainly on stage performances (the most often in FGs), so this type of repertoire may have remained unreported.

Similar sound characteristics for all groups were reported. This may be related with the fact that FGs do not present relevant differences on instrumentation used in the traditional orchestra (or *tocata*), as indicated in previous literature (Artiaga, 2010; Carvalho, 2010; César, 2010; Morais, 2010; Raposeira & Castelo-Branco, 2010). The results here discussed corroborate previous descriptions that concertina is the most frequent instrument (Raposeira & Castelo-Branco, 2010) in FGs. It is possible that the use of this instrument also contributed to the development of specific voice characteristics in *cantadeiras*. Although only speculative, the concertinas' frequency, intensity and timbre may act upon

how female soloist use their voices, in order to cope with this loud accompaniment. This influence of accompaniment on voice use is not new. For example, the singer's formant cluster found in classically trained male voices (Sundberg, 1974) is a physiological and acoustical phenomena related with the need that these singers have to be heard above a loud orchestral accompaniment. There is a cluster of formants F3, F4 and F5 around 2.5 kHz and 3.5 kHz (depending on whether the singer is a Baritone or a Tenor), right within the frequency zone where the human hear is most sensitive (i.e. 2 and 5 kHz), resulting from the lowering of the larynx and the enlargement of the pyriform sinuses (Sundberg, 1987). So, the voice is heard despite the loud accompaniment and the absence of a microphone (Sundberg, 1987). One might argue that, similarly, *cantadeiras* might have a rather unique voice timbre and intensity for comparable reasons, although applying completely different physiological and acoustical strategies related with being a women and with singing in acoustical environments quite different from classical singers.

Cantadeiras are placed on stage right beside the concertinas, substantially impacting with their self-to-other ratio (SOR) (Ternström, Södersten, & Bohman, 2002) and certainty creating a Lombard effect[27] (Tonkinson, 1994). When singers are singing in a choral ensemble, they prefer a high positive SOR, which means to hear themselves more than the others (in this case the whole sound of the group). This applies specially to female high voices (sopranos). Female singers' feel less vocal strain when being broadly spread in a choir, so their voice production is not so much affected by the proximity of other fellow singers (Daugherty, 1999). Thus one might argue that *cantadeiras* would benefit, in terms of less vocal strain, if placed somewhere else in the group. The Lombard effect, would also contribute to this vocal strain. C*antadeiras*, not being trained singers, may have difficulties in coping with the Lombard effect (Tonkinson, 1994), and may naturally raise their voices in the presence of these loud sounds of the *concertinas*. Such vocal adaptations are certainly a very interesting phenomenon to investigate. The remaining instruments of *tocata* are well-known traditional instruments, with the exception of the accordion, that may not be considered as a traditional instrument (Raposeira & Castelo-Branco, 2010). This might be one reason for being played by few FGs.

[27] Lombard effect - Phenomenon in which speakers/singers increase their vocal levels in the presence of a loud background noise and make several vocal changes in order to improve intelligibility of the speech signal Therrien, A. S., Lyons, J., & Balasubramaniam, R. (2012). Sensory attenuation of self-produced feedback: the Lombard effect revisited. *PLoS One, 7*(11), e49370, Tonkinson, S. (1994). The Lombard effect in choral singing. *J Voice, 8*(1), 24-29.

The understanding of the performance practices of the FGs was another aim of this handed in survey. While few FGs (n=2) may have a great number of annual national and international performances, possess structured rehearsal practices, and are quite worried with aesthetics of the sound they produce, the remaining groups may be more relaxed about these questions and so be regarded as "less professional". These different strategies may also affect the *cantadeiras*' voice use. For example, the reported absence of adaptation of the *tocata's* intonation system to the *cantadeiras*' vocal range and tessitura[28] may be responsible for *cantadeiras*' vocal strain. Only few groups have this question in mind, the main reason being limitations imposed by *concertinas*' tuning system. The solutions were: (i) to have more than one concertina, tuned in different keys (an expensive option that not every FG could support); (ii) to substitute the concertina by the accordion, although this seemed controversial, as the absence of a concertina may also impact on *tocata*'s overall sonority and on FG's identity; or (iii) to exclude the concertina from some songs, as it happened on early 20th century in Portugal, previously to the introduction of this instrument in the country.

Voice warm-ups and cool-down exercises were not part of FGs practices. FGs, unlike other vocal groups such as amateur choirs (Tavares, 2011), seem not to care as much about vocal health, or vocal efficiency. FG performance practices seem to regard voice use as close as possible to daily-life voice practices. When the voices get tired, less demanding or interesting repertoire is played to avoid the *cantadeira*'s vocal overload. One of the goals of this enquiry was also to understand whether voice problems exist among FG singers, especially those who are soloists. Few cases of vocal problems were reported: two cases of permanent or transitory vocal trouble that required voice treatments. Potential risk factors that were spotted included: (i) effortful voice use, associated with both high frequency and intensity singing, and with possible competition with the *tocata* accompaniment (especially with the *concertinas*); (ii) absence of warm-ups, both in rehearsals and in performances; (iii) absence of adaptation of the *tocata* to the singers' vocal range, timbre and intensity; (iv) absence of voice rest of soloist singers, who are often the same in all pieces of the repertoire (unlike what happens with dancers); (v) absence of voice care, especially when singing in poor acoustic conditions (e.g. street performances); (vi) extra voice load during the high season (due to the number of performances and rehearsals after a period of rest); and (vii) frequent travelling, with voice use out of the performances.

[28] Tessitura - The average pitch level of a song or part of a song in relation to the overall range of the (vocal) instrument. Titze, I. R. (1994). *Principles of Voice Production*. New Jersey: Prentice-Hall.

As expected, one might say that FGs performance practices greatly influence vocal behaviours on vocal use of their *cantadeiras*. This seems to corroborate the initial proposed model of this study: one should not investigate singing ignoring its performing contexts. In fact, subjective interpretation of a given human construct should take into account its related contexts attribution (vanDijk, 2008).

3.4.3. DISCUSSION 3: SEMI-STRUCTURED INTERVIEWS

This study aimed at understanding and describing current vocal practices of *cantadeiras* of FGs from AM, Portugal. Particular attention was given to their vocal characteristics, their attributes and functions within the FG, considering the changes occurred in the last decades.

Semi-structured interviews were shown to be a suitable method to obtain valid data; the study sample was able to represent a large diversity of opinions from FGs' members. However, FGs with lower level of performance experience and fewer years of existence were not included, so some specific phenomena from these particular contexts may have not been represented by the participants' testimonies.

According with the literature, most transformations in folk performance have been attributed to the folklorization process, described during the second and third quarters of the 20th century (Castelo-Branco & Branco, 2003). However, none of these reports referred to this phenomenon (directly or indirectly), possibly because it already was implemented when most of the respondents jointed a FG. In fact, the participants' age seemed relevant when describing singing practices of the past: a) people with more than 60 years spoke about their own experience as singers and/or participants in rural activities; b) people between 40 and 60 years usually spoke about what they used to observe during their youth; and c) people younger than 40 years usually made descriptions based on what they have heard or on experiences shared by family members. As consequence, many young elements never experienced the life conditions of previous generations, and their references about traditional singing are diminished. This observation confirms the tendency shown in the telephone questionnaires, as much of the elements in current FGs were born after 1980. Therefore, recent transformations further discussed should be analysed in a different paradigm, the one reflecting social and cultural modifications occurred after 1974 (Barreto

& Pontes, 2007; Rosa & Chitas, 2010), which might be seen as a new (modern) period of the folklorization process.

Cantadeira's vocal identity seems to be of paramount importance to define the identity of a FG in AM. Some of the most important features expected in *cantadeiras*' singing were: good voice, proper word pronunciation, rural and old accent, ability to adjust to instrumental tuning, good vocal extension, loud voice and a good sense of rhythm to act as a coordinator between all constituting elements of FGs. Other important voice characteristics were: sing high pitch notes in chest register, loud voice with high but non-excessive vocal effort, and thin voice.

These results seem to confirm the existence of a representative or, according to the expression used by FG members themselves, a typical voice (*voz típica*). In one of the oldest (and singular) documents referring to Minho *cantadeiras*' voices, one can find that *«(…) there are naturally lots of poor, of sufferable and good cantadeiras (...)»* and that *«(...) the most necessary and appreciated qualities in the execution of these choirs are: tuning, sonority and sustaining notes (...)»* (in Sampaio, 1929, p. 1)[29]. This description refers to polyphonic vocal performances and not to the solo performances of today's FG *cantadeiras*, so it may not provide information on what is currently considered typical.

Rodney Gallop, a British diplomat and folk music scholar which documented music traditions in a large part of the country in the 1930s, made descriptions of Minho women as having an important role in music. Their voices were "strident, high pitched and nasal" and their volume was "unbearable in a closed room, but suitable for open spaces…" (Gallop, 1960, pp. 24-25). These characteristics, excepting nasality, are consistent with the descriptions found in our results, showing that probably most relevant voice features still exist in present days.

The high pitch and loud voice mentioned in the interviews confirm previous descriptions (Muszkalska, 2000). However, the concept of 'squeaky voice' (*voz esganiçada*), often used to characterise those *cantadeiras*, acquired a new meaning according to these testimonies. Vocal effort is a common and well-accepted vocal characteristic, although excessive vocal effort may mischaracterise this singing style. Effort must not be used to obtain two other important features: loudness and a 'thin' voice. A loud voice must be obtained using chest

[29] *«Claro está, pelo respeitante à execução, que há naturalmente lotes de más, de sofríveis e de boas cantadeiras; mas as qualidades mais necessárias e que mais se apreciam na execução destes coros são: afinação, sonoridade e sustentação das notas, qualidades que chegam a ser realmente perfeitas nos grupos mais adestrados.»* Sampaio, G. (1929). Cantos Populares do Minho.

register, even when singing higher notes. This description is also seen in other singing styles, such as *belting* (a deeper description about *belting* characteristics was provided in section 2.5.3) (LeBorgne, et al., 2010). Possibly *cantadeiras* in AM might share some similar vocal strategies. The 'thin voice', a specific timbre characteristic, might be related with some sort of resonance strategy which reinforces the energy of higher harmonic partials, producing the perception of a high pitched voice, even when the tone is only in the middle of the female range. This phenomenon was previously found in other folk styles, as the ones in Sweden (Johnson, 1984) and Bulgaria (Henrich, et al., 2007), both performed by women, and in Croatia (Boersma & Kovacic, 2006), performed by men.

Although most singing features were already known, some of them were described here for the first time. This is the case of the old northern accent, which was highly valued as typical and now fading feature. A relevant number of interviewees where focused on the importance of understanding the songs' lyrics but also on preservation of the old speaking manner. *Cantadeiras* should replicate accents, expressions and linguistic structures of the past. In this case they should consider sociolinguistic variations of different nature: (a) geographical/regional differences (i.e. dialects); (b) social strata (in this case, the lower ones); and (c) time or period of the original songs (Bussmann, 1996; Mateus, Brito, Duarte, & Faria, 2006). As consequence, it would be important in future research to collect and/or analyse old speech and singing registers, and proceed to phonetic transcriptions, to accurately define which characteristics each region and period have regarding their accent. This could constitute valuable material to train younger *cantadeiras* to adapt their speech patterns to folk singing.

Not only accent was described as a problem of younger *cantadeiras*. Also, the most typical vocal characteristics were reported to be more frequent in older *cantadeiras*. In fact, it was clearly assumed that today it is hard to find young women able to produce such similar voices. The lifestyle, the context where the singing is performed, the learning strategies and the musical culture are very different in our days, and may be responsible for potential losses in the typical voice characteristics of the *cantadeiras*, in a near future. Relationship between representative voice levels and voice characteristics are further explored later on in this research.

The role of *cantadeiras* also suffered transformations during the past decades. Unlike the old days, when singing was a personal and social current expression in daily life, today the *cantadeira* assumes several other functions besides singing. The skills of the *cantadeira*

are of paramount importance to the group overall performance, but there is a relevant interdependence between all members, according with individual particular roles.

The dynamics of FGs seem to fit in the definition described by Johnson & Johnson (2006) of a group, which includes individuals that: (i) interact; (ii) perceive their own social unit; (iii) are interdependent; (iv) have mutual influences; (v) accomplish a common goal; (vi) fulfil individual needs in group; and (vii) are related in a hierarchical structure, based on a set of established roles and norms. Interdependence between FG members was evidenced by those participants assuming that all members are equally relevant, and *cantadeiras* have not a distinctive role in the group. However, most reports showed clear expectations about the *cantadeiras* skills, supporting the existence of different roles within the groups. Mutual influences were also evident for members reporting that *cantadeiras* should 'fit' in the FG's repertoire and instrumental accompaniment, and that they often need to use uncomfortable pitches and compete with instruments sound load. These considerations support the belief that to understand *cantadeiras* voice use, not only their individual behaviour must be studied, but also their FG background.

Much of the existing dynamics of a FG are influenced by family ties (Holton, 2003): many of the participants assumed to have family relations with other FG members. According to some reports, while in the past the *cantadeiras* were frequently recruited from the same families, generation after generation, today this does not happen so often, revealing a possible modification in the oral tradition chain.

The *cantadeira* is still seen as fundamental to the external image of the FG, reflecting the group's identity, with the quality of their voices and the text of the songs. These seem to be the most relevant singing competences. The *cantadeiras*' interpersonal aptitudes are also highly valued by the group. Their ability to manage stress, to communicate and coordinate with other elements, and to expose themselves on stage are seen as essential. This is why some participants assumed that several non-soloist singers remain in the choirs, although they have excellent vocal skills to be *cantadeiras*. Only one FG claimed to have invested in those background *cantadeiras*, and to use strategies to develop their non-vocal skills, in order to recruit them for soloist roles.

Opinions diverge when referring to the importance of formal and informal singing learning processes. Informal processes (i.e. oral tradition and rural experiences) are highly valued, but it is unanimous that today the opportunities and living style do not allow most young women to learn from others, in the fields, and become a *cantadeira* easily. FGs'

traditions are far from the original ones, as claimed by previous authors (Vasconcelos, 2001).

Formal learning processes (i.e. traditional singing classes) have emerged as a welcomed solution to teach nowadays *cantadeiras* the vocal characteristics of a style. However, this opinion was highly controversial. The need for experimenting traditional activities was considered essential to support younger elements to develop a folk cultural identity while learning their roles in the group. On the other hand, formal learning was valued by some other elements, usually younger *cantadeiras* and younger musical directors, which were highly conscious of an eminent cultural loss. Accordingly, the access to specific knowledge and vocal technique, provided by specialised voice practitioners, could provide the tools for voice longevity within this type of singing.

To avoid the disappearance of concertinas, courses have been organised in the last decades to promote concertina learning. The results of such initiative were encouraging (Raposeira, 2001; Raposeira & Castelo-Branco, 2010). Today, concertina is a fashion instrument in AM, and is recovering its importance (lost for the accordion for many years). Revitalising a singing folk style was also tried, with positive results, in a rural region of Serbia (Jovanovic, 2010). Some countries, as Croatia make a serious investment in their traditions and folklore is performed even by professional companies (LADO, 2014). Supporting Portuguese FGs and their *cantadeiras*, and helping them to grow, would certainly be a fruitful measure to contribute to a revitalised new folk generation. In the particular case of AM, organising activities combining informal and formal learning processes including not only the *cantadeiras*, but all the FGs, might be a balanced way to promote typical singing in the region and to support the *cantadeiras'* needs.

3.5. SUMMARY

This part of the thesis consisted of three studies that, combining both qualitative and quantitative methods, explored demographic characteristics and performance practices in AM FGs contexts and, more specifically, the *cantadeiras*' voice characteristics and their role within the FGs.

Using a telephone questionnaire, FGs from AM were characterised in terms of experience, age of their members, number of singers and number of performances/ year. Most of the

results are in accordance with those presented in previous studies, pinpointing AM as a region with a high number of people currently joining the folklore movement. Although Viana do Castelo and Ponte de Lima are the districts gathering higher number and older FGs, the AM region as a whole seems to have a dynamic folklore movement, including more than 1000 male and female amateur singers (near 200 *cantadeiras*). There is a considerable youth representation within the FGs, which ensures the continuity of these folklore traditions. On the other hand, because over 60% of the FGs' elements were born in the past three decades, and may have had little or no contact with rural traditions, it is possible that traditions are changing and influencing the practice of folklore in the near future.

Handed in surveys with FG directors were carried out to describe FGs' organization. Detailed information on rehearsal and performance practices were described. Several factors were identified as potentially influencing *cantadeiras*' voice use: traditional orchestra instruments, rehearsal and performance orientations, tuning system, use of amplification, stage distribution and voice habits.

Semi-structured interviews carried out with FG elements have shown that inside the FGs community there is a "typical voice" profile attributed to the *cantadeiras* of AM. This profile includes singing in high pitches, with high intensity levels, using chest register, a strident timbre and a regional old accent. These features seem to be explained by natural talent but also by some vocal learning. Nowadays, voice use is claimed to be different from the one described in the past, and people believe that younger *cantadeiras* no longer maintain the characteristics of the old *cantadeiras*. According with several opinions and with some national and international experiences, the necessary actions to revitalise AM folk singing could combine formal and informal learning processes.

CHAPTER 4

PILOT STUDY

4. PILOT STUDY

4.1. INTRODUCTION

Previous chapters discussed investigations on traditional non-classical singing. It became evident in the systematic literature review (Chapter 2.5) that different recording protocols and methods have been used in several studies. While this may have served the purposes for their research questions, the use of different methods complicates or even prevents comparative studies. The following chapter aims at developing a recording protocol that could serve as a guideline for other studies to come concerning the study of folk voice, so that cross-cultural studies can be carried out. The following recommendations emerged from the results of previous studies. First, the singer must be representative of the style. Second, as most folklore singers are not formally trained, a single recording of a song or a task might not be sufficient. Third, the recorded vocal tasks should belong to the singers' usual vocal practices; for example, singing a scale or a triad may be a totally exotic task, evoking a non-representative vocal behaviour. Fourth, the recording settings may consider including listening to an accompaniment, as singers may be used to sing with accompaniment or with other singers.

To test the outcomes of a research protocol that may follow these recommendations, the chapter here presented explores a specific recording protocol, tailored for analysis of voice function in AM Portuguese traditional singers, and possibilities of comparison of these results with those on other non-classical singing styles. Therefore, this protocol was tested aiming to: a) understand if amateur / non-educated singers (*cantadeiras*) could accomplish it; b) explore the voice measures extracted from the recordings; c) determine adaptations needed to improve the protocol for the following research phases.

4.2. METHODS

4.2.1. SUBJECT SELECTION

The singer included in this study was selected from previous contacts with FGs, made during data collection described in Chapter 3. She was a soloist *cantadeira* with 65 years old, from Vila Nova de Cerveira, which had more than 30 years of experience singing as soloist *cantadeira* in different FGs. She had never had formal voice training and learned to sing based in oral tradition in a rural context: she came from a family with old traditions in female folklore singing. She also participated in other non-public activities, performing *a cappella* polyphonic singing. During the selection process she was submitted to a preliminary voice assessment made by a speech pathologist (the author) using a perceptual protocol and acoustic analysis. All voice parameters were normal and there was no previous history of vocal problems. The singer was then invited to participate in the study and signed an informed consent.

4.2.2. RECORDING PROTOCOL

The recording protocol was specifically developed aiming at obtaining descriptions of voice production of this *cantadeira* during folk singing. The tasks included in the protocol (presented in Table 14) were chosen to cover multiple aspects of *cantadeira*'s voice.

Table 14. Identification and brief description of the tasks included in the preliminary protocol

Task identification		Task content
1	Spontaneous speech	Speech sample in conversational speech mode
2	Glissando	Soft and loud glissandos covering the entire vocal range
3	Singer's chosen songs	Traditional song(s) chosen according to the singer's preference
4	Reference song	*Rosinha do Meio* (well-known traditional song)
5	Reading lyrics	Reading lyrics of the reference song *Rosinha do Meio*
6	Reference song in [pæ]	*Rosinha do Meio* sung with the syllable [pæ]
7	Repetitions of [pæ]	Repetitions of [pæ] sung as diminuendos in low, medium and high pitches

Task 1, "spontaneous speech", intended to record the singer's daily voice use pattern. It was chosen to serve as individual reference to assess the modifications made during

singing activities. To get spontaneous speech samples, the *cantadeira* was asked to talk about her daily life activities and her life experiences related with folk singing. In this task only audio and ELG signals were used. The recording had a duration of approximately 60 seconds, in order to allow for a reliable LTAS (Lofqvist, 1986).

Task 2, entitled “glissandos”, was chosen to determine the frequency range profile of the singer. Ascending glissandos were asked to be sung using the vowel [i] and descending ones using the vowel [u]. Those vowels were selected because they cause opposite configurations of the vocal tract: the [i] elevates the larynx and [u] lowers the larynx, which facilitates reaching higher and lower tones, respectively (Sundberg, 1987). Only audio and ELG signals were collected and analysed for this task.

For task 3, the singer was asked to choose one or two songs where she felt comfortable and which represented what she considered to be near her best singing of AM folk style. Because of this, the task was named “singer’s chosen song(s)”. The *cantadeira* chose two different songs, named *Espanhol* and *Gota*, both typical from her birth region. The tone of the song was chosen by the singer, and the song was performed with no instrumental accompaniment. Again, this task only used audio and ELG signals.

Task 4 was considered a “reference song” because it was chosen by the author, based on a previous analysis of the most common regional songs played by AM FGs. It was also chosen after informally getting the opinion of three FG musical directors and analysing the musical structure of the song. The chosen song is named *Rosinha do Meio* and is classified as a *Vira* (see Chapter 2.3), one of the most traditional choreographic styles in AM. The score (only the refrain part) is presented in Figure 33. The singer was asked to sing the whole song, although the analysed part was only the refrain, constituted by two phrases, repeated eight times during the song. The song has a frequency range of 15 ST, considering all the song, and 10 ST, considering only the refrain part. The tonality was chosen by the singer and no instrumental accompaniment was provided. Similarly to previous tasks, only audio and ELG signals were recorded.

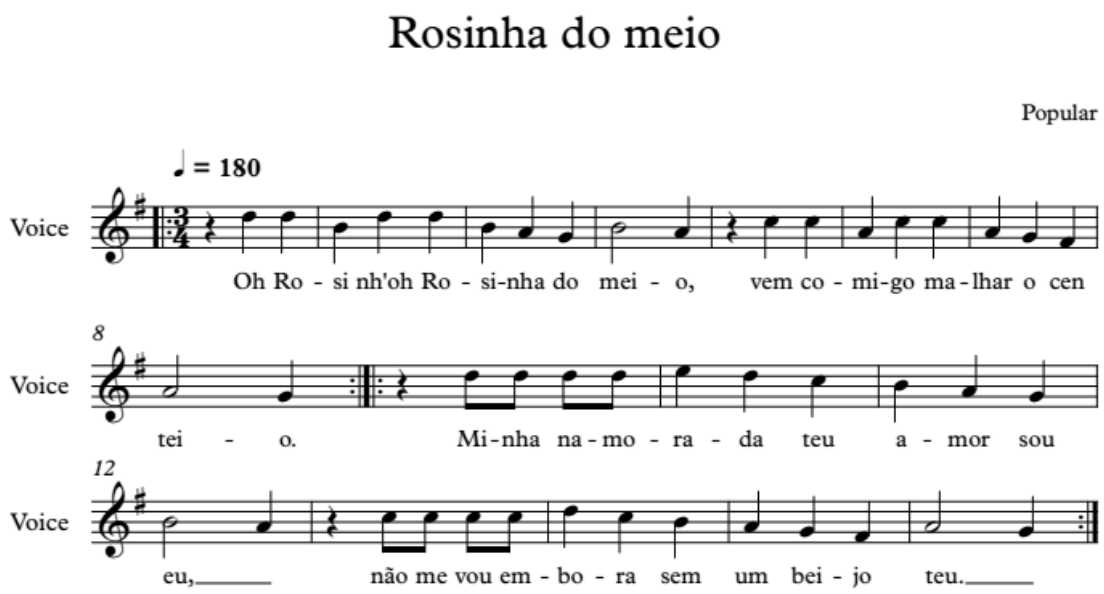

Figure 33. Score of the refrain from *Rosinha do Meio*.

Task 5 is a spoken adaptation of the previous task. It was named “reading lyrics” because only the lyrics of the song were used to obtain an additional record of speech, now using the same phonetic context as the one for singing. The *cantadeira* was asked to read the refrain part of the lyrics, using a comfortable and speech-like pattern, during at least 60 seconds. Again, audio and ELG signals were recorded.

Task 6 is another variation of Task 4: singing the same song, but substituting the lyrics by the syllable [pæ]. The starting note was the same as the one used for Task 4, which was given by a keyboard. No instrumental accompaniment was provided during the song. This task was included to offer complementary information about oral flow and pressure, and also to allow inverse filtering analysis. The occlusion during the [p] production allow the measurement of oral pressure, and thus an estimation of Psub. The vowel [æ] was chosen because it is referred as the best vowel to carry out inverse filtering analysis, since both F1 and F2 are comparatively high (Sundberg, 1987). This task was recorded using a hybrid system, previously presented in Figure 15 (Chapter 2.4), including audio, ELG, flow and oral pressure signals.

Task 7 is probably the most unfamiliar task for a non-classical singer. It was called “repetitions of [pæ]” and was included to allow the estimation of vocal fold motility in terms of PTP and CTP measures. The [pæ] syllable was chosen for the same reasons as

presented for the previous task. The *cantadeira* was asked to produce six renderings of the syllable [pæ] sung as diminuendos in low, medium and high pitches. The tones were determined considering the frequency range obtained in Task 2: medium tone at 50%, low tone at 10% and high tone at 90% of the total frequency range. The reference tones were provided by a keyboard. This task was recorded using four signals: audio, ELG, flow and oral pressure.

4.2.3. SIGNAL COLLECTING SYSTEM

As mentioned before (Chapter 2) there is a large list of choices regarding voice analysis and many of these methods were already applied in describing traditional singing styles. This study intended to analyse diverse aspects of voice production, namely concerning voice source and acoustic characteristics. To fulfil these requirements it was selected a system that allowed multi-signal recording.

The chosen system includes a four channel equipment, comprising: a) audio; b) ELG; c) flow and d) intra-oral pressure. This is a combined system including elements from the Digital Laryngograph Microprocessor (Laryngograph Ltd, London, UK) and the Glottal Enterprises (Syracuse, NY) MS-110 computer interface. The audio signal is collected by a head set omnidirectional Knowles EK3132 electret condenser microphone. The ELG signal is recorded by the Laryngograph device. The flow signal is collected by means of a Rothenberg flow mask and the oral pressure signal comes from a pressure transducer attached to a thin plastic tube inserted into the flow mask. Both the last mentioned signals are recorded by the Glottal Enterprises unit. All four channels were digitised with a sampling frequency of 16 kHz for each channel and sent over a USB contact into a laptop by means of the Speech Studio software (Laryngograph Ltd, UK).

The described system was chosen because the included signals allow the acquisition of the most common voice measures used in other studies, as shown in Chapter 2. The fact of having a unique and synchronised system facilitates data collection and analysis, simplifying the required procedures and reducing the possibility for errors associated with signal synchronisation.

4.2.4. DATA COLLECTION

The recordings were made in a sound treated room in a music school in AM: Academia de Música de Viana do Castelo (AMVC). Previously to the recordings, calibrations have been carried out. Leq was calibrated using a sine tone, the SPL of which was measured at the recording microphone by means of a sound level meter. Also, the flow and pressure transducers were calibrated using the devices provided by Glottal Enterprises. All four channels were digitised with a sampling frequency of 16 kHz for each channel, sent over a USB contact into a laptop, recorded by the Speech Studio software (Laryngograph Ltd, UK) and saved as *wav* files.

The software's real time analysis outputs allowed for visualisation of the signal during the recording procedures, and thus modifications to improve signal quality, if needed. The distance of the microphone to the mouth was adjusted and measured for each task, varying from 6.5 (speaking tasks) to 16 cm (singing tasks). Use of conductive gel and several trials concerning position of the ELG electrodes were needed in order to get a better signal quality.

Figure 34. Photography of the *cantadeira* during a recording session

All tasks were performed in a standing position, as this is the same used by the *cantadeira* in her singing activities (Figure 34). Voice warming up exercises prior to data collection was not done because this is not a common practice in *cantadeira*'s routine. Explanations about the protocol were provided to the *cantadeira* at the beginning of the recording session and before each task.

Overall, special difficulties in gathering a good signal or a good performance at the task were recognised during the performances of tasks 2 (glissandos), 6 (reference song in [pæ]) and 7 (repetitions in [pæ]).

4.2.5. DATA ANALYSIS

The first step in data analysis was to calibrate all recorded files, using the software Soundswell™ (Hitech Medical, Sweeden). The calibration segments of each signal together with the reference values recorded in the file were used to calibrate all signals in every file, using the CAL tool of this software. Additionally, the ELG signal was high passed filtered and amplified using function EXTRACT. Figure 35 shows an example of a calibrated file of the task 6, presenting all four signals recorded.

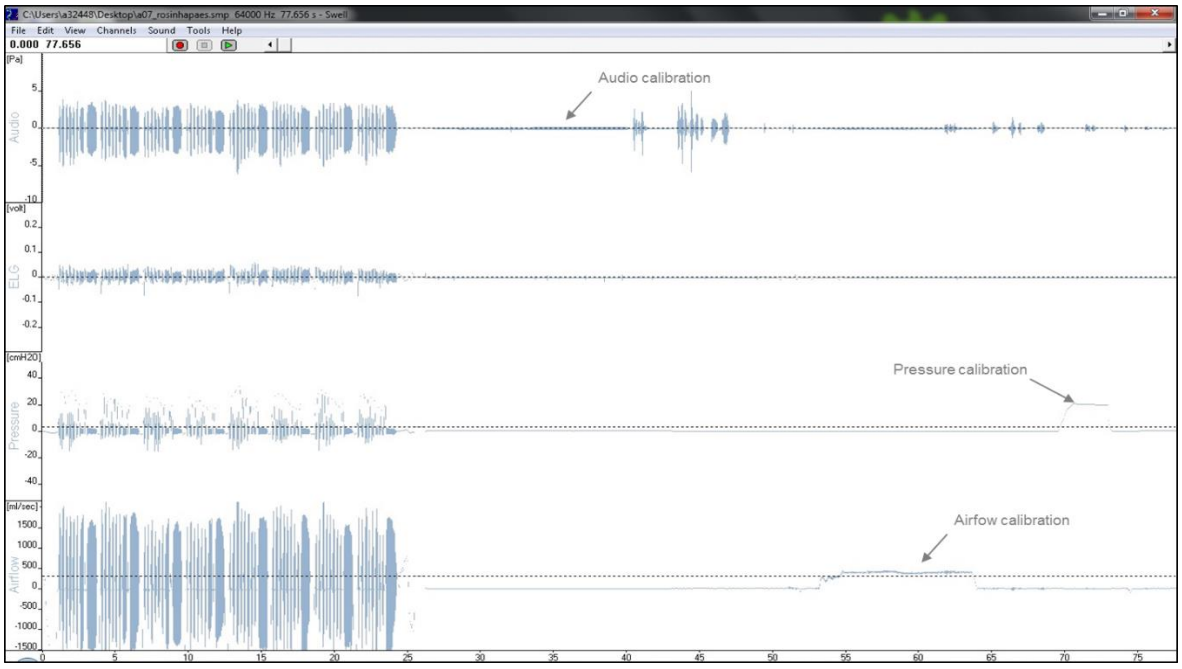

Figure 35. Example of a calibrated file including audio, ELG, oral pressure and flow signals. Task 6. *Cantadeira* S07.

Then, the frequency range was measured and F0 extracted using the PRAAT software, version 5.2.35 (by Paul Boersma) for tasks: *(2) glissando*, *(1) spontaneous speech*, *(5) reading lyrics*, *(3) singer's chosen song* and *(4) reference song*. For the last mentioned tasks, mean F0 was also measured using the same software, as well as the first and third

quartiles (Q1 and Q3) as distribution measures of the data. F0 data were finally converted from Hz to a ST scale.

Leq and LTAS were extracted using Soundswell, from tasks *(1) spontaneous speech*, *(5) reading lyrics*, *(3) singer's chosen song* and *(4) reference song*, using the Spectrum Section tool. An analysis bandwidth of 400 Hz, a 0-6 kHz frequency range, Hanning window and 112 FFT points were used. Data was then exported to Microsoft Excel. The segments selected in each file for data analysis included all the recorded speech/singing tasks with a duration between 60 and 120 seconds. The different distances of the microphone to the mouth were taken into account and data converted to the standard 30 cm distance used in previous studies (Nordenberg & Sundberg, 2004). LTAS was then used to calculate alpha, Leq and $(H1\text{-}H2)_{LTAS}$ measures.

To analyse oral pressure signals, data was extracted from task 6*, reference song in [pæ]*. Psub was determined as an estimation of oral pressure during the [p] occlusion. Pressure values were taken from the flat higher segments of the peaks in the signal. Only refrain parts were analysed. ELG signal was used to extract F0 from the same segments used for Psub analysis.

The following process involved inverse filter of the flow signal in the refrain part of the task *(6) reference song in [pæ]*, using the custom made DeCap program (Svante Granqvist, KTH). In the present application, the program displays the inverse filtered waveform of the audio signals (i.e. flow glottograms), the derivative of the ELG signal, and the spectrum before and after the inverse filtering. A ripple-free closed phase and a smoothly falling source spectrum envelope, void of dips and peaks, were used as the criteria for tuning the inverse filters. Only segments with a minimum duration of 400 ms were filtered. Because the song had very fast segments it was only possible to extract reliable data from longer syllables, usually located at the end of each phrase, totalising seven filtered samples. From the results several measures were extracted, including: Q_{closed}, NAQ, MFDR and H1-H2. Data were then exported to Excel and analysed by means of tables and graphs.

The last analysed data concerned measures of PTP and CTP, taken from the oral pressure signal in task *(7) repetitions of [pæ]*. However, this was not possible because the singer was not capable of varying loudness while maintaining the same pitch. Usually she tended to increase pitch with increasing loudness.

4.3. RESULTS

Figure 36 summarises the median and interquartile differences for F0 of all recorded tasks. The overall range covered a total of 36 semitones (three octaves), from B2 (≅ 123 Hz) to B5 (≅ 988 Hz), measured in both ascending and descending glissandos. Speaking tasks showed a wide range, spontaneous speech being the greatest range (between C3 and C#5). The mean F0 values in the singing tasks were located in the medium and higher parts of the singer´s pitch range. The reference song presented the lowest F0 range, less than one octave wide (Eb4-C#5).

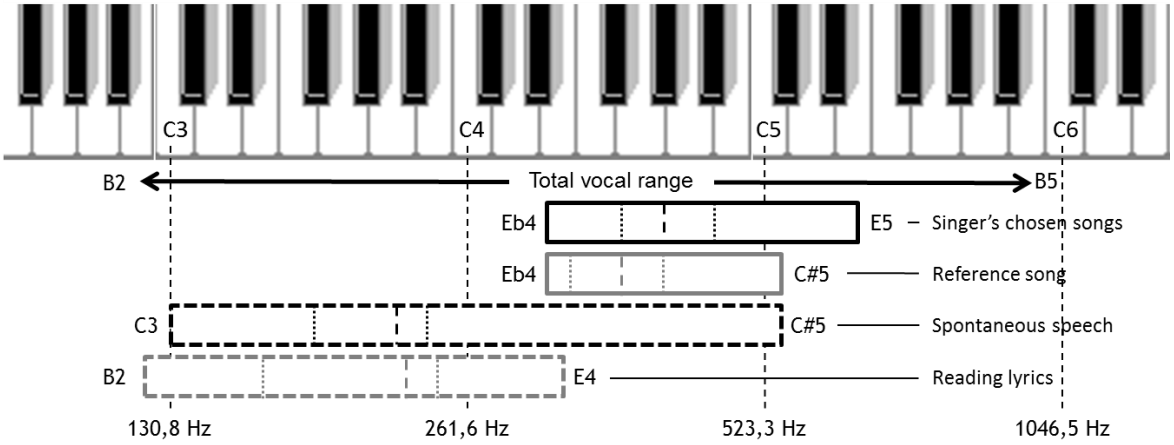

Figure 36. Frequency ranges of the recorded vocal tasks. Within the rectangles the dotted lines refer to the first and third quartiles, and the dashed line to the median.

Table 15 summarises results for F0, Psub, MFDR, NAQ, H1-H2, Q_{closed}, Leq, alpha and $(H1-H2)_{LTAS}$. The lowest mean F0 was observed for reading lyrics (210 Hz) whereas the highest mean F0 was found for the singer's chosen songs (450 Hz). SD values suggest a great difference in F0 variation between the two speaking tasks, being much higher for spontaneous speech than for reading lyrics.

Psub, MFDR, NAQ, H1-H2 and Q_{closed} values were obtained from notes C4, D#4, E4, F#4 and A4, part of the refrain of the reference song sung in [pæ]. The last four measures were obtained by inverse filtering the flow signal. To obtain valid data only long sustained syllables were considered for analysis. Psub was quite high, varying between 20 cmH2O and 30.5 cmH2O (mean = 24.6; SD 2.8); it correlates positively with F0 (r=0.77). These values are considerably higher than those found in a study of pressed phonation in loud singing (Thalén & Sundberg, 2001) as it is displayed in Figure 37.

Table 15. Voice source and spectral measurements extracted for different tasks: fundamental frequency (F0); subglottal pressure (Psub); maximum flow declination rate (MFDR); normalised amplitude quotient (NAQ); H1-H2; closed quotient (Q_{closed}); Leq; alpha; and $(H1-H2)_{LTAS}$.

Task	Voice source analysis			Spectral analysis		
	Measure	Mean	SD	Leq (dB)	Alpha (dB)	$(H1-H2)_{LTAS}$ (dB)
Spontaneous speech	F0 [Hz] (Audio)	233	82	79.0	-8.83	0.4
Reading lyrics		219	36	80.3	-8.29	4.8
Singer's chosen song		450	76	95.5	5.63	-10.6
Reference song		371	62	89.5	0.32	-12.5
Reference song in [pæ]	**F0 [Hz] (ELG)**	356	57			
	Psub [cm H_2O]	24.6	2.8			
	MFDR [l/s/s]	3088	409			
	NAQ	0.15	0.02			
	H1-H2 [dB]	8.19	1.85			
	Q_{closed}	0.42	0.04			

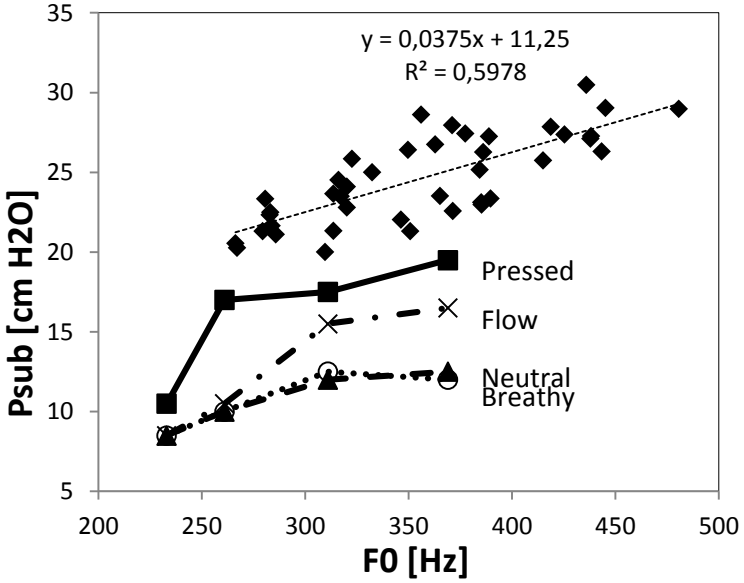

Figure 37. Subglottal pressure (Psub) as function of fundamental frequency (F0) for the reference song *Rosinha do Meio*. Solid, chain-dashed, dashed and dotted curves pertain to data from Sundberg & Thalén (2001) on pressed, flow, neutral and breathy phonation, respectively in loud singing.

As shown by Fant and associates, MFDR represents the excitation of the vocal tract resonator (Fant, 2006). Hence, for a given combination of formant frequencies and F0, MFDR should be closely related to Leq. The average Leq at 30 cm was 89.6 dB (SD 1.8), while the mean MFDR was 3088 (SD 409). Figure 38 shows their relationship: the low correlation (r=0.45) reflects the fact that Leq is determined not only by MFDR.

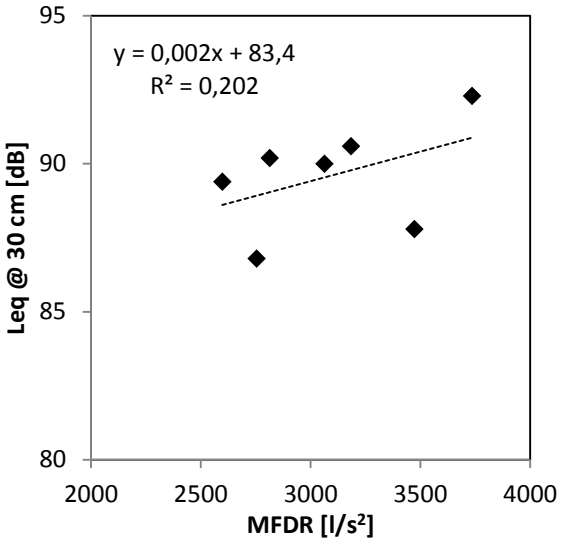

Figure 38. Leq as function of MFDR for the reference song *Rosinha do Meio*

The perceived phonatory pressedness[30] is indirectly reflected in the NAQ, the H1-H2 and the Q_{closed} parameters (Sundberg, et al., 2004). NAQ varied between 0.13 and 0.17, H1-H2 between 5 and 10.7, and Q_{closed} between 40 and 50%. Using equations proposed in a previous investigation describing the relationships between mean rated pressedness and each of these parameters (Sundberg, et al., 2004), the degree of perceived phonatory pressedness could be predicted. Figure 39 compares the predictions based on the Q_{closed} and H1-H2 values with those based on NAQ values. The predicted values are similar. Also, they are strikingly high, ranging between 71 and 105. The similarity suggests that the predictions are reasonably realistic and the extremely high values clearly indicate a pressed type of phonation used by the *cantadeira*.

[30] Phonatory pressedness – Perceptual measure resulting from an evaluation of different degrees of glottal adduction using a continuous breathy-pressed phonation scale. Sundberg, J., Thalén, M., Alku, P., & Vilkman, E. (2004). Estimating perceived phonatory pressedness in singing from flow glottograms. *Journal of Voice, 18*(1), 56-62.

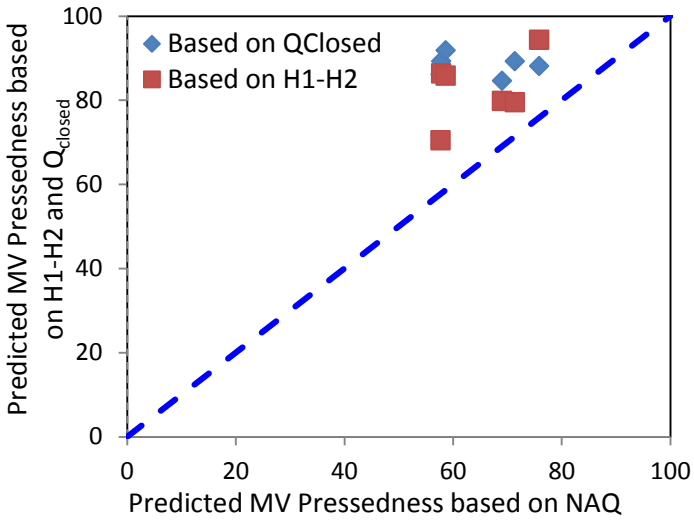

Figure 39. Comparison between perceived phonatory pressedness derived from three equations presented in a previous study (Sundberg, et al., 2004) – dashed line – relating pressedness with NAQ, H1-H2 and Q_{closed}. Square and diamond symbols represent the correlation values between NAQ and H1-H2, and NAQ and Q_{closed}, respectively. MV = mean values.

Comparisons between LTAS for speech and LTAS for singing are presented in Figure 40 (left panel). A clear difference can be observed: both the singer's chosen and reference songs presented a spectrum peak around 1.3 kHz, 5.7 dB louder in the first case. In both spontaneous speech and reading lyrics, a peak at around 4.5 kHz can be observed. The LTAS differences between tasks are illustrated in the right panel of the same figure. As compared with spontaneous speech, the singer's chosen songs, the reference song and the reading lyrics all exhibit a peak near 1.3 kHz. Folk songs show the greatest differences as compared to spontaneous speech between 1 and 4 kHz, amounting to more than 20 dB for the former and 15 dB for the latter. In addition, they exhibit other peaks near 2.3 kHz and 3.2 kHz. The peaks are separated by valleys, possibly reflecting shifts in formant frequencies; hence, a closer analysis of formant frequencies of this material would be worthwhile.

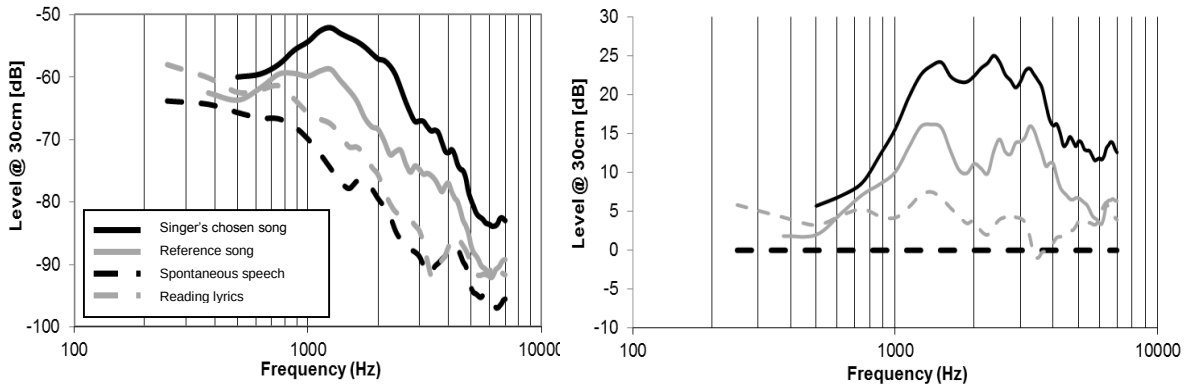

Figure 40. Left panel: LTAS of speech and singing tasks. Right panel: LTAS tasks deviations' from the LTAS of spontaneous speech.

An increase of vocal loudness is typically associated with a decrease of LTAS slope, since under these conditions higher partials gain more than lower partials in the spectrum of the voice source (Sundberg & Nordenberg, 2006). Hence, alpha, reflecting the energy ratio of the LTAS above and below 1 kHz, tends to increase with Leq (Sundberg & Nordenberg, 2006). For this subject, this relationship was almost perfectly linear (see Figure 41); 16.5 dB Leq difference between speech and the loudest singing was associated with an alpha increase of 14.5 dB. It is interesting to compare these data with those observed in untrained female subjects represented by the dashed line in Figure 41 (Sundberg & Nordenberg, 2006). The alpha for the subject's speech is about 6 dB less and for the loudest singing about 1.5 dB greater than the average for untrained speakers. The 6 dB difference suggests that the subject's overtones in speech were much less prominent than in untrained female voices. In singing, by contrast, they were as prominent as for untrained female speakers' speech for this same Leq value.

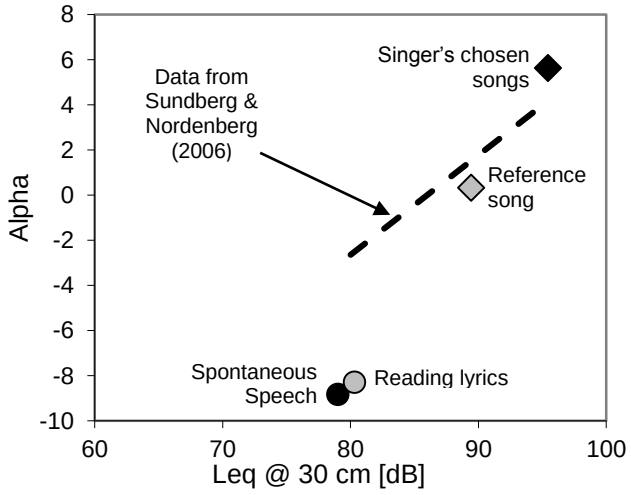

Figure 41. Alpha as function of Leq for the indicated speech and singing tasks. The dashed line represents the mean relationship between these two parameters according to a previous investigation (Sundberg & Nordenberg, 2006).

Also $(H1\text{-}H2)_{LTAS}$ tends to vary with Leq, i.e. the dominance of the fundamental tends to vary with vocal loudness. Figure 42 illustrates this for the singer. LTAS interpretations suggest that F0 (first partial) is much stronger in relation to the second partial for speech than for singing, particularly for the case of the singer's chosen songs. As the first partial becomes less dominant with increasing phonatory pressedness, this suggests that the singer used a rather pressed type of phonation when singing.

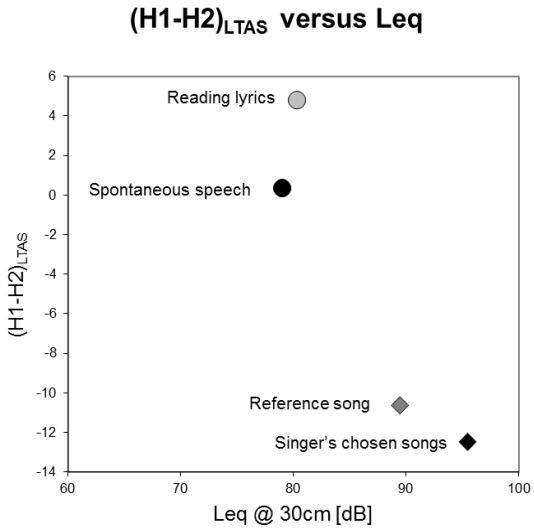

Figure 42. $(H1-H2)_{LTAS}$ as function of Leq for the indicated speech and singing tasks.

4.4. DISCUSSION

The fourth chapter of this thesis consisted of a pilot study, aiming to present and test a recording protocol, purposely developed to study voice function of AM Portuguese folk singers. In this study a protocol was tested aiming to: a) understand if amateur / non-educated singers (*cantadeiras*) could accomplish it; b) explore the voice measures extracted from the recordings; c) determine adaptations needed to improve the protocol for the following research phases.

Previous studies suggest that both phonatory and resonatory strategies should be included when describing for the first time a particular singing style (see Chapter 2). Thus, tasks that yield information on subglottal pressure, voice source properties, and formant frequencies were included, and a four channel recording system with audio, ELG, airflow and oral pressure signals was selected. The recording protocol was then designed to cover several voice tasks, exploring the singers' physiological limits, as well as different speech and singing behaviours.

During this process, one should consider that, for gathering reliable datasets, the singer needs to feel familiar with the vocal tasks. Some vocal tasks designed for classically trained singers may appear as totally strange to singers in other vocal traditions. For example, in

the present case, performing a glissando turned out to be an extremely demanding task: the singer found it difficult to reach extremes of her pitch range.

To repeat the syllable [pæ] sung in diminuendo sequences was also difficult to perform by this single subject. Often, untrained singers and non-singers show difficulties in changing loudness without changing pitch. This was the case also for this *cantadeira* who probably is not familiar with diminuendos in her style of singing. A better alternative could be to sing a given tone at different dynamic levels, e.g., neutral, soft, and loud.

A third problem was to produce the vowel [æ]. This vowel is optimal for inverse filtering analysis, since both F1 and F2 are comparatively high; inverse filtering becomes less reliable when F0 approaches F1 or when F1 and F2 are close in frequency (Sundberg, 1987). However, the vowel [æ] is not included in the Portuguese phonetic lexicon; the singer kept changing between either an [a] or an [ɜ]. For Portuguese folkloristic styles of singing, the vowel [a] would be preferable, as it is the vowel with highest F1 (around 780 Hz, for female speakers) (Escudero, Boersma, Rauber, & Bion, 2009), which allows for voice analysis in higher pitches (until approximately G5). In addition, for inverse filtering it is advantageous that the tasks include vowels with long duration, which was not the case in some segments of the reference song.

The representativeness of the chosen songs within the repertoire of the region under investigation also seems important, so the choice of songs is crucial. Here, the singer was asked to perform three songs from traditional repertoire: two of her own choice, *Espanhol* and *Gota*, and a reference song *Rosinha do Meio*. The former two songs should be representative of what the singer is capable of, while the latter, a well-known song the Minho's tradition, will be representative of the region's repertoire and allow between-singers comparisons in future studies.

No instrumental accompaniment was provided during the recordings. It is possible that this made the *cantadeira* feel somewhat uncomfortable when singing the less familiar song *Rosinha do Meio*, which she sang considerably softer than the other two songs. A similar limitation had already been reported in a study on *country* singing style (Cleveland, et al., 1997). Providing an accompaniment in one ear may reduce this effect and would also ensure that repeated tasks are performed in the same key.

With respect to the speech tasks, including both reading the lyrics of a song and spontaneous speech seems worthwhile for comparison purposes. The comparison will show to what extent the singing style is different from speaking.

Obviously, recording a single subject does not allow for general conclusions. Nevertheless, it provides clear information on what type of vocal tasks and analysis may be performed and useful to carry out on a study with a larger number of participants. Considering that the main purpose of this pilot investigation was to test a protocol for describing AM *cantadeira*'s singing one might summarise the following recommendations for further studies as the main results:

1) the singer needs to feel comfortable with the vocal tasks; in this case it excluded glissando, diminuendo, and vowels not belonging to the singer's lexicon;

2) it is advantageous to record not only songs from the singer's repertoire but also a reference song that is commonly sung in the region under investigation, complemented by the reading of the respective lyrics and also spontaneous speech;

3) it is advantageous to arrange recording conditions as similar to those of a real performance as possible, by, for example, providing instrumental accompaniment in one earphone.

If these considerations are taken into account, the final protocol should allow descriptions of a number of relevant characteristics of this singing style, such as loudness, pitch range, formant frequencies, voice timbre and phonation types. Generally speaking, the protocol was found to be mostly adequate to the research general objectives: the study of the voice function. The usefulness of speech and differentiated singing tasks was demonstrated.

Therefore, results of this pilot study also allow for some descriptions of vocal performance in this type of singing. It seems that some AM songs require around an octave of F0 range, using a high Psub: about 3 to 4 times higher than what is commonly used in conversational speech. Voice source and LTAS analysis both suggested an extremely high degree of phonatory pressedness. The LTAS curves showed a peak near 1.3 kHz, corresponding to the second and third partials of most common notes in the melodies (between 400 Hz and

500 Hz). A somewhat similar LTAS peak was observed in a study of various substyles of *belting*, also found to be produced with quite high Psub (Sundberg, et al., 2012).

Also speech revealed an interesting result: an LTAS peak appeared near 4.5 kHz, somewhat similar to the previous reported "speaker´s formant" that characterises "good" male voices (typically between 3 kHz and 3.5 kHz) (Leino, Laukkanen, & Radolf, 2011; Master, De Biase, & Madureira, 2012).

Summarising, these preliminary results suggest that this *cantadeira´*s singing is rather loud, is produced with high subglottal pressures, has strong partials above 1 kHz and likely to be perceived as having a rather elevated level of phonatory pressedness. However, these findings should be regarded as preliminary and be tested with more subjects, using a recording protocol that takes into account all considerations made.

CHAPTER 5

REPRESENTATIVENESS OF ALTO MINHO CANTADEIRAS VOICES

5. REPRESENTATIVENESS OF ALTO MINHO CANTADEIRAS' VOICES

5.1. INTRODUCTION

In Chapter 4, a pilot study was carried out, involving one experienced *cantadeira*, to test a recording protocol aiming at a larger and more comprehensive study on descriptions of voice function of AM *cantadeira*'s singing. The results allowed the refinement of a recording protocol: the recording tasks and respective analysis allowed interpretations on what voice measures would suit best the aims of the current investigation. After achieving a final protocol design, the following natural step in this investigation would be to proceed with a selection of a representative sample of singers. This was done by carrying out a LT, presented as follows in this chapter.

Perceptual evaluations of voices (or LTs) are widely used, especially in studies with a reduced number of singers (see studies described in Chapter 2). LTs have been mostly applied to describe perceptions of specific voice characteristics. Moreover, although the rating scales are often similar to those used in clinical voice research, the attributes of the voice that are assessed are quite different. For example, identifying singing styles (Björkner, 2008; Borch & Sundberg, 2011) and substyles (Sundberg, et al., 2012); discriminating voice types (pressed vs neutral vs flow vs breathy) (Thalén & Sundberg, 2001) and voice registers (head vs chest) (Björkner, Sundberg, Cleveland, et al., 2006); attributing voice classifications (Cláudio, 2012); perceiving specific qualities as phonatory pressedness (Sundberg, et al., 2004), timbral brightness and voice tiredness (Lã & Sundberg, 2012); determining the degree of intelligibility of the lyrics (Sundberg & Romedahl, 2009); understanding formant tuning strategies (Sundberg, Lã, & Gill, 2013); and assessing intonation as a parameter of vocal expressiveness (Sundberg, Lã, & Himonides, 2013).

The voices of the participating singers are usually further explored using objective voice analysis so that perceptual evaluations can (or not) be confirmed. As studies involving singers not always achieve a great number of participants related to difficulties in recruiting volunteers, to achieve an acceptable validity level with a reduced sample, researchers use LTs to confirm the representativeness of their singers and voice samples to the topic under

study. Moreover, the results of LTs are used to guide the researchers on finding objective descriptions of perceptually described vocal events.

The most common LT designs use a visual analogue scale (VAS) assessing several voice samples, often duplicated and randomly presented to assess intra-judge reliability. Furthermore, the panel of judges is usually constituted by expert listeners (e.g. experienced singers, singing teachers or advanced student musicians). Most LTs frequently rely in the judges' individual internal understanding of vocal qualities, and although the use of anchoring or previous training to reduce inter-judges variability has been recommended (Chan & Yiu, 2002, 2006), most studies do not take into account this recommendations.

The current chapter is dedicated to identify a group of representative AM *cantadeiras* currently singing in FGs, by rating their voices, according to their level of representativeness of AM singing style. To achieve these goals the main method consisted of a LT. As mentioned in Chapter 1 and reinforced by the results of the semi-structured interviews (Chapter 3), several listeners identify certain voice characteristics as unique to AM *cantadeiras*. Partially because of this, the *cantadeiras* have been considered as an icon of AM folklore. Therefore, a perceptual evaluation of *cantadeiras'* voices from different districts in AM was considered necessary to select those voices that most represent (or not) the expected perceived unique voice characteristics.

5.2. METHODS

When evaluating perceptive (thus subjective) voice parameters such as voice quality, and when trying to rate the level of representativeness of a given voice when singing a particular singing style, LTs have been considered a good method of assessment (Shrivastav, 2011). Aural-perceptual evaluations of a voice are quite popular because they have a high construct validity, are easy and inexpensive to implement and require minimal time and effort (Shrivastav, 2011). However, when designing such analysis, it is important to take into account several methodological considerations. For example, the reduced intra- and inter judge reliability should be overcame (Gerratt, Kreiman, Antonanzas-Barroso, & Berke, 1993). As the perceptual evaluations are highly subjective, it is convenient to evaluate the consistence of evaluation made by the judges. Thus, methods of audio-

perceptual assessments usually include a group of listeners considered experts in a particular aspect of voice quality rather than a single one (Shrivastav, 2011). These methods have been used in voice research also to understand the contribution and meaning of objective voice parameters (Granqvist, 2003). Research on non-classical and traditional singing styles (already explored in Chapter 2) often used LTs, especially in studies with reduced number of singers.

Several investigations were carried out to understand what specific problems exist in perceptual voice analysis, namely: (a) instability of internal standards for different presented voice qualities; (b) difficulties isolating individual attributes in complex acoustic voice patterns; (c) measurement scale resolution; and (d) magnitude of the attribute (Gerratt, et al., 1993; Kreiman & Gerratt, 1998; Kreiman, Gerratt, & Ito, 2007; Kreiman, Gerratt, & Precoda, 1990; Kreiman, Gerratt, Precoda, & Berke, 1992). The results suggested that the assessments' variability is not random, but largely predictable and therefore avoidable using suitable measurement instruments (Kreiman & Gerratt, 2011).

Listeners develop their individual internal references system for voice assessment through past experiences when listening to voices. These references are therefore mainly maintained in the memory. As time passes, they become unstable and can be affected by internal factors (i.e. overall experience and sensitivity to the characteristic being rated, lapses in memory and attention), and external variables (i.e. acoustic context, listening task, among others) (Kreiman, et al., 1992). Consequently, different ratings are obtained according with the level of the listeners' experience/training. An experiment comparing clinicians and naive listeners' evaluations, rating normal and pathological voices, has shown that all naive listeners used similar perceptual strategies, while individual clinicians differed substantially in the parameters they considered important when judging similarity (Kreiman, et al., 1990). On the other hand, other studies showed a significant improvement in intra and inter judge reliability in naive listeners after different training sessions for the LTs (Chan & Yiu, 2002, 2006; Eadie & Baylor, 2006; Iwarsson & Reinholt Petersen, 2012).

The second factor was also studied, testing different training approaches and protocol structures. Results revealed that both perceptual training and anchor stimuli improve the results of perceptual judgement (Chan & Yiu, 2002, 2006). Synthesised anchors combined with training were more effective in improving reliability in the rates given to some perceptual attributes (i.e. roughness and breathiness) as compared with natural voice anchors (Chan & Yiu, 2002).

Considering the “measurement scale resolution”, different studies identified differences in the results according with the type of scale applied (Kreiman, et al., 2007; Wuyts, De Bodt, & Van de Heyning, 1999). The most commonly used ones are: equal-appearing interval scales, ordinal scales and VAS. In an equal-appearing interval scale, judges attribute a number between 1 and *n* to a voice sample, where *n* is the number of points on the scale (often n = 7). An ordinal scale uses categories, such as “normal", slight", "moderate", and "severe", which are later converted into numbers (e.g. 0, 1, 2 and 3). A VAS is made of a 100 mm long undifferentiated line on which both extremes are marked with the top opposite quantifiers (for example, "normal" and "very severe") and the listener indicates his or her opinion by putting a line mark somewhere along the line (Wuyts, et al., 1999).

Research has been carried out to understand how the scale nature can affect the listeners’ answers. Wuyts, de Bodt and Van de Heyning (1999) compared assessments using two versions of GRBAS[31] (the original 4 point ordinal scale and a VAS) and found that, although the VAS seemed to enable a finer judgment of overall voice quality, it actually decreased the inter-rater agreement. Later research, however, showed that listeners agreed significantly better when assessing quality on continuous (VAS) scales versus six-point scales, and that inter-rater variability is not determined by the listeners’ unreliability, but by the task design (Kreiman, et al., 2007).

The last studied factor, the magnitude of the attribute being rated, quantifies the systematic variability in agreement levels as a function of the mean rating for a voice. A common example is the higher convergence of results when listeners use the endpoints of the scale, comparing with the poorer agreement when rating in the midpoints. Using alternative designs in the LT (i.e. method of adjustment tasks) the balanced use of the scale and the agreement can be improved (Kreiman, et al., 2007).

Conventional statistical measures for intra-judge reliability is obtained by a test-retest procedure, which consistency is assessed by the Pearson’s r correlation (Kreiman, et al., 1992; Marôco, 2011). The measures for inter-judge rating reliability are Cronbach’s alpha and the Intra-class Correlation Coefficient (ICC) for the reliability of mean ratings (Marôco, 2011). However, Kreiman and Gerratt (1998) claim that they do not reflect the variability

[31] GRBAS is a widely used scale for clinical perceptual assessment of voice, using parameters (Grade, Roughness, Breathiness, Asteny and Strain). A four-point grading is used for each parameter: 0 – non-hoarse or normal, 1 – slight, 2 – moderate, and 3 – extreme Hirano, M. (1981). Psycho-acoustic evaluation of voice: GRBAS Scale for evaluating the hoarse voice. In M. Hirano (Ed.), *Clinical Examination of Voice*. New York: Springer-Verlag..

that occurs in inter-rater agreement, because they cannot represent patterns of agreement among raters and they cannot indicate agreement for specific voice samples. Again, special attention is recommended to the LT protocols' design, as a way to reduce the effect of non-controlled variables inherent to the listeners and to the listening context.

Taking into account the above-mentioned considerations, a LT was designed to rate *cantadeiras'* voices according to their level of perceived representativeness of AM singing. The scale used was a VAS. Only the responses of raters whose consistency of rating was found high were considered. The next sections of this chapter concern all steps that have been made in order to build up such test, starting with (i) the selection of the participating *cantadeiras*, (ii) the recording procedures that allowed the data base from which a set of excerpts were selected, (iii) the procedures to run the LT, (iv) the calculation of the most consistent raters, and finally, (v) the results of the evaluations made.

5.2.1. CANTADEIRAS' SELECTION

The choice of *cantadeiras* that were recorded for this LT was done from a previous selection of FGs existing in AM (presented in Chapter 3). These groups were selected according to the following inclusive criteria: (a) more than 30 years of experience; (b) more than 20 performances in the previous year (2010); and (c) having at least two female soloist singers (i.e. *cantadeiras*). Thus, the initial number of 78 eligible FGs was reduced to 24 groups, with four districts being excluded. In order to avoid further limitation of the represented districts in the *cantadeiras* sample, additional criteria were applied: (d) to include one third of the total FGs in each of the six remaining districts; (e) to select the groups having the higher number of performances in the previous year (2010); and (f) to select the older groups (only used if there was needed a tie-break between groups). Eight FGs remained from this consecutive selection process: 3 from Viana do Castelo, and 1 from Ponte de Lima, Arcos de Valdevez, Ponte da Barca, Monção and Caminha.

The eight selected FGs were then contacted and invited to participate in the LT. Formal invitations were sent to their directors and a visit was scheduled (during a rehearsal or according to the director and *cantadeiras*' convenience). At this point, *cantadeiras* within these groups were chosen to be recorded taking into account the following inclusive criteria: (a) to have more than 18 years; (b) to have more than two years of experience as a soloist *cantadeira*; (c) to have a normal voice quality, with no signs or complaints of voice disorders;

and (d) to obtain acceptable quality in the recorded signals. Before the recordings, each singer was informed about research related details, signing in an informed consent form (see Appendix 4), and answered to a brief questionnaire (later on described). Also a perceptual assessment of the speaking voice was made. A total of 23 *cantadeiras* were identified, although only 18 were recorded, as 3 were younger than 18 years, and 2 presented voice disorders. From the 18 recordings, two needed to be excluded from analysis due to low quality of the audio signal, resulting in a final sample of 16 *cantadeiras*: 5 from Viana do Castelo, 3 from Ponte de Lima, 3 from Caminha, 2 from Arcos de Valdevez, 2 from Monção, and 1 from Ponte da Barca.

5.2.2. RECORDING PROTOCOL AND PROCEDURES

The questionnaire applied at the beginning of the recordings was developed to explore: (i) daily vocal use; (ii) singing activities; (iii) singing learning process; (iv) musical experiences; (v) rehearsals and performance practices; (vi) warming-up routines; (vii) instrumental accompaniment; and (viii) history of voice problems. This questionnaire was filled by the author according with the *cantadeiras*' answers, because some of them might have a reduced literacy level.

The recording protocol was adapted from the one tested during the Pilot Study (Chapter 4), recording exclusively audio signals. Three vocal tasks were included: (a) spontaneous speech, (b) reference song and (c) singer's chosen song. Only the reference song was included in the LT. The other tasks were used to test quality of the audio signal in softer (speech) and louder (chosen song) conditions.

Recording conditions could not be entirely controlled regarding room acoustics: most of the rooms provided by the FGs were not sound treated or were located near some sort of noise source. However, these recordings were used only for the purposes of LT and not acoustically analysed.

The recording equipment included: (i) microphone Audio-Technica MB1k|c; (ii) external sound board Alesis iO|2 USB; (iii) laptop computer Lenovo ThinkPad SL300; and (iv) headphones Sennheiser PXC 310. The microphone was placed in a 45º relative position in front the mouth, at a 30 cm distance (see Figure 43). The same distance and gain were maintained for all recorded tasks and each *cantadeira*. The microphone-to-mouth distance

of the *cantadeiras* was controlled by means of a mark in the floor and a ruler. Sound level gain adjustment was regulated before beginning the recordings, using a high loud voice production as reference to avoid signal distortion. Guidelines concerning how the tasks should be performed were given prior to each task.

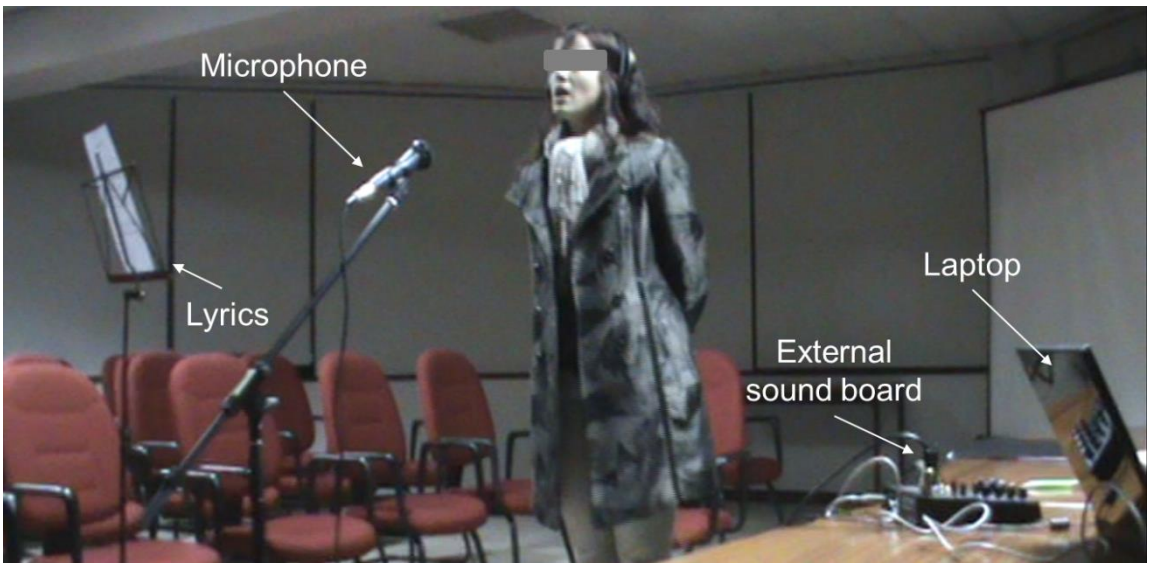

Figure 43. Example of a recording setting for gathering data for the LT, showing the equipment used.

Recordings were made using the software Audacity (version 2.0.0) and exported to the database as wav files.

5.2.3. JUDGES' SELECTION FOR THE LISTENING TEST

The recordings made were used to create a LT, aiming at classifying the *cantadeiras'* voices according to their level of representativeness of AM female solo folk singing. It seemed appropriate to include members of FGs, as their large experience as consumers of folk music would provide solid opinions on how a AM *cantadeira* should sound. Every FG member was considered for LT, independently of age, profession or role in the group. The FGs of the recorded *cantadeiras* and all their members were excluded, as voices could be recognised and influence the overall LT result.

The first selected FGs were the older groups from each of the 10 districts. LTs were carried out during a rehearsal or booked for another day, scheduled according to the participant's convenience. Eight FGs accepted to participate, which gave a total of 38 raters.

Joining this panel of evaluation, there were 39 extra FGs members, recruited during the annual AM folk festival, from 6 FGs that accepted to participate. Thus, a total of 77 evaluators took part in this LT. Table 16 displays the distribution of evaluators per FG and district.

Table 16. Distribution of the LT participants (FGs and raters) according to districts and selection phases

	Viana do Castelo	Ponte de Lima	Arcos de Valdevez	Ponte da Barca	Monção	Caminha	Valença	Vila Nova de Cerveira	Paredes de Coura	Melgaço	**TOTAL**
Total number of FGs	27	16	13	12	9	7	4	3	3	1	**95**
FGs successfully contacted	26	10	10	11	7	6	2	2	3	1	**78**
First FG selection	1	1	0	1	1	1	1	1	1	0	**8**
Second FG selection	1	1	0	1	1	1	0	0	0	1	**6**
Total selected FGs	2	2	0	2	2	2	1	1	1	1	**14**
Number of listeners	8	11	0	9	9	13	6	6	7	8	**77**

5.2.4. LISTENING TEST PROTOCOL AND DATA ANALYSIS

The next step to carry out the LT was to select and organise the collected audio samples constituted by 16 *cantadeiras* singing the reference folk song. As this was a strophic song, repeating 3 to 4 times the refrain, only the second or third repetition of the refrain were included, as by this time the *cantadeira* would be comfortable with the recording setting. This excerpts lasted approximately 25 seconds and were taken from the original file and pasted to a new one using the software Audacity. Once all excerpts were taken from the original files, a new file was created, including a total of 23 stimuli: 16 excerpts plus 7 randomly chosen excerpts that became repeated. These repetitions were randomly allocated in the final file, the LT file, using the tool Glue included in the software Soundswell workstation (Hitech Medical, Sweden), with the purpose of evaluating each judge consistency of response.

This randomization was done differently twice, using the same software, so that two LTs were obtained, LT_A and LT_B, stored as wav files. The 7 replicated stimuli were also different for each of these tests. This procedure was carried out when preparing the files for the LT because the randomisation also avoids possible biases in the results associated with the order of the presentation of the stimuli. Each of the 23 stimuli included in the final LTs were separated by a 5 second interval, totalising 11 minutes test duration.

Once the files were prepared and saved as wav files (corresponding to LT_A and LT_B), a questionnaire including a VAS for each stimuli was created to assess the level of representativeness of AM folkloristic singing of each included *cantadeira.* Each VAS was constituted by a line with 100 mm long where evaluators were asked to put a vertical mark somewhere along the line, indicating how much the voice they heard was representative of AM singing. To be more precise, the question included for each of the 23 stimuli was "how typical of AM folk singing style is this example?" This question emerged from the analysis of the interviews (Chapter 3), where reports of a typical sound associated with the voice of *cantadeiras* were mentioned several times. This LT was carried out taking into account that the ultimate goal of this investigation was to understand whether there are voice characteristics considered representative of AM singing, as the voice of these singers has been regarded as an icon of the folklore of this Portuguese region. This questionnaire with 23 VAS accompanied both LT_A and LT_B, and also included a cover sheet (providing information about the research), and information on the identification of the evaluators, namely his/her role within the in the FG (see Appendix 5).

A pre-test was carried out to validate the LTs prior to its application with all participants. Five elements from a FG of the district of Braga were asked to complete the LT and give their opinion about its structure and content. The aspect pointed out as most difficult was rating a stimuli without knowing when the next starts. To minimise this problem, an oral identification of the number of each sample was added to the final LT_A and LT_B.

The LT was carried out in a silent room of the FGs' facilities. LT_A and LT_B were randomly assigned to each participant, who heard the stimuli through headphones Sennheiser PXC 310 connected to a laptop computer Lenovo ThinkPad SL300. Verbal orientations on how to fill in the LT, and particularly the VAS, were given prior to playing the audio file to each participant.

The analysis of the data consisted on measuring the marks given in the VAS and transforming the answers in a scale from 0% to 100%, creating a database on an Excel file

(Microsof Office). Intra-judge reliability was measured applying Pearson's r correlations between the replicated stimuli in the test (Kreiman, et al., 1992). Those evaluations presenting correlation values higher than 0.8 between the first and the second presentation of the same stimuli were accepted as consistent. Thus, data analysis was carried out only considering the ratings given by these evaluators. The inter-judge reliability was also measured using ICC (two-way random model, and consistency type) to assess the consistency or reproducibility of the quantitative measurements made by the different observers measuring the same voice samples (Weir, 2005).

Both Pearson's r correlations and ICC were carried out using IBM SPSS Statistics (version 2.2). Microsoft Excel 2012 was used for organising data, outputs, tables and graphics.

5.3. RESULTS

5.3.1. SAMPLE CHARACTERIZATION

Sixteen *cantadeiras* provided the stimuli used in the LT; their age varied from 28 to 65 years. Half of them (n=8) had their music and singing experience limited to the FGs contexts. The other 8 had some experience also in choirs (religious or others) and only one (S12) also had experience in other musical and singing styles, namely a *bossa nova* band. Most of them (except S12) had professions with no relation to music; some (n=5) had professional activities requiring vocal demands (S07, S10, S12, S21, and S22), usually associated with education.

The majority of the *cantadeiras* (n=12) had no access to any kind of formal voice education, explaining their vocal abilities based on family traditions. Four participants revealed some sort of voice education: singing classes (individual), choir classes (group) or speech therapy (individual). Only S12 had music and singing education. Concerning voice problems history, 9 *cantadeiras* assumed to have a healthy voice, while seven referred some past problems. Three of them have presented vocal symptoms such as fatigue after activities involving the use of the voice (as singing) and two of them had to be treated: phonosurgery and singing classes (S14), and speech therapy (S18). Table 17 summarises relevant background information on the participating *cantadeiras*.

Table 17. Characterization of the 16 *cantadeiras* included in the LT

Singers' ID	Age	Profession	Music / singing experience	Voice education	Voice problems history
S_01	45	Factory worker	Only in the actual FG	No	No
S_02	60	Housemaid	FG and church choir	No	No
S_07	33	Educational assistant	Only in the actual FG	No	No
S_10	34	Educational assistant	FG and church choir	No	Yes, in the past
S_12	31	Music teacher	FG, church choirs and music band	Yes. Classical singing and jazz classes	Yes, in the past.
S_13	54	Housemaid	Only in the actual FG	No	No
S_14	57	Office assistant	FG, church choir and orpheon	Yes. One year of singing classes	Yes, in the past. Need for phonosurgery.
S_15	44	Seamstress	Only in the actual FG	No	No
S_16	30	Factory worker	Only in the actual FG	No	Yes, in Summer.
S_17	48	Housemaid / Agricultural labourer	Only in FG contexts	No	Yes, after voice effort.
S_18	56	Housemaid / Agricultural labourer	Several FGs	Yes. In speech therapy treatment.	Yes, in the past, after voice effort.
S_19	56	Retired factory worker	FG and choral group	No	No
S_20	38	Office assistant	Only in the actual FG	No. Music classes.	No
S_21	65	Retired primary teacher	Several FGs and choral groups	No	Yes, anxiety related problems
S_22	28	Primary teacher	FG and youth choir	Yes. Three years of choir classes.	No
S_23	55	Waiter	Several FGs and choral groups	No	No

The evaluators in the panel presented a mean age of 42.8 years (±15.3); there were 35 male and 37 female elements. They had a mean of 21.4 years (±12.8) of experience within FGs, with a minimum of 3 and a maximum of 60 years. Regarding the roles within the FG, most members had more than one role according with the following distribution: 47 dancers, 27 choir singers, 12 soloist singers (male or female), 16 instrument players and 23 with other functions, as FG directors, musical directors, secretaries, banner bearers or dressmakers. The professional activities of the evaluators included: students (n=8), civil construction and woodworkers (n=8), technical assistants in public services (n=8), housemaids (n=7), retired people (n=7), office workers (n=7), education professionals (n=5), factory workers (n=4), car drivers (n=4), higher technicians (n=3), tradespeople (n=2),

handicraft workers (n=2), business people (n=2), and health and wellness technicians (n=2). Three evaluators were unemployed at the time this LT was carried out.

5.3.2. INTRA AND INTER JUDGE RELIABILITY

Intra-judges reliability was measured using a Pearson's r correlation between the first and second time each stimuli appeared repeated in the LT. Results are presented in Table 18. From the 77 selected listeners, five had incomplete or miss filled forms, so they were excluded, remaining 72 valid responses. From these, 25 had Person correlations higher than 0.7, revealing strong consistency in their perceptual assessments (Marôco, 2011). Nevertheless, intending to achieve a better consistency level, results were also examined using the judges with even better correlation levels (higher than 0.8). For this case, only 18 listeners were identified. As mentioned in the methods section, further analysis used the assessments of these last judges, with higher correlation levels. Mean consistency for all raters was 0.458, and there were differences between versions both versions of the LT, LT_B obtaining higher consistency levels (mean r = 0.604) than LT_A (mean r = 0.312)

Table 18. Intra-judge reliability measures by the Pearson correlation

Judge Id.	Pearson r	Judge Id	Pearson r	Judge Id	Pearson r	Judge Id	Pearson r	Judge Id	Pearson r
1 A	0.036	17 A	0.848	33 A	0.290	49 A	-0.372	65 B	-0.060
2 A	0.099	18 B	0.928	34 B	0.541	50 B	0.770	66	-
3 B	0.811	19 A	0.324	35 A	0.752	51 A	0.699	67	-
4 A	0.314	20 B	0.797	36 B	0.468	52 B	0.275	68	-
5 B	0.786	21 A	0.503	37 A	0.543	53 A	0.816	69	-
6 A	0.837	22 B	0.832	38 B	0.148	54 B	0.876	70 B	0.941
7 A	0.735	23 A	0.522	39 A	0.804	55 B	-0.340	71 A	-0.026
8 B	0.694	24 B	0.238	40 B	0.877	56 B	0.652	72 A	0.384
9 A	0.535	25 A	0.690	41 A	0.517	57	-	73 A	0.228
10 B	0.802	26 B	0.473	42 B	0.935	58 A	0.150	74 B	0.653
11 A	0.591	27 A	0.643	43 A	-0.855	59 A	-0.581	75 B	0.801
12 B	0.899	28 B	0.707	44 B	0.840	60 B	0.439	76 B	0.421
13 A	0.416	29 A	0.076	45 A	0.833	61 A	-0.629	77 A	0.230
14 B	0.541	30 B	0.592	46 B	0.820	62 B	0.598	**Mean A**	**0.312**
15 A	-0.099	31 A	-0.078	47 A	0.556	63 A	-0.156	**Mean B**	**0.604**
16 B	-0.216	32 B	0.843	48 B	0.561	64 B	0.784	**Mean AB**	**0.458**

Note: (A) Version A of the LT; (B) Version B of the LT; Light grey cells – Pearson r > 0.7; Dark grey cells – Pearson r > 0.8

The inter-judges reliability was then measured considering the 18 final judges. As there was a tendency not to use the extreme segments of the line in the VAS, there was also the need to normalise each judge assessment. Therefore, inter-judges reliability was measured using ICC in both original and normalised data. Results show generally high ICC

values (near 0.9) revealing excellent consistency between the judges' assessments both for original (ICC = 0.885) and normalised (ICC = 0.887) ratings.

5.3.3. LISTENING TEST RESULTS

Ratings obtained in the LTs are listed in Table 19. Mean and standard deviation for each *cantadeira* are listed. Both original and normalised data were considered to calculate the *cantadeiras*' ranking (left and right, respectively). As one might observe, a relatively low mean rating was obtained for the group (41%), considering the normalised results: only 3 *cantadeiras* had relatively high percentages (more than 60%), and at least 6 obtained considerably low ratings (less than 29%). If the original data were considered, even lower results were observed, with a mean rating of 38.5%.

Table 19. LT results including original and normalised ratings of 18 most consistent judges

Singers' ID	Original data			Normalised data		
	Mean (%)	SD	Ranking	Mean (%)	SD	Ranking
S_01	35.9	23.3	*8*	**38.4**	30.1	***8***
S_02	42.6	25.4	*5*	**47.2**	31.2	***5***
S_07	66.7	17.7	*1*	**78.9**	20.7	***2***
S_10	32.3	23.3	*9*	**30.3**	27.2	***10***
S_12	26.9	19.4	*13*	**24.4**	23.0	***14***
S_13	41.8	19.8	*6*	**43.1**	24.8	***6***
S_14	27.0	21.4	*12*	**27.8**	31.3	***11***
S_15	31.1	24.3	*10*	**34.1**	30.7	***9***
S_16	50.6	22.3	*4*	**55.2**	29.6	***4***
S_17	36.6	25.8	*7*	**39.9**	32.1	***7***
S_18	65.7	23.5	*2*	**79.2**	30.0	***1***
S_19	22.9	23.8	*16*	**20.4**	28.7	***16***
S_20	28.5	20.7	*11*	**27.6**	23.1	***12***
S_21	24.5	17.9	*15*	**22.3**	23.4	***15***
S_22	55.7	28.3	*3*	**62.3**	31.8	***3***
S_23	26.7	21.0	*14*	**25.6**	26.0	***13***
Mean	38.5	22.4	-	41.0	27.7	-

As ICC was slightly higher for normalised ratings, these were selected to be used in further parts of this research. Figure 44 presents the results of the normalised LTs for the 16 *cantadeiras*, according with the 18 judges showing the highest consistency in their responses.

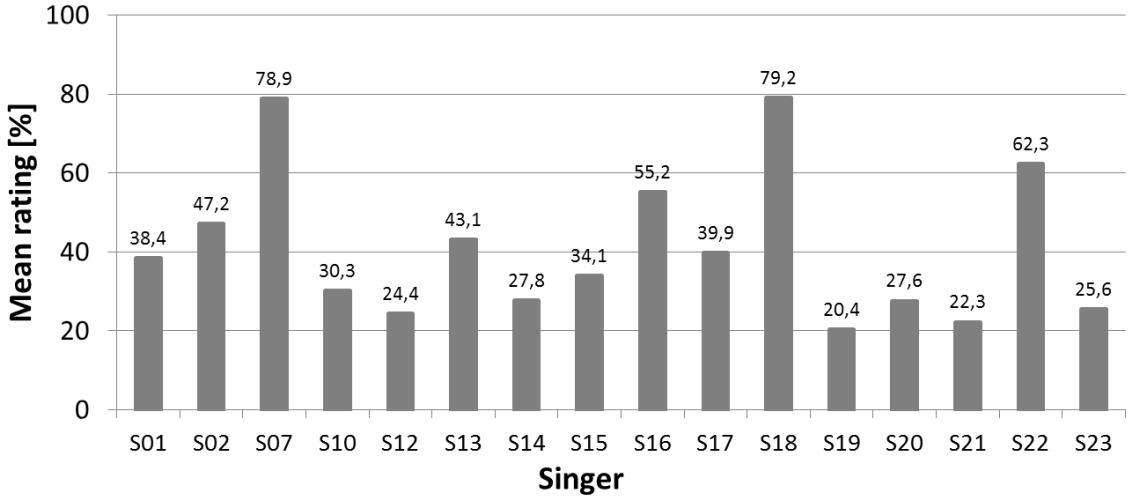

Figure 44. Classification of *cantadeiras* representativeness for AM folk singing obtained in the LT. Values are based in the most consistent judges classifications (n=18; Pearson r > 0.8) and in normalised LT data.

5.4. DISCUSSION

Selection of *cantadeiras* and evaluators for the LT was done carefully, as the results of such test would provide the subjects for a multichannel recording study (described in Chapter 6). The selected FGs were the most experienced and active ones. Also, FGs' selection criteria were chosen to ensure representation of all the districts constituting AM region. This procedure also provided a wide range of *cantadeiras* instead of focussing on particular districts.Taking into account that the *cantadeiras* are considered to represent these groups and regions, one would expect that they would also be experienced and representative of this style of singing. However, results showed that they mostly obtained rather low scores in the representativeness levels for AM singing style.

The *cantadeiras* characterization added relevant information to previous findings indicated on Chapter 3. It was confirmed that: (i) several *cantadeiras* do not exclusively perform folk singing, they sing also in choirs and at least one in other non-classical styles (i.e. *bossa nova* band); (ii) 1/3 of the *cantadeiras* had basic or advanced voice education, but not in folk singing; (iii) voice problems existed in *cantadeiras*; past voice problems were reported by 7 (44% from the 16 recorded *cantadeiras*), and 2 (8.9% from the 23 selected *cantadeiras*) were excluded because of current voice disorders. This reinforces the possibilities of external influence of music education and other singing styles in the folklore way of singing, and the possible relations of voice disorders as a result of voice loading in folk singing.

The recordings of the *cantadeiras* that participated in the LTs were done in the locations where the FGs would rehearsal, so as closest as possible to their natural performance environments. In addition, and bearing in mind previous experience taken from the pilot study (Chapter 4), an instrumental accompaniment (played by a FG of Viana do Castelo) was played in one head phone while each participant was recorded, avoiding pitch variations on the song that was recorded by all singers (i.e. the reference song *Rosinha do Meio*), and that could affect the results of the LTs. Although all *cantadeiras* were able to accomplish this task, some of them reported to have difficulties concerning the pitch range of the song provided by the accompaniment (between F4 and Eb5). Some of their reports included vocal effort, out of tune voice, and register breaks when approaching the top notes. These difficulties may constitute an evidence that not all singers would have been recorded singing in their vocal comfort zone, which, in turn, may had affect the ratings of the evaluators of how representative of the AM folk singing these singers were. Even so, performing this task using the same pitch was essential to allow vocal ratings based on individual voice characteristics rather than on pitch-related ones.

All LTs were carried out in normal conditions, voided of technical or acoustical problems. As none of the evaluators had previous experiences in assessing voice using a VAS, the researcher was present at the moment of filling in the LT to explain any doubts concerning the test. To guarantee that no cues could be given to the evaluators on how to rate the stimuli, the researcher did not know their order nor where the replicated stimuli were located in the LT. In fact, the randomisation of the stimuli carried out by the tool *Glue* generates a code for the stimuli identification and order in an excel sheet that can be broken only at the end of data collection.

The participants mentioned that it was rather difficult to assess the voices of the first stimuli in comparison with the last ones. It could be advantageous to include some training samples in the beginning of the test, to allow the familiarisation of the evaluators with the applied VAS. This could be the reason for such poor consistency found in the raters (from 78 evaluators, only 25 showed high consistency levels).

It is worth to mention that evaluators of the version LT_A presented lower consistency mean correlations (mean r = 0.3) as compared with those rating version LT_B (mean r = 0.6). This seems to corroborate the results of previous investigations, highlighting the effects of the order of the stimuli in the perceptual evaluations (Kreiman, et al., 2007). In fact, it was latter observed that in version LT_A, the repeated stimuli were located more in the first half of the

test, while in version LT_B they were more distributed in the second half. This may constituted a training opportunity for respondents of test LT_B, explaining the higher mean consistency of evaluators.

As the ratings revealed, the majority of the *cantadeiras* were not rated as extremely representative of AM folk singing, corroborating the evaluators' reports, at the end of the LT, that there were only a few "good singers". This constitutes an important result, as the aim of this LT was to select singers that could allow descriptions of current voice characteristics of singer in AM folklore singing. By including a wide range of voice types, one might more accurately isolate those characteristics which still preserve some unique particularities of a given style and compare them with others that, although even not being considered as representative, are also *cantadeiras* of several FGs.

Actually, unlike other studies, in this study the main problem found in the LTs was not the inter-rater reliability, which was quite acceptable, but the intra-rater reliability. This phenomenon was indeed expected and overcame by including a large sample of listeners. Although many judges were excluded because of the reduced consistency in their assessments, the final number of judges and the consistency of their assessments allowed for a valid classification of the *cantadeiras*.

5.5. SUMMARY

In current chapter a LT was carried out to rate the voices of a group of *cantadeiras* of AM folk singing, according with the level of representativeness of their singing. The LT involved the voice of 16 *cantadeiras* from 8 FGs, and the assessments of 77 listeners from 14 other FGs.

High levels of intra and inter-rater reliability were obtained in this LT, although only 18 listeners remained in the final classification. The test-retest consistency of the listeners was affected by the LT version, corroborating previous literature reports about the influence of the test structure in the final results.

In the LTs, only three *cantadeiras* obtained considerably high ratings for representativeness (above 60%) of AM folk singing. Considerably low classifications (<29%) were given to 6

singers. Results suggest that, although most experienced FGs were selected, many *cantadeiras* may not be strong representatives of typical AM female solo folk singing. Probably, current *cantadeiras* sing in a way that does not match the singing manner of older days, not corresponding to the expectations of the listeners. This would explain why only three participants obtained a rating score above 60%. By objectively identifying voice characteristics of these singers as compared with the ones who got lower ratings, one will be able to identify which vocal characteristics may be unique to this singing style, and thus contribute to their preservation.

The next chapter will thus concern objective measures of physiological and acoustical characteristics of the singers involved in the LT, aiming at identifying which parameters are more associated with high ratings of vocal representativeness of AM folk singing.

CHAPTER 6

VOICE FUNCTION OF CANTADEIRAS IN ALTO MINHO FOLK SINGING

6. VOICE FUNCTION OF CANTADEIRAS IN ALTO MINHO FOLK SINGING

6.1. INTRODUCTION

So far, this thesis presented a perceptual contextualization of AM female solo folk singing, taking into consideration the opinions of those involved in the practice and dissemination of this singing style. Perceptions of relevant aspects of the performance of this singing style were firstly discussed, followed by the assessment of how representative of this style a *cantadeira's* voice can be. As this study constitutes the first attempt to describe this singing style, from both perceptual, physiological and acoustical points of view, it seemed relevant to test a recording protocol with one *cantadeira* before collecting a wider dataset. The following step would be to record of a larger sample of *cantadeira*s, aiming at gathering data to describe perceptual, physiological and acoustical characteristics recognised as unique to this singing style. Therefore, this chapter concerns exactly the definition of physiological and acoustic parameters that may characterise perceptions of how AM female solo singers interpret this folk singing style. More specifically, it attempts to find which physiological and acoustic parameters best predict the ratings given to perceptual evaluations of *cantadeiras'* voices, concerning their representativeness of this singing style, as presented in the previous chapter. It also provides comparisons between the parameters identified as most relevant to characterise this singing style with those described for other non-classical and traditional singing styles.

In order to achieve these goals, this chapter starts with descriptions of the study design, followed by the procedures for data collection, presentation and analysis. The discussion of the respective results will be the last section of this chapter.

6.2. METHODS

6.2.1. STUDY DESIGN

As mentioned above, the main goal of this chapter is to describe vocal behaviour of AM *cantadeira*'s singing, comparing it with the vocal behaviour during the performance of other singing styles. In order to do this, a descriptive comparative study was carried out, aiming at (a) describing *cantadeira*'s general voice characteristics, understanding the relations that may exist between perceptual, physiological and acoustical parameters, and (b) comparing these characteristics with those found in other singing styles previously described in the literature.

Descriptive comparative study designs allow the collection of information that will demonstrate relationships and describe the phenomena under investigation as it exists (Robson, 2002). Thus, it seems rather important to use this type of study design when describing and understanding the underlying complexity of several voice parameters responsible for a certain singing style. Using the current study design, the researcher is an observer that tries to understand AM female solo folk performance practices under the light of the perceptions of those who are involved in the performance of this singing style.

6.2.2. PARTICIPANT'S SELECTION

As the main aim of this study is to describe *cantadeiras*' general voice characteristics, understanding the relations that may exist between perceptual, physiological and acoustical parameters, participants were drawn from the previous perceptual evaluation study (see Chapter 5). All sixteen singers who were perceptually evaluated were also invited to be further investigated in the current study. However, six of them had to decline this invitation: some had health issues at that time, whereas others had difficulties in finding transportation to the location of the recordings - a sound treated room in AMVC. Therefore, a total of 10 *cantadeiras* were further recorded in this study: singers number 1, 2, 7, 10, 16, 18, 19, 20, 21, 22 (see Chapter 5 for further information on these participants). Figure 45 lists the participants according to LT ratings: possessing a representative voice of AM female solo folk singing.

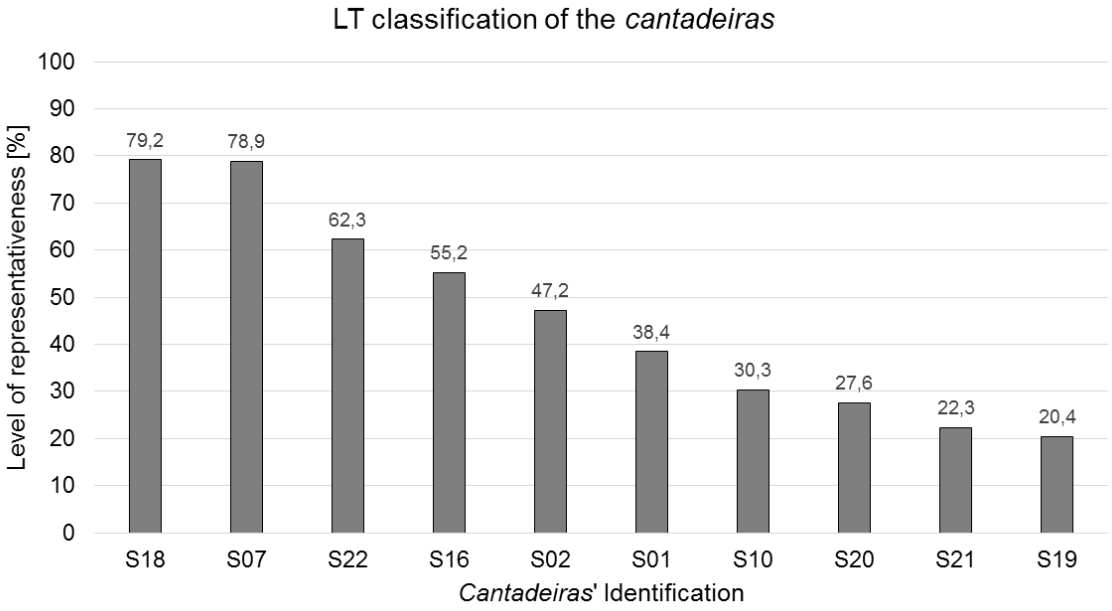

Figure 45. C*antadeiras'* ordering according to the results of the LT: #1=S18; #2=S07; #3=S22; #4=S16; #5=S02; #6=S01; #7=S10; #8=S20; #9=S21; #10=S19.

6.2.3. DATA COLLECTION

The vocal tasks included in the present recording protocol followed the recommendations resultant from the previously tested recording protocol (see Chapter 4). These tasks are summarised in Table 20, numbered according to the order followed in the recordings.

Table 20. Vocal tasks' identification and brief description.

	Task identification	Task content
1	Spontaneous speech	Speech sample in conversational mode
2	Glissando/ Scales	Glissandos/ scales covering the entire vocal range
3	Singer's chosen song	Traditional song chosen according to the singer's preference
4	Reference song	*Rosinha do Meio* (well-known traditional song, commonly used in AM folk singing repertoire)
5	Reading lyrics	Reading the lyrics of the reference song *Rosinha do Meio*
6	Reference song in [pa]	*Rosinha do Meio* sung substituting its lyrics with the syllable [pa]
7	Repetitions of [pa]	Repetitions of [pa] in three tones (low, medium and high) each sung in three different vocal loudness (loud, medium and soft)

Unlike the pilot investigation, an instrumental accompaniment (i.e. typical toccata of an AM FG) was played in one headset to all participants while singing the "reference song",

Rosinha do Meio (see Figure 33). This was done in order to provide the same reference tone and tempo. This version has a 10 ST frequency range, varying from 370 Hz (≅F#4) to 659 Hz (≅E5). To guarantee that the song's lyrics were also the same for all participants, these were provided in tasks 4 and 5.

Other differences between the recording protocol used in this part of the study and the piloted one (Chapter 4) include modifications of tasks 2, 6 and 7.

Task 2 was simplified to avoid difficulties previously revealed by non-trained singers in performing glissandos. Instead of glissandos, singers were asked to sing different notes that were first played in a piano. Thus, as a reference tone was given and all that the singers would need to do was to repeat this reference note. By doing so, each *cantadeira* individual vocal range could also be explored.

Taking into account the difficulties revealed by the participant of the piloted recorded protocol in singing the syllable [pæ], tasks 6 and 7 were sung substituting the lyrics by the syllable [pa] instead. This was found to be a useful modification, as this syllable is part of the Portuguese language phonetic inventory and also presents a high F1 (Escudero, et al., 2009).

Task 7 also included modifications. Three renderings of five repetitions of the syllable [pa] were recorded, in nine different combinations of frequencies and intensities: (1) medium pitch (i.e., 50% of the total frequency range) and medium loudness (i.e., *mezzo forte*); (2) medium pitch and high loudness (i.e., *forte*); (3) medium pitch and soft loudness (i.e. *piano*); (4) low pitch (i.e., 15% of the frequency range) and *mezzo forte*; (5) low pitch and *forte*; (6) low pitch and *piano*; (7) high pitch (i.e., 85% of the frequency range) and *mezzo forte*; (8) high pitch and *forte*; and (9) high pitch and *piano*. The 15%, 50% and 85% of the frequency range were calculated based on the results of task 2, and a voice synthesiser (Madde, by Svante Granqvist, KTH, Sweden) was used to provide the target-tone models to the *cantadeiras*.

Microphone calibration and data collection followed the same protocol as described in the previously tested recording protocol (see Chapter 4). Recordings were all made in the same sound treated room at AMVC during two consecutive days. Each recording lasted approximately 30 to 45 minutes.

6.2.4. DATA ANALYSIS

Data analysis were similar to those carried out for the previously tested recording protocol (see Chapter 4), except for F0 extraction. For the current study, it was now extracted from the ELG signal (instead from the audio signal). This was done taking into account that F0 extraction from ELG signal presents less flaws as compared with F0 extraction from the audio signal (Epstein, 2011).

Data analysis (and also the results section) can be divided into four main parts: (i) a general characterisation of *cantadeira*s' voice, while performing spontaneous speech, reading lyrics, and singing a chosen and a reference song, analysing data gathered from both audio and ELG signals; (ii) comparisons between speaking and singing tasks – this was done in order to understand how far is this singing style from speaking; (iii) descriptions of the relationships between all evaluated aspects of voice productions, i.e. perceptual evaluations of representativeness of the *cantadeira*'s voice, physiological and acoustical voice parameters; and (iv) the determination of the physiological and acoustical voice parameters that best predict the results of the LT. This last part was done to identify whether there are particular acoustical and physiological parameters that may distinguish *cantadeiras*' voices according to perceptions of being representative of AM female solo singing style.

Tasks 1, 2, 3, 4 and 5 serve the purposes of providing the data to generally describe the *cantadeira*'s singing voice. F0 measures (mean F0, F0 SD, frequency range), LTAS measures (Leq, alpha, $(H1\text{-}H2)_{LTAS}$), and ELG measures ($Q_{contact}$, CFx and CAx) were extracted. Recalling previous explanations of these measures (Chapter 2): (a) mean F0 represents the mean rate at which the vocal folds vibrate per unit of time of a voice task in a determined period of time, measured in Hz (Baken & Orlikoff, 2000); (b) F0 SD is the F0 variance of a voice task in a determined period of time; (c) frequency range represents F0 variation of a voice task in a determined period of time, from minimum F0 to maximum F0, measured in ST; (d) LTAS represents mean frequency and intensity in a variable duration sound signal; (e) Leq, a loudness-related measure in dB, is defined as the logarithm of the average sound energy, and represents a standard measure of sound level variation over time; (f) alpha is the ratio between the sound energy above and below 1kHz; (g) $(H1\text{-}H2)_{LTAS}$ is the level difference between the first and the second voice source spectrum partials in a LTAS; (h) $Q_{contact}$ measures the contact phase during the vocal folds' vibration; (i) CFx and

CAx are a perturbation measures from ELG signal, which reflect cycle-to-cycle variability in vocal fold vibration, considering the signal frequency and amplitude, respectively.

The first type of data analysis consisted of a simple frequency range profile, comparing all four main tasks: spontaneous speech, reading lyrics, chosen song, and reference song; followed by a comparative voice range profile including Leq as function of mean F0. Individual LTAS and related measures were extracted for all tasks. Additionally, all voice parameters were statistically compared between speech (i.e. spontaneous speech vs reading lyrics) and singing (i.e. the chosen song vs the reference song). As the data was not normally distributed, these comparisons were carried out using a Wilcoxon non-parametric test, applying a 0.05 significance level. Finally, Psub was also analysed, measured from task 6 (i.e. reference song substituting the lyrics by the syllable [pa]), and presented as function of Leq and F0.

The second part of data analysis compared spontaneous speech and the chosen song. These two tasks were selected because they are considered representative of the singer's habitual speech and singing modes. As data was not normally distributed, comparisons were carried out using a Wilcoxon non-parametric test, applying a 0.05 significance level.

The third part of data analysis concerned the identification of relationships between all independent variables, using: (i) hierarchical cluster analysis (HCA), for defining data structure and (ii) principal component analysis (PCA), for data overview and feature selection. HCA is especially suitable for cases in which there is no "a priori identification of classes", suggesting a structure of the data based on clusters. These clusters are further detailed and rationalised by PCA with bi-plot representations. The latter techniques allow the visualization of the data, and thus direct observation of the most relevant patterns. The procedure based on HCA and PCA requires a description of the objects, i.e. points in Euclidean space. In this analysis, each *cantadeira* corresponded to one of these points. *Cantadeiras* were described on the basis of five components related to physiological and acoustical parameters. Specifically, the data set contains information on 10 singers characterised by two physiological parameters, $Q_{contact}$ and mean Psub, and by 3 acoustic observations, including Leq, $(H1\text{-}H2)_{LTAS}$ and alpha. The software codes were developed and optimised using software R (version 3.0.1) (Venables & Smith, 2013).

As a result of HCA and PCA analyses, singers were organised in 3 groups (PCA-I, PCA-II and PCA-III), so that comparisons between these groups could be carried out. Graphs describing all voice measures were computed in order to visually compare PCA groups.

Finally, Kruskal Wallis non-parametric test, at a 0.05 significance level was used to compare these groups. This particular test was chosen as data was not normally distributed and presented extreme values and outliers.

Particular acoustical and physiological characteristics that may predict *cantadeiras*' voices recognised as representative of this singing style were finally investigated, by means of a stepwise multiple regression analysis. For this analysis, only data gathered from tasks 4 and 6 (concerning the reference song) were used. This task selection took into account that singing the reference song was the task used in the LT study to assess the participants' representativeness of this singing style (Chapter 5), in other words, the dependent variable. The independent variables included all acoustical and physiological parameters extracted for these tasks: Leq, alpha, $(H1\text{-}H2)_{LTAS}$, $Q_{contact}$, CFx and CAx (extracted from task 4), and Psub [F4], Psub [F#4], Psub [G#4], Psub [Bb4], Psub [B4], Psub [C#5], Psub [D#5] (extracted from task 6). In order to carry out the multiple regression analysis, both dependent and independent variables were converted into standardised scores, or Z-scores. The predictive model was progressively adjusted, excluding multicollinear variables and those excluded in all forward, backward and stepwise regression methods, as recommended by Marôco (2011). Additionally, the five principal assumptions of the Model were analysed: (a) linearity and additivity of the relationship between dependent and independent variables, analysed by a scatterplot of residuals versus predicted values; (b) normality of the error distribution, assessed by visual analysis of a normal probability plot of the residuals; (c) little or no multicollinearity in the data, assessed by (i) a correlation matrix ($|R|<0.75$); (ii) Tolerance statistics ($T>0.1$); (iii) Variance Inflation Factor ($VIF<10$); (iv) Condition Index ($CI=10<30$ indicate a mediocre multicollinearity; $CI>30$ indicate strong multicollinearity); (d) statistical independence of the errors, assessed by the Durbin-Watson statistic test for significant residual autocorrelation ($d=0.24<2.82$, for $n=10$ and $p=5$); (e) homoscedasticity (constant variance) of the errors, analysed by scaterplots of residuals versus predicted values, and of residuals versus independent variables (Marôco, 2011).

The following section presents the results organised according to data analysis: (i) *cantadeira*'s general voice characteristics; (ii) voice comparisons between speech and singing; (iii) identification of relationships between all independent variables (to allow identification of *cantadeiras'* groups); and (iv) identification of acoustical and physiological characteristics that may predict *cantadeiras*' voices recognised as more or less representative of this singing style.

6.3. RESULTS

6.3.1. CANTADEIRAS' GENERAL VOICE CHARACTERISTICS

Table 21 lists the results of F0, including mean F0, F0 SD, frequency range in ST, and Leq (measured in dB at a 30 cm mouth distance), for all vocal tasks, i.e. spontaneous speech, reading lyrics, chosen song and reference song. The results are organised according to the *cantadeiras*' ranking obtained in the LT (Chapter 5).

Similar results were found for tasks of spontaneous speech and reading lyrics concerning mean F0, SD and frequency range. Mean F0 in spontaneous speech varied between 149 and 235 Hz, whereas it varied between 147 and 238 Hz for the reading lyrics. F0 SD was slightly smaller for speech (19 to 52 Hz) than for reading (18 to 61 Hz). Slightly higher differences were found for F0 range distribution, as it was between 13.5 to 24 ST for speech and 11.3 to 20.4 for reading.

F0 range profile (or maximum phonational frequency range) of each singer was determined from task 2 – see Figure 46. In this figure, the frequency range of each task is also presented. One can observe that the speech tasks (i.e., spontaneous speech and reading lyrics) were usually produced in the bottom region of the entire pitch range. Mean F0 was around 200 Hz for both spontaneous speech and reading tasks. Frequency range was about 3.5 semitones wider in spontaneous speech as compared with the reading lyrics. As concerned with the singing tasks, the chosen song presented a wider mean F0 variation (265 to 550 Hz) when compared with the reference song (448 to 475 Hz). The same finding was observed for F0 SD (38 to 92 Hz and 69 to 80 Hz, for the chosen and reference song, respectively), and for frequency range (13 to 27 ST and 10 to 12 ST, for the chosen and reference song, respectively). The chosen song was produced covering the medium region of the frequency range, while the reference song was sung in the upper region of the *cantadeiras*' voices. However, the reference song was the most limited in pitch range (about 11 ST). Finally, comparing speaking with singing tasks, singing involved higher frequencies, as expected, and greater F0 SD, indicating a higher pitch variance.

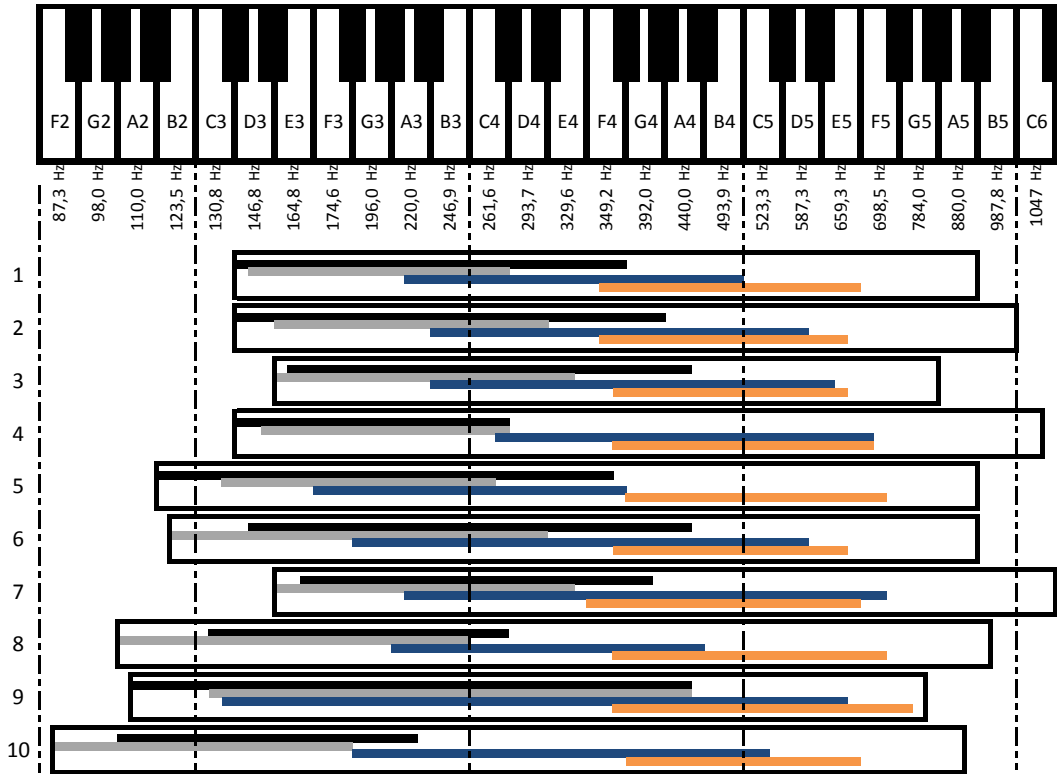

Figure 46. Display of summary results concerning total F0 range (large squares) and F0 range for each vocal task (coloured lines), presented for each cantadeira numbered according to the ranking order of the LT: #1=S18; #2=S07; #3=S22; #4=S16; #5=S02; #6=S01; #7=S10; #8=S20; #9=S21; #10=S19. Black lines = spontaneous speech; grey lines = reading lyrics; blue lines = chosen songs; and orange lines = reference song.

Leq in spoken tasks varied between 65.5 and 79.5 dB in spontaneous speech, while in reading lyrics varied between 67.4 and 80.2 dB. Higher values were obtained for the chosen and reference songs: 81.4 to 91.4 dB and 83.1 to 90.9 dB, respectively.

Comparisons between tasks have been made according with mean F0 and Leq (see Figure 47). Results show that there is a clear distinction between singing and speaking; the later presents lower Leq and F0. Mean F0 had the narrowest distribution in reference song; a natural finding considering that all singers performed the same song in similar tones.

Table 21. Summary results of F0 (including mean F0, F0 SD and F0 range in ST) and Leq, for each vocal task (spontaneous speech, reading lyrics, chosen song and reference song), for each *cantadeira*, listed according with the LT ranking order.

LT ranking order	VAS [%]	Singers' Id.	**F0 related measures**												**Leq** [dB]			
			Spont. Speech			Reading Lyrics			Chosen Song			Reference Song						
			Mean F0 [Hz]	F0 SD [Hz]	F0 range [ST]	Mean F0 [Hz]	F0 SD [Hz]	F0 range [ST]	Mean F0 [Hz]	F0 SD [Hz]	F0 range [ST]	Mean F0 [Hz]	F0 SD [Hz]	F0 range [ST]	Spont. Speech	Reading Lyrics	Chosen Song	Ref. Song
1	79.2	S18	204	39	18	207	25	11.8	346	56	14.8	475	80	11.3	71.68	74.51	87.6	90.25
2	78.9	S07	219	29	18.3	238	26	12.3	389	78	15.4	467	69	10.7	72.12	80.23	89.92	90.14
3	62.3	S22	235	43	17.4	198	24	12.4	475	79	17.4	470	70	10.5	79.45	76.19	86.86	90.94
4	55.2	S16	183	22	12.8	205	28	11.5	550	71	16.6	474	73	11.7	71.69	73.81	93.37	87.96
5	47.2	S02	196	43	19.6	195	28	11.3	265	38	13	468	76	10.8	78.33	71.86	81.35	84.25
6	38.4	S01	207	50	19	201	31	15.4	398	69	19.7	448	74	11	78.99	74.61	88.83	86.69
7	30.3	S10	215	38	15.8	214	29	12.7	418	83	19.3	467	72	11.6	65.47	67.38	83.79	83.12
8	27.6	S20	177	25	13.5	169	22	16	344	50	13.5	473	73	11.9	70.95	74.05	88.67	88.75
9	22.3	S21	228	52	24	237	61	20.4	419	71	27.1	466	75	12	75.01	75.06	87.32	90.91
10	20.4	S19	149	19	13.5	147	18	13.5	372	92	18.3	453	67	10.1	73.16	75.58	91.38	87.9

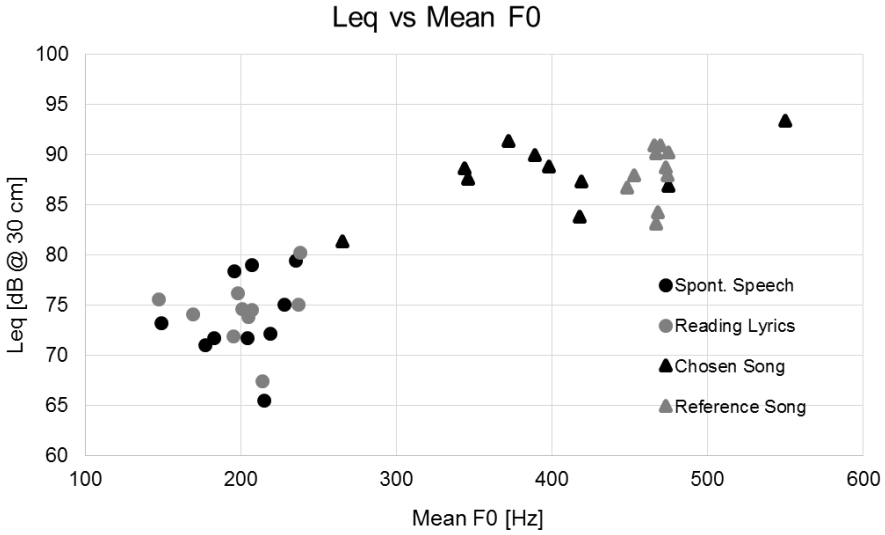

Figure 47. Distribution of Leq as function of Mean F0 in speech and singing tasks

Figure 48 displays LTAS for each *cantadeira* and vocal task. Once again, there are clear differences between speaking and singing tasks: singing presents higher energy, with a Leq increase of about 14 dB; and alpha measures are higher in singing, presenting an increase in energy levels above 1 kHz. Variations in $(H1\text{-}H2)_{LTAS}$ were not consistent among *cantadeiras*: singers S18, S07, S16 and S01 presented reduced values in singing (mostly between -9 and -5), while S22, S02, S10, S21 and S19 displayed similar values for both speech and singing, between -2 and 2.

Spectral peaks for the speaking tasks appear around 2.6-3.2 kHz, and 4-4.5 kHz, the last more evident for reading. Inconsistent differences between the speaking tasks were also found for alpha and $(H1\text{-}H2)_{LTAS}$ (see Table 22 with summary results for both LTAS and EGG measures, for each vocal task and *cantadeira*).

Concerning the singing tasks, alpha varied between -10.6 and 3 for the chosen song, whereas $(H1\text{-}H2)_{LTAS}$ varied between -9.7 and 0.5. Subjects S16 and S02, produced especially high and low spectral energy, respectively. They also obtained the highest and lowest Leq values, and performed some of the highest and lowest pitch songs, respectively.

Table 22. Summary results of LTAS and ELG, for each vocal task (spontaneous speech, reading lyrics, chosen song and reference song), for each *cantadeira*, listed according with the LT ranking order.

LT ranking order	VAS	Singers' Id.	LTAS related measures								ELG related measures											
			Spont. Speech		Reading Lyrics		Chosen Song		Reference Song		Spont. Speech			Reading Lyrics			Chosen Song			Reference Song		
			Alpha	$(H1\text{-}H2)_{LTAS}$	Alpha	$(H1\text{-}H2)_{LTAS}$	Alpha	$(H1\text{-}H2)_{LTAS}$	Alpha	$(H1\text{-}H2)_{LTAS}$	$Q_{contact}$ [%]	CFx [%]	CAx [%]	$Q_{contact}$ [%]	CFx [%]	CAx [%]	$Q_{contact}$ [%]	CFx [%]	CAx [%]	$Q_{contact}$ [%]	CFx [%]	CAx [%]
1	79.2	S18	-8.9	-0.84	-12.1	-0.97	-1.4	-5.36	4.04	-9.04	29.6	3.74	3.65	22.5	1.49	3.04	39.4	9.47	2.14	50.9	4.91	2.25
2	78.9	S07	-11.7	0.77	-9.0	-0.1	-1.6	-9.67	-0.57	-6.88	41.4	5.34	5.25	47.7	5.95	3.86	31.2	0.51	1.7	46.2	4.18	2.39
3	62.3	S22	-6.7	-1.69	-10.6	-0.56	-0.7	-1.05	-0.29	0.57	24.8	5.91	5.45	17.1	3.68	5.1	40.9	1.91	3.12	38.6	1.28	2.31
4	55.2	S16	-12.7	0.42	-10.3	0.38	3.0	-0.9	0.34	-3.39	25.0	5.67	3.43	32.3	8.96	4.25	53.2	2.02	2.66	46.3	8.5	3.07
5	47.2	S02	-10.6	-0.97	-14.3	1.54	-10.6	-0.83	-7.28	6.99	27.7	9.94	5.52	17.3	2.18	3.23	18.9	2.6	2.12	35.8	0.87	2.01
6	38.4	S01	-6.0	-0.68	-7.6	0.13	-1.4	-9.12	-0.7	-5.18	26.4	9.44	3.23	34.1	11.1	4.93	-	-	-	-	-	-
7	30.3	S10	-12.2	0.64	-9.7	0.3	-2.1	-0.06	-1.58	0.93	26.4	5.57	3.01	26.8	2.77	1.96	39.8	1.58	1.89	39.2	0.71	1.38
8	27.6	S20	-11.6	-0.51	-10.9	-0.39	-0.4	-6.96	-5.85	4.82	27.8	5.74	4.83	26.7	5.11	5.72	20.8	0.85	0.27	37.0	3.18	0.99
9	22.3	S21	-11.6	-0.91	-14.4	-0.21	-3.5	0.52	-1.19	0.70	35.1	11.9	7.09	35.3	10.1	4.5	35.4	1.59	1	39.3	2.87	1.94
10	20.4	S19	-14.3	1.1	-14.5	0.34	-4.5	-9.05	-6.01	2.39	23.1	3.36	4.98	22.8	4.02	5.3	24.4	2.11	1.39	38.5	1.48	1.34

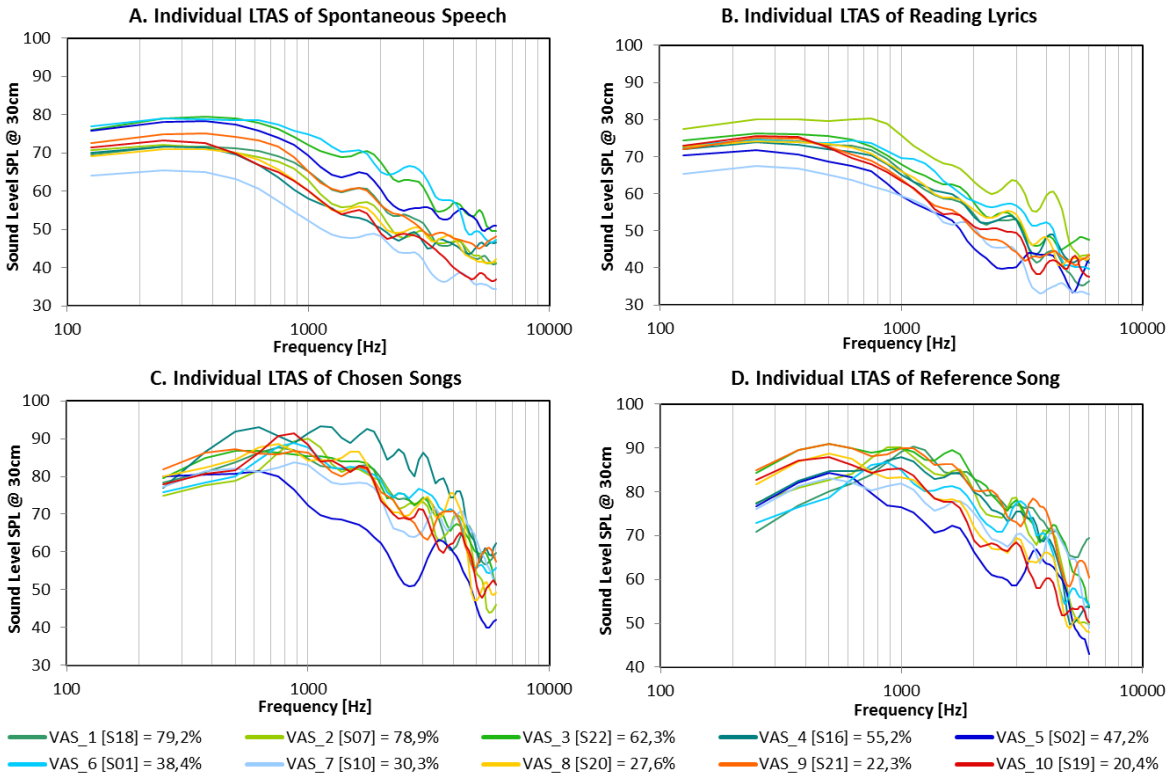

Figure 48. Individual LTAS in speech tasks – (A) spontaneous speech and (B) reading lyrics – and singing tasks – (C) chosen song and (D) reference song.

For the reference song, curves in the region under 1 kHz present some differences among singers: six singers (S07, S02, S10, S20, S21 and S19) have descendent curves, while the remaining four (S18, S07, S16 and S01) have ascendant curves and presented a peak in the 0.8 to 1.2 kHz region. This observation was confirmed with $(H1\text{-}H2)_{LTAS}$ measures: the first six singers had positive values (between 0.57 and 6.99), while the other four obtained negative values (between -9.04 and -3.39). Leq values varied between 83 and 91 dB and alpha between -7.3 and 4, revealing great differences in the proportion of energy above and below 1 kHz. Additionally, the existence of clear peaks in the 3 to 5 kHz region is also evident for most of the singers.

Concerning ELG related parameters, the ELG signal for the singing tasks of singer S01 could not be analysed: the signal quality failed to provide robust data. Thus, the results next presented will disregard this singer.

Generally speaking, $Q_{contact}$ varied between 23 and 41% for spontaneous speech, 17 and 48% for reading lyrics, 19 and 53% for the chosen song, and 37 and 51% for the reference song. Results showed a tendency for lower contact of the vocal folds in speech tasks as

compared to the singing ones (especially for the reference song). For CFx, values varied between 3.7 and 11.9% in spontaneous speech, 1.5 and 11.1% in reading the lyrics, 0.5 and 9.5% in the chosen song, and 0.7 and 8.5% in the reference song. Thus, one can argue that frequency perturbation was lower for the singing as compared to speaking tasks. Also, measures of amplitude perturbation (CAx) were found to be lower for singing tasks: 0.3 to 3.1% for the chosen song, and 1 to 3.1% for the reference song, as compared with 3 to 7.1% for spontaneous speech, and 2 to 5.7% for reading the lyrics.

After presenting all voice measures which explored differences between speaking and singing tasks, a Wilcoxon non-parametric test was carried out to assess whether differences between voice parameters for the two speech tasks (spontaneous speech vs reading lyrics) and also between the two singing tasks (chosen song vs reference song) exist and are significant. This test was particularly chosen because data were not normally distributed. Results are listed in Table 23.

Table 23. Wilcoxon non-parametric test results (Z) assessing whether differences between voice parameters analysed for speech tasks (spontaneous speech vs reading lyrics) and for singing tasks (chosen song vs reference song) are significant (n = 10 singers).

	Spont. Speech vs Reading Lyrics		**Chosen Song vs Reference Song**	
	Z	***p-value***	***Z***	***p-value***
Mean F0	-0.051	0.959	*-2.193*	***0.028****
F0 SD	-1.838	0.066	-0.357	0.721
F0 Range	*-2.431*	***0.015****	*-2.803*	***0.005****
Leq	-3.57	0.721	-0.357	0.721
$(H1\text{-}H2)_{LTAS}$	-0.561	0.285	-1.784	0.575
Alpha	-1.070	0.575	-0.561	0.074
$Q_{contact}$	-0.255	0.799	-1.836	0.066
CFx	-1.070	0.285	-0.415	0.678
CAx	-0.968	0.333	-0.711	0.477

* Significant differences at a 0.05 level; ** Significant differences at a 0.01 level

For the speech tasks, frequency range seems to be the only parameter able to distinguish spontaneous speech from reading lyrics (p = 0.015). For the singing tasks, mean F0 (p = 0.028) and also frequency range (p = 0.005) seem to statistically reflect the differences between the chosen and the reference song. All remaining measures, reflecting vocal loudness, timbre and vocal folds vibratory dynamics, were found to be similar among spoken and sung tasks under comparison.

Finally, Table 24 displays Psub values for the pitches included in the refrain of the reference song. Data of all singers is included, except for singer S20, as data analysis revealed non flat pressure peaks, which could overestimate Psub values.

Table 24. Subglottal pressure in task "reference song in [pa]"

LT ranking	VAS	Singers' Id.	Psub (cm H_2O)							
			F4	F#4	G#4	Bb4	B4	C#5	D#5	Mean Psub
1	79.2	S18	26.2	27.5	30.9	33.7	36.1	39.8	40.7	**33.6**
2	78.9	S07	16.4	18.0	21.1	23.9	25.8	28.8	30.6	**23.5**
3	62.3	S22	19.5	19.4	23.1	23.8	25.3	26.4	28.1	**23.7**
4	55.2	S16	16.5	17.7	20.1	22.3	24.7	28.3	-	**21.6**
5	47.2	S02	11.5	13.4	16.4	18.5	19.5	21.4	-	**17.8**
6	38.4	S01	18.1	21.1	22.4	24.0	24.5	26.5	23.5	**22.9**
7	30.3	S10	12.5	13.4	14.9	16.2	17.5	19.8	19.9	**16.3**
8	27.6	S20	-	-	-	-	-	-	-	**-**
9	22.3	S21	11.4	13.5	15.6	17.6	18.5	20.6	22.8	**17.1**
10	20.4	S19	11.6	12.8	14.1	14.4	16.3	18.0	17.1	**14.9**

Mean Psub values among singers varied from 15 to 34 cmH_2O. The highest value was obtained by the *cantadeira* with the highest classification in the LT (achieving 40 cmH_2O) whereas the lowest value was presented by the *cantadeira* with the lowest LT classification.

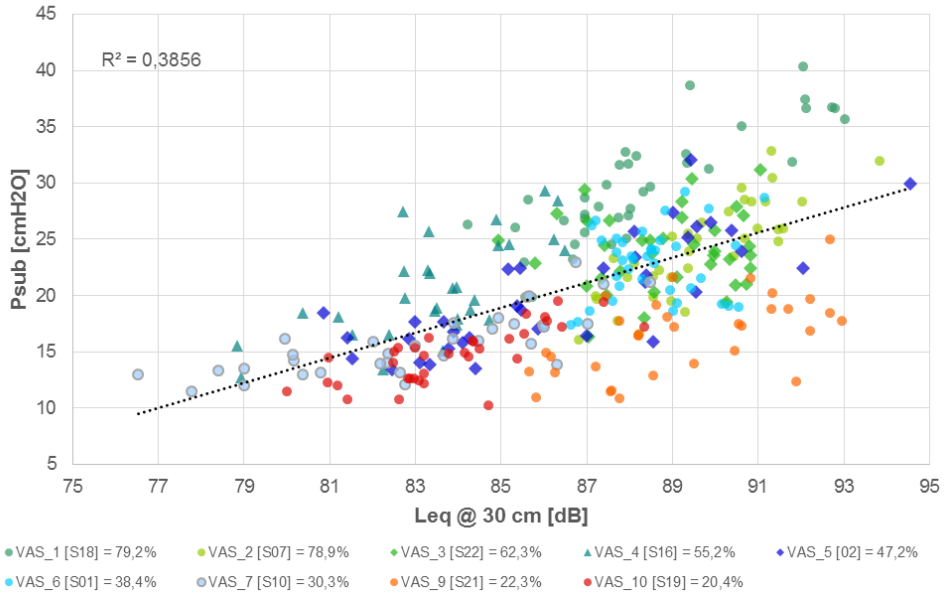

Figure 49. Distribution of Psub as function of Leq. Each data point represents a different pitch for each of the 10 *cantadeiras*.

Figures 49 and 50 display the variation of Psub as function of Leq and F0, respectively. Psub shows a linear relationship with Leq (r = 0.62). Also, when analysing how Psub varies as a function of F0, a tendency for Psub to increase with increasing F0 is observed. Singers with higher LT classifications appear to present higher Psub values all-over the frequency range of the song: the most representative singer (S18) reveals the highest Psub.

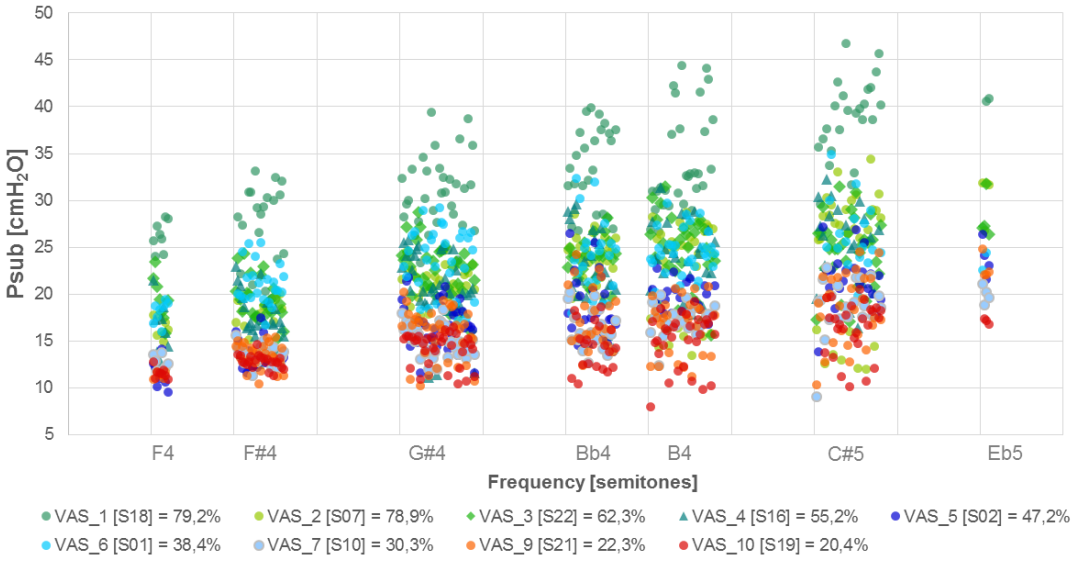

Figure 50. Distribution of Psub as function of Leq. Each data point represents a different pitch sung by each of the 10 participating *cantadeiras*.

6.3.2. COMPARISONS BETWEEN SPEECH AND SINGING VOICE CHARACTERISTICS

When describing a singing style for the first time, it seems a natural step to compare vocal behaviour during singing with vocal behaviour during speech. Thus, in this study and like the pilot one (Chapter 4), *cantadeiras*' voice characteristics were compared for singing and speaking tasks. The tasks chosen for this comparisons were spontaneous speech and the chosen song, as they constitute non-imposed phonatory situations and thus might represent habitual behaviours.

F0 related measures for spontaneous speech and the chosen song presented relevant differences concerning: (i) mean F0 (149 to 235 Hz for speech, and 265 to 550 Hz for singing); and (ii) F0 SD (19 to 52 Hz for speech, and 38 to 92 Hz for singing). Smaller differences were found for F0 range, 13.5 to 24 ST for speech, and 13 to 27 ST for singing.

LTAS comparisons between tasks also showed relevant differences, as shown in Figure 51. Higher spectral energy levels were observed both above and below 1 kHz in singing. Leq also reflected this difference: between 65.5 and 79 dB for spontaneous speech, and between 81 and 93 dB for the chosen song. Alpha ratio in speech varied between -14.3 and -6.0, negative values meaning that, for all singers, the sum of spectral energy below 1 kHz is higher than above. In singing, alpha varied between -10.6 and 3. Although only one singer (S16) had a positive value, most singers had much higher values (near to 0) when compared with speech. This finding is related with the evident gains of energy above 1 kHz, observed for singing in Figure 51.

Considering $(H1\text{-}H2)_{LTAS}$, values were considerable lower in singing (-9.7 to 0.5) than in speech (-1.69 to 1.1): apparently, in singing the second harmonic partial (H2) has consistently higher energy than the first (H1). In speech, the difference between H1 and H2 was lower, near 0 (between -1 and 1 for 9 singers). This finding was somewhat corroborated by LTAS slope below 1 kHz: a positive slope [y = **0,0095**x + 78,068] around the region of F0 was found for most singers in singing, while a flat or negative slope [y = **-0,01**x + 75,712] can be observed in speech for the same spectral region.

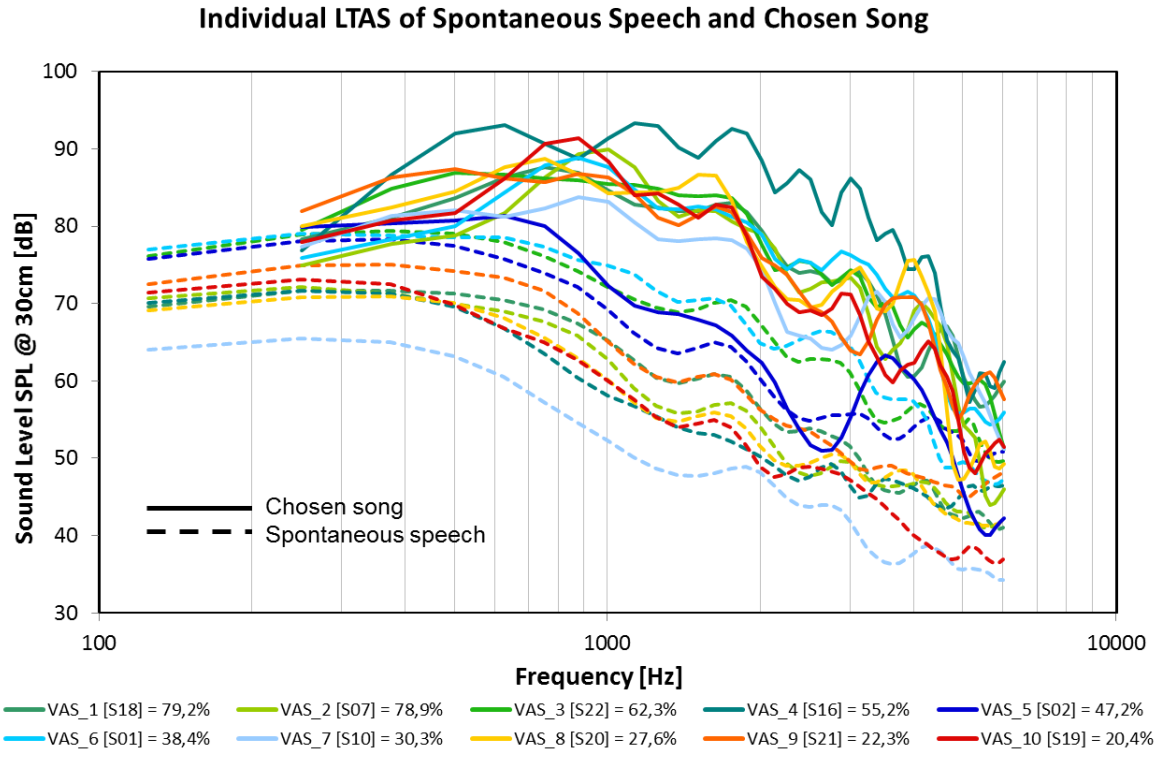

Figure 51. LTAS for spontaneous speech (dotted lines) and for the chosen song (filled lines), for each individual *cantadeira*.

Concerning ELG measures, half of the *cantadeiras* presented $Q_{contact}$ values below 35% in singing, whereas for spontaneous speech almost all singers presented $Q_{contact}$ values below 35% (see Figure 52). It is interesting to observe that one singer outlies in singing with both the highest $Q_{contact}$ and Leq; she obtained the fourth highest LT rating (55,2%), although not in the chosen, but in the reference song.

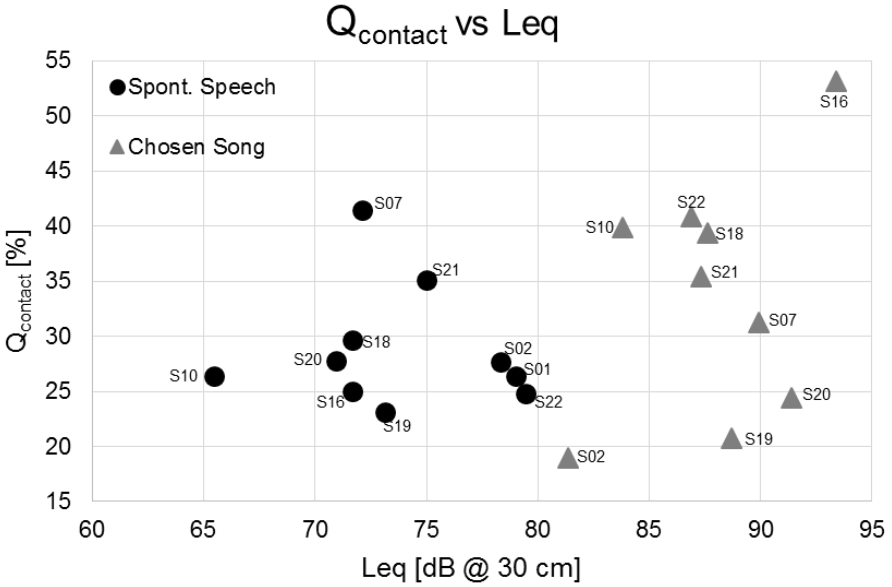

Figure 52. Distribution of $Q_{contact}$ values as function of Leq, for both spontaneous speech (bullet points) and the chosen song (triangles). Each data point corresponds to a single *cantadeira*.

Figure 53 displays CFx and CAx as function of Leq for both spontaneous speech and reference song. Apparently, when singing, *cantadeiras* have a lower ELG cycle-to-cycle perturbation for both frequency and amplitude.

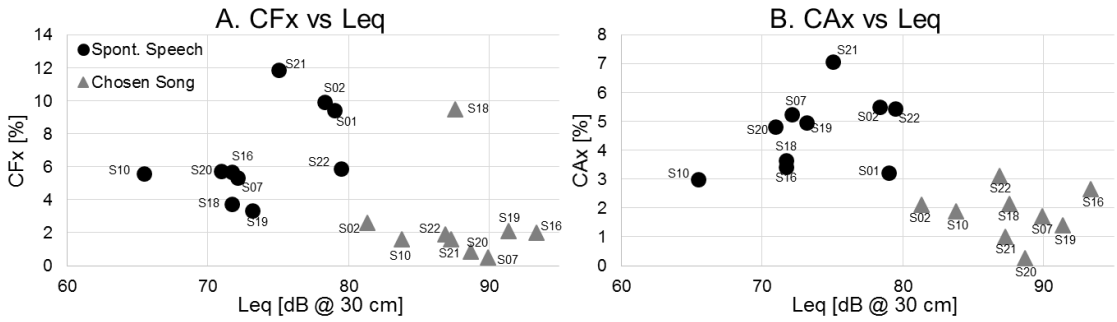

Figure 53. Distribution of CFx (A) and CAx (B) as function of Leq for spontaneous speech (bullet points) and the chosen song (triangles). Each data point corresponds to a *cantadeira*.

A Wilcoxon non-parametric test (Z) was used to assess whether differences between the vocal parameters analysed for speech and singing were significant. As presented in Table 25, most significant differences between speech and singing were found for mean F0 ($p = 0.005$), Leq ($p = 0.005$), F0 SD ($p = 0.007$), $(H1\text{-}H2)_{LTAS}$ ($p = 0.008$), and CAx ($p = 0.008$). Smaller but also significant differences were found for alpha ($p = 0.047$). F0, F0 SD, Leq and alpha were higher in singing, while $(H1\text{-}H2)_{LTAS}$ and CAx were higher in speech.

Table 25. Wilcoxon non-parametric test (Z) results testing whether differences between several voice parameters analysed for spontaneous speech and chosen song exist and are significant (n = 10 singers).

	Spontaneous Speech VS Chosen Song	
	Z	***p-value***
Mean F0	***-2.805***	***0.005*****
F0 SD	***-2.705***	***0.007*****
F0 Range	-0.560	0.575
Leq	-2.803	***0.005*****
$(H1\text{-}H2)_{LTAS}$	***-1.988***	***0.047****
Alpha	**-2.668**	***0.008*****
$Q_{contact}$	-1.125	0.206
CFx	-1.836	0.066
CAx	***-2.666***	***0.008*****

* Significant differences at a 0.05 level; ** Significant differences at a 0.01 level

6.3.3. IDENTIFICATION OF CANTADEIRAS' GROUPS BASED ON THE RELATIONSHIP BETWEEN INDEPENDENT VARIABLES

In order to identify how *cantadeiras* could be grouped according to the relationships between all independent variables (i.e. physiological and acoustical parameters), rather than exclusively according to LT results, both HCA and PCA were carried out. HCA was carried out for defining data structure and, together with PCA, data overview and feature selection were also possible.

The data used to perform HCA and PCA was normalised into z-scores (calculated as the difference between each score and the average of all scores, divided data by the standard deviation). This data normalization was performed as voice parameters present different units.

The dendrogram presented in Figure 54 provides a two dimensional plot of the data structure, indicating the merging singers and the merging distances between them. This structure is constructed on the basis of the whole available information for the 10 singers. The data possess a super-structure in which three groups of singers emerge, highlighted in different colours. One can argue that the distribution of these groups reflects to some extent the ranking order obtained in the LT. Groups I and III include the singers classified with a VAS between 20 and 79%, whereas Group II has only one singer, the one possessing the highest LT score (>79%).

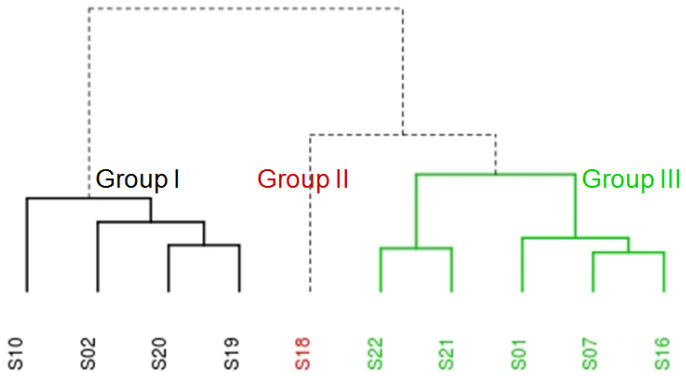

Figure 54. Dendrogram grouping the *cantadeiras*, constructed using Ward's method with Euclidean distances and using both physiological and acoustical parameters as variables defining each of the singer voices. Data was previously transformed to z-scores.

One can reorganise the singers in PCA groups (Figure 55). Group PCA-I integrates 4 singers with a mean LT score of 31.3% (SD = 9.82; range 20.4 to 47.2%), Group PCA- II included only one singer, the one obtaining the highest score in the LT (79.2%), and Group PCA-III was constituted by 5 singers, with a mean VAS of 51.42% (SD = 15.8; range 22.3% to 78.9%).

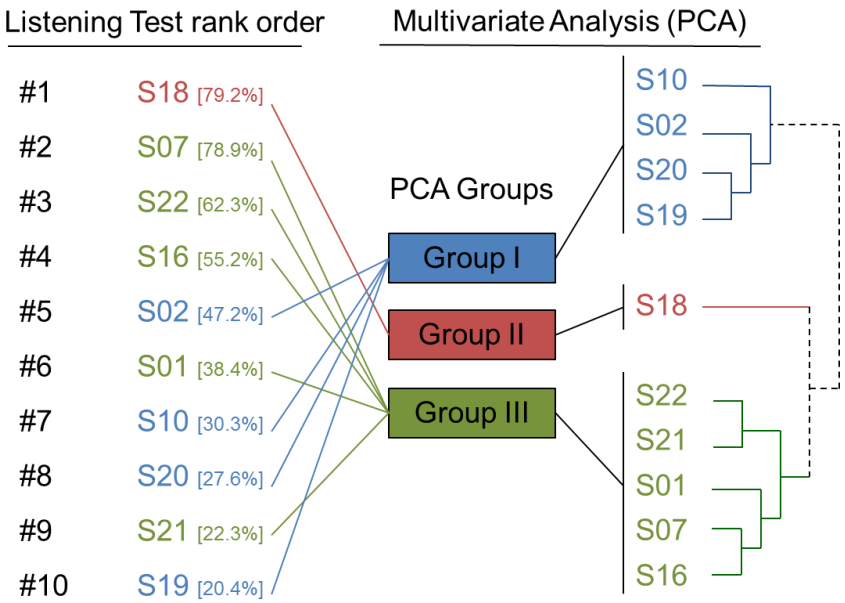

Figure 55. Reorganization of singers' groups according to the results of PCA (right of the figure). The left of the figure presents the respective correspondence between PCA groups and the rank order of the singers according to the LT scores.

After establishing the number of clusters, PCA was then directly applied in order to assess possible relationships between physiological and acoustical voice parameters and the established groups.

Table 26 summarises PCA results, using a correlation matrix. This approach, performed on the z-scores, emphasises those fractions with a higher degree of absolute variation, i.e., variables with a large percentage variation but small value, are lost in the characterization. It is seen that the first two principal components are able to recover 89% of the data variability, indicating that a graphical representation based on these two components is clearly meaningful.

Table 26. PCA results for the first two components using the correlation approach (n = 10 singers).

Principal components	Explained variance (%)	Cumulative explained variance (%)
PC_1	74.0	74.0
PC_2	15.0	89.0

The scree graph of the eigenvalues, presented in Figure 56, shows that the first component contains, in fact, the most relevant information for discrimination, suggesting a one-factor solution.

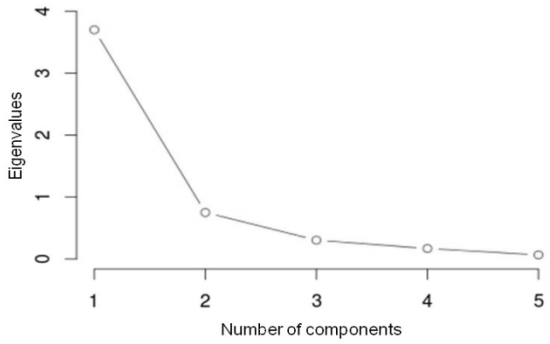

Figure 56. Scree plot of eigenvalues including 5 physiological and acoustic parameters: $(H1\text{-}H2)_{LTAS}$, $Q_{contact}$, alpha, mean Psub, and Leq. Principal components are sorted by decreasing fraction of total variance explained.

Figure 57 displays a composed view of the singers in a bi-plot form, considering the new orthonormal principal component system (Gabriel, 1971). The relative location of the singers can be interpreted. Singers that are close together correspond to observations that have similar scores on the components displayed in the plot. To the extent that these components well-fit the data, the singers also correspond to observations that have similar values on the variables. Singers that are close together are the ones presenting similar overall voice profiles.

Both the direction and length of the vectors can also be interpreted. Vectors that point in the same direction correspond to variables that have similar response profiles, and can be interpreted as having similar meaning in the context set by the data. So, for these data, where the vectors represent voice parameters, and the points represent the singers, a group of vectors pointing in the same direction correspond to a group of singers having similar voice profiles.

This two dimension representation allows the visual discrimination between singers. As a preliminary PCA result, the data scores representation is in direct agreement with the results obtained with HCA.

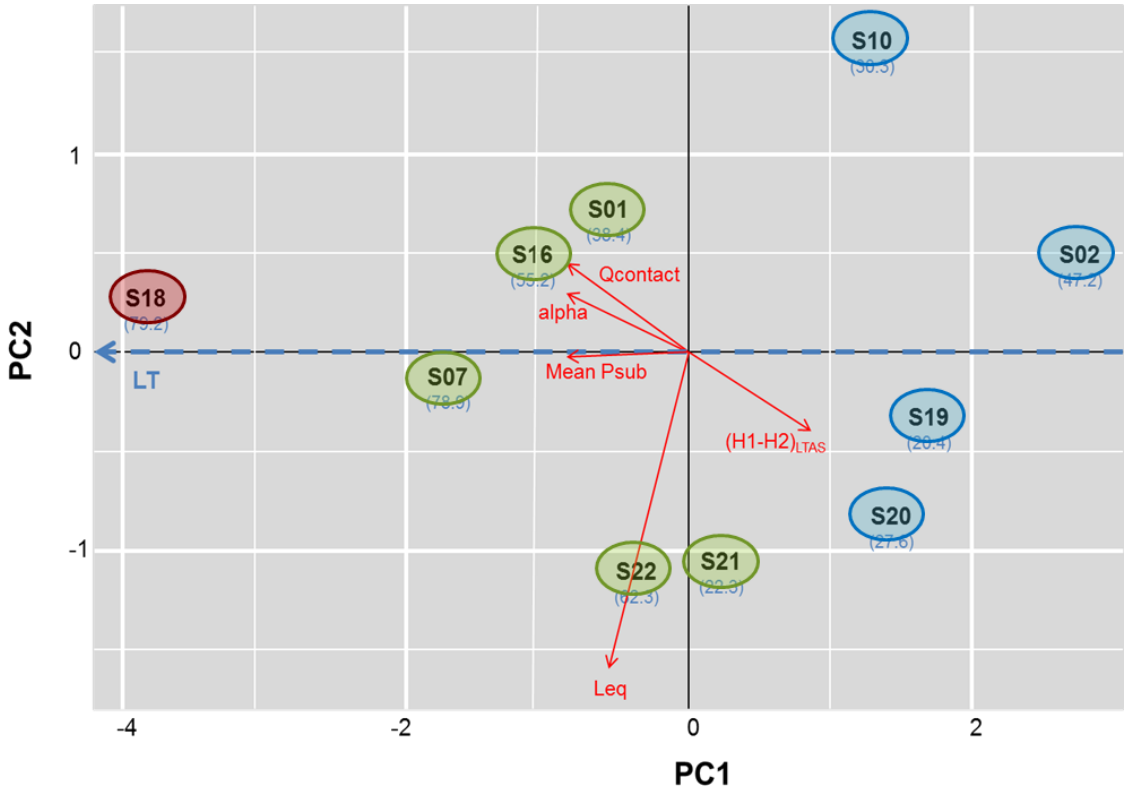

Figure 57. Representation of the voice data from ten singers on the first two components with 89% of information recovery (n = 10 singers).

In Figure 57 the points representing the singers are ranked along a virtually straight line, PC1, if one takes into account the lower relevance of the second component. This line corresponds, in turn, to the LT classification scores which, as response variable, was not included in the analysis. LT reflects the most representative voice of the AM female folk singing. This suggests that there are significant changes in the voice profile of singers included in the groups defined in the dendogram (Figure 54).

The first component, PC1, retains mainly information over $(H1\text{-}H2)_{LTAS}$, $Q_{contact}$, alpha and mean Psub: absolute weights of 0.488 for $(H1\text{-}H2)_{LTAS}$, 0.485 for $Q_{contact}$, 0.480 for alpha and 0.453 for mean Psub. Further observations can be drawn from the fact that the values of this first component are almost all negative, suggesting that PC1 represents the results of LT classification. High values of these voice parameters suggest an increase in the LT scores. The second component is mostly related with Leq (absolute weight of 0.931).

The length of the red vectors in Figure 57 approximates the variances of the variables. The longer the vector, the higher the variance. This figure also shows a strong relationship between $Q_{contact}$ and alpha and a weak relationship between Leq and both $Q_{contact}$ and (H1-

$H2)_{LTAS}$, as extracted from the angles between the vectors corresponding to these variables. The correlation between $(H1\text{-}H2)_{LTAS}$ and each of the other variables is negative.

Singer S18 stands out with the highest LT score, highest $Q_{contact}$, mean Psub and alpha values, and lowest $(H1\text{-}H2)_{LTAS}$ value, followed by S07, S16 and S01. These singers have similar $Q_{contact}$ and mean Psub and negative values of $(H1\text{-}H2)_{LTAS}$. Singer S02 also stands out, with the highest $(H1\text{-}H2)_{LTAS}$ and lowest $Q_{contact}$.

After identifying PCA-based groups, it is important to understand the distribution of F0, Leq, LTAS, ELG and Psub related measures for the reference song among these groups. In the following sections, groups are identified by colours: PCA-I (white), PCA-II (black) and PCA-III (grey).

Analysing the distribution of Leq as a function of F0 for each PCA group (see Figure 58), results suggest little variation among groups for mean F0: between 448 and 475, which represents less than one ST. This was according to expectations, as all singers performed the same song while listening the same instrumental accompaniment. Leq exceeded 90 dB at least for four singers, from groups PCA-II and PCA-III. Two singers from group PCA-I obtained the lowest Leq values (between 83 and 84 dB).

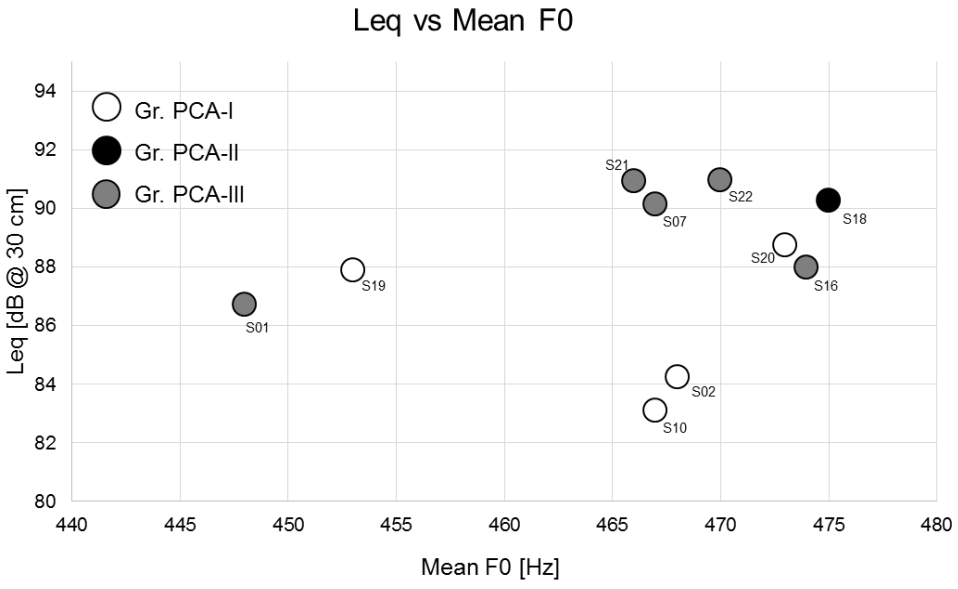

Figure 58. Distribution of Leq as function of mean F0 for the reference song, grouping *cantadeiras* according with PCA results (PCA-I, white circles, PCA-II, black circles and CA-III, grey circles).

Great diversity was already shown to exist in individual LTAS curves (Figure 59.A). Therefore, mean LTAS for each PCA group were computed (Figure 59.B) to highlight most relevant characteristics of these groups. In addition, Figures 60.A and 60.B were also plotted considering LTAS related measures (Leq, alpha and $(H1\text{-}H2)_{LTAS}$). They concern only the reference song.

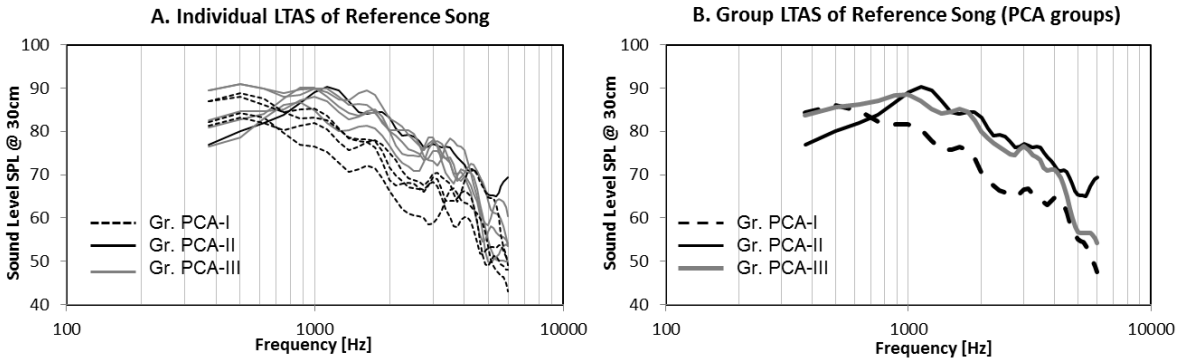

Figure 59. Individual (left panel) and group (right panel) LTAS for the reference song. Note that groups PCA-I, PCA-II and PCA-III, are represented in dotted, black and grey lines, respectively.

A tendency for higher energy distribution was observed for groups PCA-II and PCA-III, whereas PCA-I singers revealed the lowest spectral energy. Clear differences between groups were found in the slope below 1 kHz: both PCA-II and PCA-III presented a LTAS positive mean slopes [y = **0,0189**x + 70,049], and [y = **0,0076**x + 81,359] respectively; while PCA-I presented a negative mean slope [y = **-0,0066**x + 87,998].

A similar observation was obtained for Leq: PCA-II and PCA-III presented higher Leq values (86.69 to 90.94 dB), while PCA-I achieved lower values (83.12 to 88.75 dB) (see Figure 60). Alpha followed the same pattern, with higher values for groups PCA-II and PCA-III (-1.19 to 4.04), whereas lower values of $(H1\text{-}H2)_{LTAS}$ were obtained for these groups (-9.04 to 0.7). Group PCA-II singer (S18) stood out from the others, assuming the highest Leq and alpha values, and a rather low $(H1\text{-}H2)_{LTAS}$.

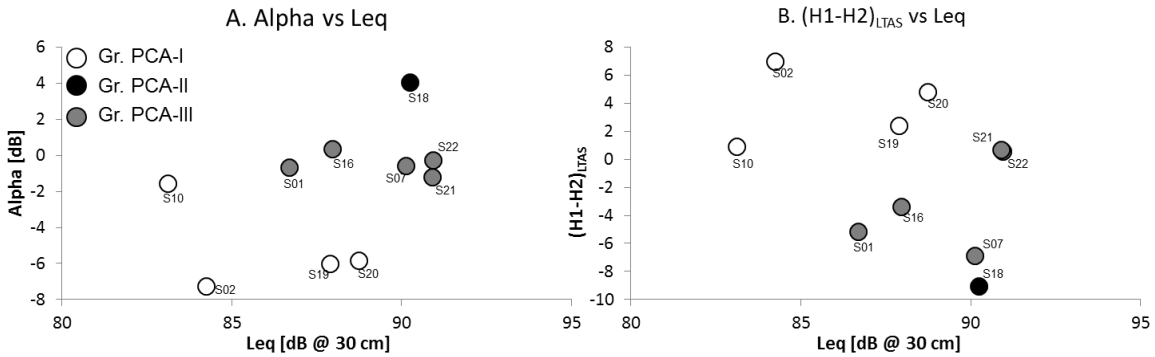

Figure 60. Distribution of Alpha (left panel) and $(H1-H2)_{LTAS}$ (right panel) as function of Leq for the reference song. Note that groups PCA-I, PCA-II and PCA-III are represented by white, black and grey circles, respectively.

ELG related measures were also computed as function of Leq (Figures 61 and 62). $Q_{contact}$ has shown wide variations among groups: group PCA-II (singer S18) and 2 singers from PCA-III obtained higher $Q_{contact}$ (between 46 and 51%), while all other singers (mostly from groups PCA-I) varied between 35 and 40%.

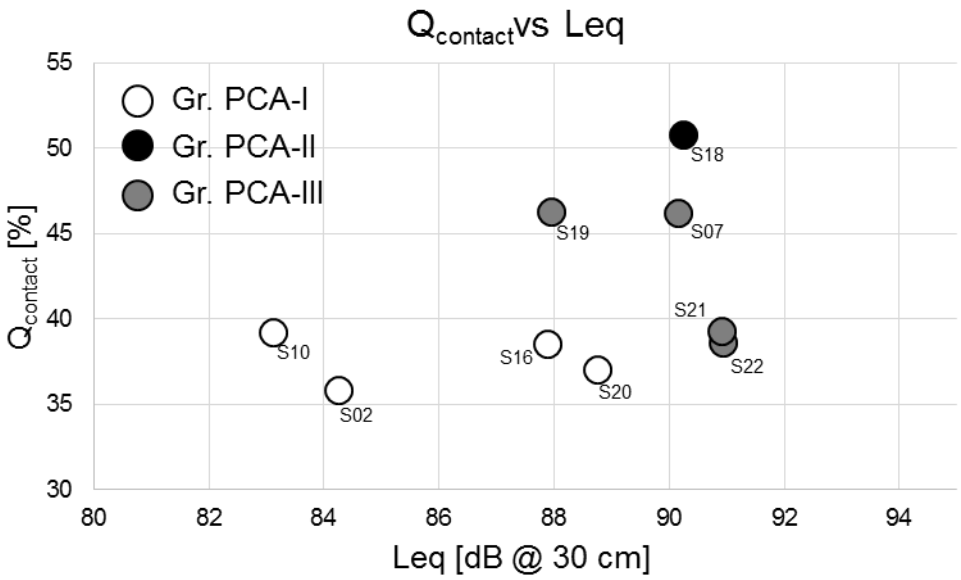

Figure 61. Distribution of $Q_{contact}$ as function of Leq for the reference song. Note that groups PCA-I, PCA-II and PCA-III are represented by white, black and grey circles, respectively.

Figure 62 presents the results for CFx and CAx parameters versus Leq (Figures 62 A and 62B, respectively). There is no clear pattern in CFx distribution among groups: most singers are located between 1 and 5% for both measures. Most PCA-II and PCA-III singers were above 2% while most PCA-I singers were below this value. Considering CAx, a narrower

distribution may be seen in all groups: groups PCA-II and PCA-III varied in a 2 to 3% interval, while PCA-I had a slightly lower interval (1 to 2%).

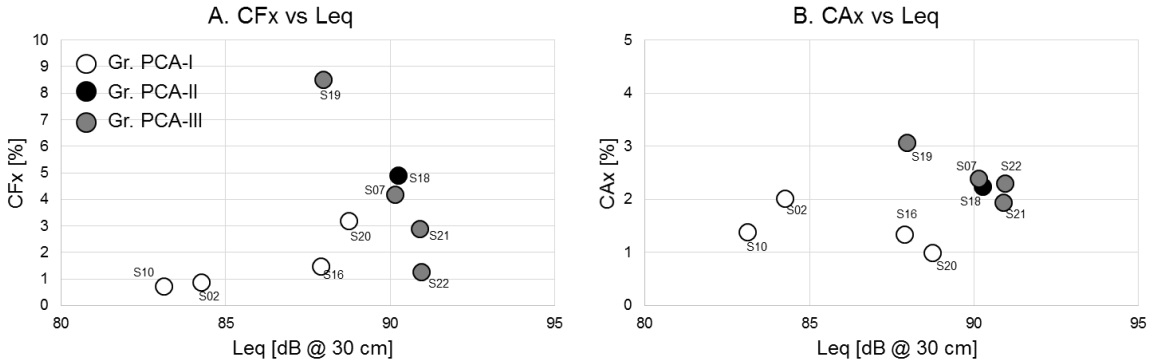

Figure 62. Distribution of CFx (left panel) and CAx (right panel) as function of Leq for the reference song. Note that groups PCA-I, PCA-II and PCA-III are represented by white, black and grey circles, respectively.

Psub was also computed as function of Leq and F0 (Figures 63 and 64, respectively). The singer from group PCA-II revealed systematic higher Psub values. Considering the linear association described in Figure 49 (dotted line in Figure 63), PCA-I Psub was mainly located below the line, in the 75-90 dB interval of Leq, while PCA-III was also below the line but mostly concentrated between 85 and 95 dB. PCA-II results were the ones with higer Psub and Leq, mostly located above the line and higher than 85 dB.

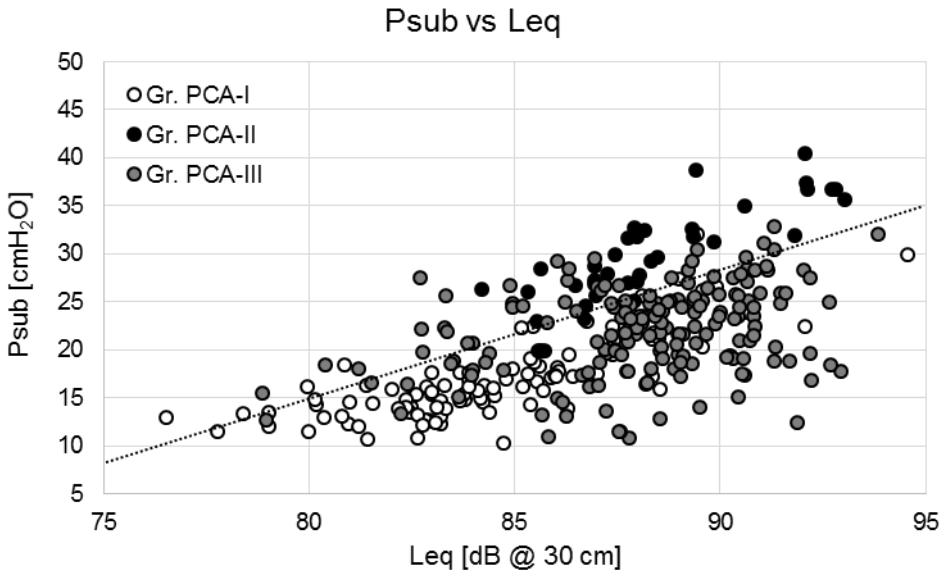

Figure 63. Distribution of Psub as function of Leq for the reference song. Note that groups PCA-I, PCA-II and PCA-III are represented by white, black and grey circles, respectively.

Regarding Psub distribution as function of F0, the highest values were found for PCA-II singer, intermediate values for PCA-III group, and lower values for PCA-I. The tendency in all groups was to rise Psub with F0. Rather high Psub values were found for S18, especially for tones B4 and C#5, achieving values between 40 and 47 cmH2O.

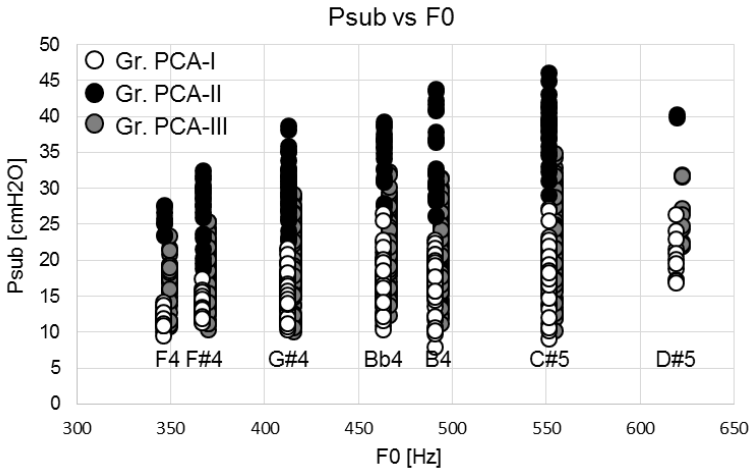

Figure 64. Distribution of Psub as function of F0 for the reference song. Note that groups PCA-I, PCA-II and PCA-III are represented by white, black and grey circles, respectively.

A Kruskal Wallis test for comparisons between groups was carried out (Table 27). This test was particularly chosen because data were not normally distributed, and because this test allows the assessment of whether differences between PCA groups regarding voice measurements are significant.

Results suggest that groups differ significantly between them concerning Leq, alpha, $(H1-H2)_{LTAS}$, and Psub for pitch F#4. $Q_{contact}$ obtained a borderline, although non-significant, p-value (0.059).

Table 27. Kruskal Wallis test summary results for comparisons concerning all voice parameters analysed between PCA groups

	PCA Groups	
	Chi square [Kruskal Wallis]	**p-value**
Mean F0	2.482	0.289
F0 SD	2.482	0.289
F0 Range	0.060	0.970
Leq	***6.840***	***0.033****
$(H1\text{-}H2)_{LTAS}$	***7.364***	***0.025****
Alpha	***7.364***	***0.025****
$Q_{contact}$	5.667	0.059
CFx	3.367	0.186
CAx	4.967	0.083
Mean Psub	5.404	0.067
Psub [F4]	3.840	0.147
Psub [F#4]	***6.454***	***0.040****
Psub [G#4]	5.404	0.067
Psub [Bb4]	5.404	0.067
Psub [B4]	5.404	0.067
Psub [C#5]	5.404	0.067
Psub [D#5]	4.821	0.090

*. Significant differences at the 0.05 level
**. Significant differences at the 0.01 level

6.3.4. PREDICTIONS OF CANTADEIRAS' PERCEPTUAL EVALUATIONS

As mentioned before, an additional aim of this study was to identify particular acoustical and physiological characteristics that may act as predictor of whose voices are recognised as representative of AM female folk singing. A multiple regression analysis testing all voice parameters analysed was carried out. Results whould allow the understanding of which of these parameters best predict the results of the LT. Mean Psub was excluded from this analysis, to avoid multicollinearity with the remaining Psub measures. Once again, z-scores of the included voice parameters and LT results were used instead of the raw data. A preliminary analysis included correlation analysis between all variables in a correlation matrix, followed by exploring regressions with forward, backward and stepwise methods, as recommended by Marôco (2011). As result, four independent variables (zPsub[G#4], zPsub[Bb4], zPsub[B4], and zPsub[C#5]) were excluded because of a multicollinear effect.

The five principal requested criteria for carrying out a multivariate regression were fulfilled, namely: normality, reduced data multicollinearity (T=0.994; VIF=1.006; CI=21), and statistical independence of the errors (*d*=0.872). Linearity and homoscedasticity were assessed in a scaterplot of residuals versus predicted values. The dispersion and reduced sample difficult a clear interpretation of the scaterplot, but results were considered satisfactory and the models were accepted as valid.

Two predictive models were obtained using a stepwise method: the first including the variable zLeq, and the second including zLeq and zPsub[F#4]. The respective equations for both models are presented in Table 28. The second model explains 92% of zLT variability, whereas the first explains merely 86% of that variability.

Table 28. Multiple Regression Analysis Summary Model.

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	Equation
1	.935[a]	.874	.858	.222	zLT = 5.633 - 1.814zLeq
2	.970[b]	.941	.924	.162	zLT = 5.361 – 1.773zLeq – 2.214zPsub[F#4]

Both models were computed, and estimated zLT classifications were compared with those obtained in the original zLT. Results are ilustrated in Figure 65. The highest association between estimated and real LT classifications were found for Model 2 (r = 0.97). However, similarly high association was obtained for Model 1 (r = 0.94).

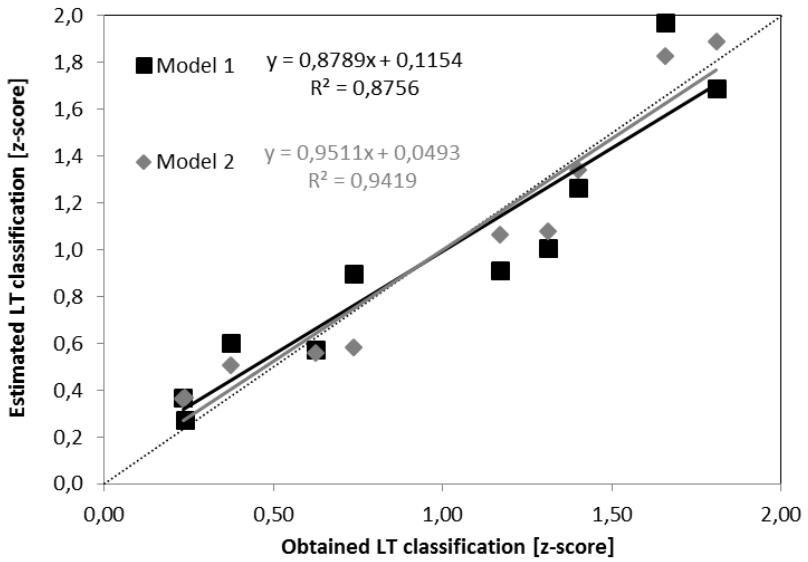

Figure 65. Comparison of LT results (dotted line) with predictions made by Model 1 and Model 2.

6.4. DISCUSSION

This chapter aimed at describing physiological and acoustic voice characteristics of AM folk singing. In order to do this, multichannel voice recordings of 10 *cantadeiras*, whose voices were previously rated as more or less representative of AM folk singing, were carried out. Audio, ELG, oral flow and intraoral pressure signals were simultaneously recorded for the reference song, while audio and ELG signals were recorded for other tasks: spontaneous speech, reading lyrics, and chosen song. Statistical methods were used, including inferential tests, HCA and PCA and multiple regression analysis. This next section discusses the results obtained in the following way: (i) *cantadeiras*' voice in speech; (ii) *cantadeiras*' voice in singing; and (iii) comparisons between AM folk singing with other singing styles. This order of presentation was chosen to attempt to answer some of the initial research questions: (i) how close (or far) is speech from singing in AM *cantadeiras*; (ii) how close (or far) is AM *cantadeiras*' singing from other non-classical and traditional singing styles?

6.4.1. CANTADEIRAS' VOICE IN SPEECH

F0 behaviour in the four main speech and singing tasks allowed relevant intra-subject and inter-subject data comparisons. The results suggest that while speech is produced in the lower boundaries of the *cantadeiras*' frequency range, singing is situated between the medium and higher regions. These findings corroborate the results of previous investigations, identifying a clear separation between speaking and singing tasks, also in other singing styles, such as classical singing (Lamarche, Ternström, & Pabon, 2010).

Spontaneous speech and reading lyrics were statistically identical for most measures, except for frequency range. This finding (also observed in the pilot study) supports previous reports suggesting that reading and spontaneous speech F0 ranges are different because they present dissimilar prosodic properties (Howell & Kadihanifi, 1991). Mean F0 in spontaneous speech (around 200 Hz) was close to the values reported in a study describing Portuguese healthy women both in reading (mean F0 = 196.9 ± 3.8 Hz) and conversational speech (mean F0 = 189.9 ± 4.2 Hz) (Guimarães & Abberton, 2005). However, F0 standard deviation (19-52 Hz) was rather high when compared with these references. Considering that limited normative data exist for Portuguese speakers, one may question whether these F0 characteristics could constitute a regional or cultural specific feature, as Portuguese

speakers included in Guimarães and Abberton (2005) were mostly non-singers living in the region of Lisbon, more towards the central coast of Portugal.

Leq obtained similar values for both spontaneous speech and reading tasks (around 74 dB). These were considerably higher than those presented elsewhere (in SPL), reporting young women and elder women reading in habitual loudness (65.96 dB and 64.63 dB, respectively)[32] (Silva, et al., 2011).

LTAS for speech tasks (especially in the reading one) shows a slightly higher spectral energy for those singers identified in the LT as possessing a more representative voice of AM folk singing style. The peaks found between 3 and 4 kHz are similar to those found in the pilot study, and could represent a resonance strategy, alike the formant cluster found for loud speech, the "speaker´s formant". The latter is a strategy based on the clustering of the three last formant frequencies (i.e. F3, F4 and F5) reported to exist in male trained voices (e.g. actors). The resulting peak in the spectra appears typically between 3 and 3.5 kHz, and is claimed to be an indicator of a "good voice" (Leino, et al., 2011; Master, et al., 2012). Perhaps, a similar strategy is developed by *cantadeiras* as a consequence of their singing habits, acquired to provide a representative sound of AM folk singing; or maybe they simply modify their vocal pattern when reading, as a consequence of adopting a declamatory atitude.

6.4.2. CANTADEIRAS' VOICE IN SINGING

The frequency range profile (also known as maximum phonational frequency range) of the *cantadeiras* was lower (both in minimum and maximum frequencies) than the reference presented by Sulter, Schutte et al. (1995), but close to the one presented by Siupsinskiene and Lycke (2011), both representing female non-trained voices.

Considering the singing tasks, most F0 related measures were significantly different between the chosen and the reference songs. These differences in F0 were expected, as an instrumental accompaniment was provided while *cantadeiras* where singing the

[32] Original data report SPL of 71.96 dB (SD 6.5) for young women and 70.63 dB (SD 4.1) for elder women reading in habitual loudness and recorded at 15 cm Silva, P. T., Master, S., Andreoni, S., Pontes, P., & Ramos, L. R. (2011). Acoustic and Long-Term Average Spectrum Measures to Detect Vocal Aging in Women. *Journal of Voice, 25*(4), 411-419.. Values were corrected to a 30 cm distance for comparison with current research data.

reference song, but not when singing the chosen one. Taking into account the results of the pilot study (Chapter 4), and that singers were instructed to sing as close as possible to a representative AM folk singing, one would expect that *cantadeiras* would choose higher frequencies to sing the chosen song, corroborating perceptions that AM folk singing is high pitched. However, this was not the case. In the present investigation, the chosen songs were usually sung in the medium/comfortable region of each singer's frequency range, despite the wider frequency ranges verified for each *cantadeira*. Perhaps this constitutes an indication that most songs might be placed in a "non-comfortable zone" of the *cantadeiras*, due to the intonation limitations of the instruments accompanying this style of singing, a phenomenon reported in the interviews (Chapter 3) and also described in other non-classical styles (Kayes, 2013).

Unlike F0 measures, all remaining measures were found to be identical between chosen and reference songs, thus confirming that a reference song may be used to represent a singing behaviour when there is the need of inter-subject comparisons. As an example, intensity levels (Leq) were found to be statistically similar in both the reference and the chosen songs. This might indicate that, although differences existed between the frequency ranges of the melodies, singers were able to reach similar intensity values in both middle and higher regions of their voices (frequency regions of the chosen songs and the reference song, respectively).

Generally, one may say that most *cantadeiras* of groups PCA-II and PCA-III presented high intensity values, similar to those found in the results of the pilot study (Chapter 4). These findings seem to corroborate the perceptions of one of the most important vocal characteristics claimed to represent this style of singing (Chapter 3): a loud voice.

When comparing the results of the LTAS for these *cantadeiras* with the results of the preceding pilot study (Chapter 4), the spectral peak found at approximately 1.3 kHz in the former study was not found in these *cantadeiras*. However, the LTAS slope below 1 kHz for singers possessing higher ratings of vocal representativeness was similar to the one found in the *cantadeira* of the pilot study. C*antadeiras* belonging to both PCA-II and PCA-III (the ones including the most representative voices) presented a LTAS positive slope below 1 kHz; S18 obtained the steepest slope of all. On the contrary, *cantadeiras* belonging to the PCA-I group (the ones with lower scores for vocal representativeness) presented negative slopes. These results may be a consequence of certain phonatory or/and resonant/articulatory strategies. A positive slope can be associated with a pressed

phonation, which usually produces a weak fundamental (Sundberg, 1987). On the other hand, a positive slope can also be associated with a F1:H2 formant tuning, similar to the one described for female Bulgarian and male Croatian voices singing traditional folk repertoire (Boersma & Kovacic, 2006; Henrich, et al., 2007).

$(H1\text{-}H2)_{LTAS}$ and alpha measures reflect the energy distribution in the LTAS (Thurman, Theimer, Welch, Feit, & Grefsheim, 2000); low/negative $(H1\text{-}H2)_{LTAS}$ and high/positive alpha values found for *cantadeiras* in groups PCA-II and PCA-III, reveal higher energy in the second harmonic region and above 1 kHz. Inversely, singers in PCA-I group showed a tendency for high/positive $(H1\text{-}H2)_{LTAS}$ values and low/negative alpha values (i.e. these singers' spectral energy is higher around the region of H1 and below 1 kHz). This last description supports the assumption of a flow phonation, where most sound energy comes from the fundamental, as it is described for professional classic singers (Thalén & Sundberg, 2001). Moreover, considering that most PCA-I *cantadeiras* also revealed lower Psub and $Q_{contact}$ values, one could argue that these singers, the ones recognised as having less representative voices for AM female folk singing style, are the ones presenting evidences of lower phonatory efforts.

Psub of *cantadeiras* in groups PCA-II and PCA-III was consistently higher than for the remaining *cantadeiras*, with significant differences between groups for pitch F#4. According to the literature, Psub is expected to increase with increasing F0 (Sundberg, 1987; Titze, 1994). This observation was found for most singers and groups. The only exceptions were S01 and S19, who had a Psub decrease in the highest tone (D#5), perhaps associated with the use of head voice register.

Psub affects also voice registers and phonation types. Previous studies found that, for the same F0, chest register and firmer adduction are both required for achieving high Psub values as compared to singing in head register or breathy phonation (Björkner, Sundberg, Cleveland, et al., 2006). Elevated Psub values and evidence of high adduction were also found for AM female folk singing, corroborating previous perceptual evaluations of loud singing in full voice. Although the perceptions of this style of singing describe non-excessive effort level involved, one might argue that the results cannot provide a clear answer on how pressed this style of singing is. Singers S18, S07, S22, S16 and S01 (from groups PCA-II and PCA-III) obtained the highest Psub mean values (between 21.6 and 33.6 cmH_2O) for frequencies varying between F4 and D#5. These values are higher than those previously reported for loud pressed singing voices (between 10 and 20 cmH_2O) (Thalén & Sundberg,

2001), however for the latter study, F0 were lower, ranging from A3 to E4. To allow for robust conclusions concerning vocal pressedeness, future analysis of the dataset collected for the present study should include the analysis of vocal parameters extracted from inverse filtering and the originated flow glottograms, namely MFDR, Q_{closed} and NAQ.

Concerning the results obtained from ELG analysis, $Q_{contact}$ values were higher for some of the most representative voices (i.e. *cantadeiras* S18, S07 and S16), with values between 45% and 51%, with the remaining *cantadeiras* revealing considerably lower values (between 37% and 39%). Although statistical differences could not be found between PCA groups, $Q_{contact}$ came up as being a determinant factor for PC1, along with $(H1\text{-}H2)_{LTAS}$, $Q_{contact}$, Alpha and Mean Psub.

CFx and CAx are perturbation measures, which reflect intrinsic variations in vocal fold vibration (Fourcin & Abberton, 2008). Both measures presented lower values for singing than for speech tasks in all singers, a result also observed in a study concerning professional classical female singers (Lã, 2005). CAx differed between groups: PCA-II and PCA-III groups varied between 2 and 3% while PC-I varied between 1 and 2%. These results suggest that the latter group may present a more regular pattern of vibration of the vocal folds than the other ones. The *cantadeira* S16 was an outlier, presenting higher values of CFx and CAx (8.5% and 3.1% respectively). According with previous research, normal voices obtain ≈3% of irregularity, while possible dysphonic voices achieve more than 10% (Fourcin & Abberton, 2008). Thus, one might speculate that none of the participating *cantadeiras* show evidence of dysphonia, corroborating perceptual assessments made during the singers' selection process.

LT classification was useful to conduct a preliminary data analysis considering the representativeness level of AM folk singing voice. However, PCA groups provided an alternative cluster of the singers according, not directly with LT assessments, but with the most statistically relevant voice measures.

The results of HCA and PCA analysis were found to be very useful in identifying the relationships between all acoustical and physiological vocal measures. Principal factors for PC1 included $(H1\text{-}H2)_{LTAS}$, $Q_{contact}$, alpha and mean Psub, whereas for PC2 was Leq. These results evidence the benefits of using multi-channel recordings when describing voice use. This approach allows a multidimensional understanding of voice production as well as contributes for a more comprehensive understanding of the complex relationships between physiological and acoustical properties of the voice.

Clustering the singers in groups obtained from HCA and PCA analysis, as already mentioned, was an important result. Group PCA-I integrated singers classified in 5th, 7th, 8th and 10th position in the LT (between 47.2% and 20.4%). This group of less representative voices included low Psub, $Q_{contact}$ and alpha, and high $(H1\text{-}H2)_{LTAS}$. A possible explanation for this combination of parameters might be the use of head register, more often for higher pitches[33]. As stated before (Chapter 3), the use of this register (at least perceptually) is perceived as non-typical of AM folk singing style. Despite the difficulties in explaining registers, it is known that the interaction between the vocalis (or thyroaritenoid) and cricothyroid muscles are central to control the use of different registers. Female head register is explained by a reduced contraction of the vocalis muscle, and a consequent lower vocal fold adduction (Kochis-Jennings, Finnegan, Hoffman, & Jaiswal, 2012). Accordingly, the values obtained in PC1 measures ($Q_{contact}$, Psub, alpha and $(H1\text{-}H2)_{LTAS}$) are compatible with this vocal adjustment: a weaker adduction produces shorter vocal fold contact (smaller $Q_{contact}$), which relates to lower Psub levels, reduction on the energy of higher harmonics (lower alpha) and a stronger fundamental (higher $(H1\text{-}H2)_{LTAS}$).

Group PCA-II included *cantadeira* S18, the one obtaining the highest classification for representativeness of AM female AM folk singing. This same singer also presented the highest Psub, $Q_{contact}$ and alpha values, and the lowest $(H1\text{-}H2)_{LTAS}$ values. These values are compatible with previous descriptions of twang[34] (see Chapter 2) (Sundberg & Thalén, 2010) and also pressed phonation[35] (Thalén & Sundberg, 2001). As the latter has been closely associated to effortful phonation, it is reasonable to hypothesise that *cantadeiras* with most representative voices might require a certain degree of vocal effort in order to be considered as representative. Despite the fact that those involved in the performance of AM folk singing have considered that to have a representative voice, one might sing with no excessive effort, this does not mean that the way of singing is, in fact, free of some degree of vocal effort. That is why perceptions of vocal effort might be misleading especially when made by those who are not voice specialists (Sataloff, Baroody, Emerich, & Carroll, 2006).

[33] Although no perceptual assessments were made to measure voice registers, this observation is corroborated by the author's perception, for all four singers in group PCA-I.

[34] Twang - Voice quality often used in non-classical singing styles, which is produced by the epilarynx narrowing, obtaining a cluster of 3rd, 4th, and 5th formants, and creating a higher spectral amplitude in the vicinity of 3 kHz Lombard, L. E., & Steinhauer, K. M. (2007). A novel treatment for hypophonic voice: Twang therapy. *Journal of Voice, 21*(3), 294-299..

[35] Although no perceptual assessments were made to measure twanginess and pressedness levels, this observation is corroborated by the author's perception, as singer S18 presented the most twangy and pressed voice quality in the entire sample.

Group PCA-III incorporated singers mostly from the bottom to the top of LT classifications: 2nd, 3rd, 4th, 6th and 9th ranked singers (22.3% to 78.9%). These singers revealed generally high Psub, $Q_{contact}$ and alpha, and low $(H1\text{-}H2)_{LTAS}$ values. According with the author's perception, three singers (S07, S22 and S16) share similar timbres: they sing using predominant chest voice, with no register breaks even in higher pitches; and they are also the youngest singers in the sample (33, 28 and 30 years respectively). The remaining singers (S01 and S21) perceptually share a twang quality, but while S01 produces a stable chest register, S21 has fluctuations between chest and head registers. Another observation is made analysing Figure 57: singers S22 and S21 seem to be grouped apart from the other three. This sub-division inside group PCA-III is also evident in the dendogram presented in Figure 54, and may be explained by the component PC2, as both singers obtained higher Leq values.

In summary, the results of this study may suggest that AM folk singing may be objectively characterised by applying a combination of research methods, including perceptual evaluations and objective voice measures. The interpretation of the results of such rich dataset may help to identify what voice characteristics should be encouraged over time to stimulate the preservation of the identity of such style of singing. The preservation of a traditional style should not rely exclusively upon people's perceptions, but also on the deep understanding of the complexity underlying its performance. The understanding of voice characteristics presented by those *cantadeiras* perceived as more representative of this singing style is a good starting point.

In this study, *cantadeiras* perceived as most representative are those belonging to PCA-II and PCA-III groups. For these, a prevalence of a pressed phonation type and a loud voice with energy on higher harmonics was found. Considering that a pressed phonation is typically associated with a high larynx position (Sundberg, 1987), the same physiologic adjustment could simultaneously produce some particular resonant/articulatory effect, justifying the timbre descriptions of this style (e.g. strident timbre).

The results of multiple regression analysis suggested that perceptions of representativeness of AM female solo folk singing can be mostly predicted by two voice parameters: Leq and Psub in pitch [F#4]. Leq is an intensity measure reflecting how loud a voice can be produced. When considered alone (as in model 1 of the multiple regression analysis), Leq is able to explain 86% of the results of the LTs. When considered together with Psub[F#4], these two voice measures are responsible for predicting 92% of the LT

ratings. It is difficult to explain why the Psub of a particular pitch would be so relevant. A possible explanation may rely on the phenomenon of voice register transition.

As previously mentioned, AM folk singing should be performed in chest register, even for the highest pitches[36]. The frequency range used by the *cantadeiras* when singing the reference song was F4–D#5. This same range corresponds directly to the vocal extension of *belting* quality, already described in Chapter 2 (Miller & Schutte, 2005). Figure 66 highlights the interval between F4 and D5, where female singing voice may be produced both in chest and falsetto registers: while in belting quality chest register is used, other softer qualities (as legit) use a middle register. To produce chest voice in such tones, there is a predominance of *thyroaritenoid* muscle, to thicken the vocal folds and to produce higher adduction and Psub levels. F#4 is precisely the start of the transition between what the authors call the regular chest register, and the beginning of the "belting extension" (Miller & Schutte, 2005, p. 280).

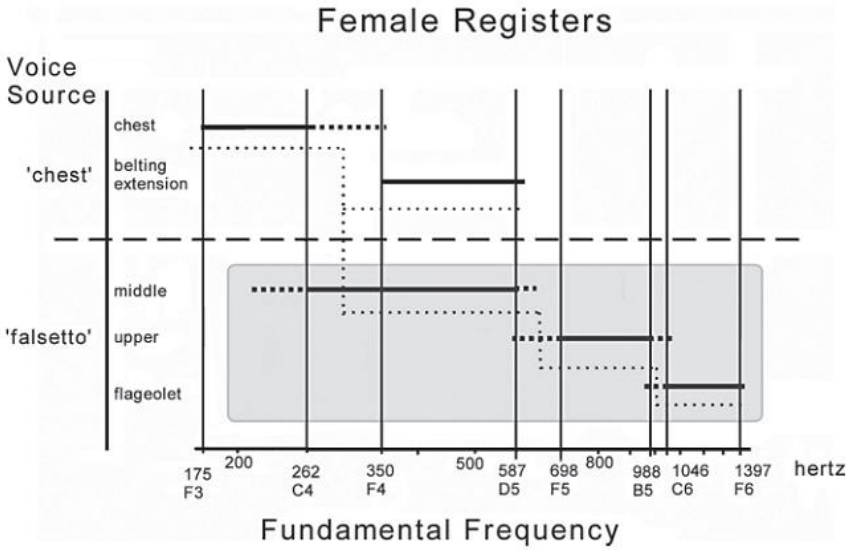

Figure 66. Female registers representation, including chest and falsetto registers and respective sub-divisions *(adapted from Miller & Schutte, 2005, p. 280)*

Previous research was carried out to compare chest and head registers in female musical theatre (MT) singers who belt. The results suggested high Psub values (between 15 and 20 cmH_2O) for chest register samples (below A#3) (Björkner, Sundberg, Cleveland, et al., 2006). Psub of the most AM representative *cantadeiras* (groups PCA II and III) presented

[36] In the interviews of Chapter 3 no descriptions were found defining which the highest tones of the *cantadeira* were. In the songs recorded in this research the highest tones achieves G5 (≈ 784Hz).

rather higher values, varying between 15 and 34 cmH_2O, even though comparisons are limited as the pitches sung were also higher.

6.4.3. COMPARING ALTO MINHO FOLK SINGING WITH OTHER SINGING STYLES

When studying a traditional singing style, one natural question is whether this particular style is close to other cultural traditions, or even musical genres. This is the purpose of this next section. As singers belonging to groups PCA-II and PCA-III were those identified as most representative of AM female solo folk singing, the following considerations will be taken only regarding these *cantadeiras*.

The frequency range found for the chosen songs of AM folk singing was greater than the frequency range described for Bulgarian traditional songs (Henrich, et al., 2007). Also, the reference song was produced in higher tones (between 349.6 Hz and 698.5 Hz). However, AM folk singing, when compared with *kulning*, another traditional style from Sweden, presents lower F0 ranges, as *kulning* varies between 500 Hz and 1 200 Hz (Johnson, 1984).

When considering Leq of AM *cantadeiras* (87 to 91 dB), one might notice that values are similar to those presented in a single study describing speech-like *belting* (Sundberg, et al., 2012). When compared with traditional styles, intensity levels found in *kulning* were considerably higher (reaching 94.5 dB[37] when producing higher tones (≈ D6)) than the ones found for AM singing. However, at lower tones, *kulning* and AM cantadeiras singing becomes more similar (≈81 Hz for D#5 in *kulning*) (Johnson, 1984). AM singing can also be compared with *country* singing in terms of intensities that are reached in both styles (SPL around 85-95 dB) (Cleveland, et al., 1997).

Another important vocal parameter to be compared betweeen singing styles is Psub. AM *cantadeiras* presented mean Psub values (17 to 34 cmH_2O) close to those reported for brassy and heavy *belting* (20 to 25 cmH_2O) (Sundberg, et al., 2012). The highest Psub values were obtained by *cantadeira* S18, reaching 40.7 cmH_2O for the pitch D#5, a value

[37] Original data report SPL of 105 dB recorded at 100 cm Johnson, A. (1984). Voice Physiology and Ethnomusicology: Physiological and Acoustical Studies of the Swedish Herding Song. *Yearbook for Traditional Music, 16*, 42-66.. Values were corrected to a 30 cm distance for comparison with current research data.

situated in the Psub range found for male *country* singers, when singing high notes[38] (30 to 50 cmH_2O) (Cleveland, et al., 1997). When comparing Psub values of this representative AM female folk singer with the ones achieved by a female Swedish *kulning* singer, the latter presents lower Psub values (varying from 10 to 20 cmH_2O at D#5 (622 Hz). This same *kulning* singer achieved values around those of the cantadeira (i.e. approximately 40 cmH_2O) but only at frequencies between 900 and 1000 Hz, and her highest values were even higher (close to 60 cmH_2O) for frequencies around 1200 Hz (an F0 range that is not reached in AM female folk singing).

Generally speaking, one may say that LTAS from AM *cantadeiras* has similarities with the one presented by Croatian *ojkanje* singers. This style of singing has been described as a shouting-like voice, with great loudness, spectral peaks at 0.6 and 1.1 kHz, presence of a speaker's formant (2.2-3.8 kHz), and a formant tuning strategy of F1:H2 (Boersma & Kovacic, 2006). Also similarities were found with LTAS from *belting*, especially heavy and brassy types, with spectral peaks around 1, 1.7 and 3 kHz (Sundberg, et al., 2012), approximately the same found for *cantadeiras* considered as representative of AM singing. Additionally, LTAS measures in AM typical singers suggested a weak fundamental, also a finding reported in *belting* (Sundberg, et al., 2012). Another style presenting similar LTAS configuration was *pop-rock*, and although the first peak was found at lower frequencies (because the singer was male), all other peaks were produced in similar locations (Borch & Sundberg, 2011).

An important measure regarding glottal adduction was $Q_{contact}$, which varied from 39 to 51% in AM *cantadeiras*. S18, obtained the highest values (51%) which are comparable with those described for *belting* (48.53%; ±4.92) (Lebowitz & Baken, 2011). Although other styles were studied using ELG signals, none of them was a traditional singing style and several were the studies in which Q_{closed} was considered instead of $Q_{contact}$. *Belting* was shown to have Q_{closed} around 50%, particularly in heavy and brassy belting, and NAQ around 0.12 for heavy *belting* (Sundberg, et al., 2012); and *pop-rock* presented NAQ around 0.12 (Borch & Sundberg, 2011). All these values are indicative of an approximation to a high degree of phonatory pressedness, which was also shown to exist in AM most representative singers.

[38] No specific frequencies were reported as singers sung *a cappella*, with no standardised intonation.

Summarising, AM female folk singing seems to share vocal features with *belting*, and to some extent with USA *country*, Croatian *ojkanje* and *pop-rock*.

6.5. SUMMARY

This chapter aimed at describing physiological and acoustic characteristics of AM folk singing. Ten *cantadeiras,* were recruited from a previous LT where their voices were assessed concerning representativeness of AM folk singing. Multichannel recordings, including audio, ELG, oral flow and intraoral pressure signals in a LT, were carried out to allow for voice function analysis. Descriptions and comparisons were made between different voice tasks: spontaneous speech, reading lyrics, chosen song and reference song. Statistical methods were used, including inferential tests, HCA and PCA and multiple regression analysis.

The *cantadeiras*' speech behaviour was shown to have relevant features which may be explored in subsequent studies: wide prosodic variations and a possible speaker's formant. Concerning singing, several voice measures were found to be relevant contributors to identifying most representative AM singing voices: high alpha, Psub and $Q_{contact}$ values and low $(H1\text{-}H2)_{LTAS}$ values. Intensity (Leq) was found to be a predictor of representativeness of AM singing, together with Psub for the pitch F#4.

Thus, one might say that voice parameters, together with perceptual evaluations, constitute a good method of identification of *cantadeiras*' voice characteristics, and allow for a more comprehensive understanding this folk style. The findings also revealed that AM folk singing has some similarities with other non-classical and traditional singing styles, but mostly with *belting*, a mode of singing typically applied in musical theatre genres.

So far, this chapter has answered to two of the initial questions brought in light by this study: (i) what physiological and acoustical characteristics define AM female solo folk singing; and (ii) what voice characteristics of *cantadeiras*' singing might be close to other traditional and non-classical singing genres, in general. The next chapter will explore the general conclusions that can be drawn considering performance practices of AM *cantadeiras* in general.

CHAPTER 7

FINAL DISCUSSION AND CONCLUSIONS

7. FINAL DISCUSSION AND CONCLUSIONS

The current research project was developed to understand and describe performance practices of female folk singers of AM. These singers were particularly chosen as they are often recognised as possessing particular vocal characteristics.

This last chapter articulates the most relevant conclusions drawn by the research outcomes, reflecting on possible limitations, and finishing with future directions for research in the field of interdisciplinary voice science and ethnomusicology.

7.1. DISCUSSION

This PhD research involved: a) a systematic literature review on performance practices of non-classical singing styles; b) a brief historical review of folklore in Portugal and in Minho; c) descriptions of FG activities in the AM region; d) aspects related to vocal and social representativeness of AM *cantadeiras*' singing, comparing past and present days practices; e) development and testing of a recording protocol specific to study vocal behaviour during the performance of folk singing styles; f) the assessment of *cantadeira's* vocal representativeness from a perspective of those who perform this style regularly; and g) physiological and acoustical voice assessment, using up-to-date techniques and voice measurements.

By integrating in a single work these several approaches, this investigation presents a clear example of an integrated interdisciplinary perspective of singing performance. Only one similar approach to the present work has been found in the literature. This was a study about *kulning*, a pastoral singing style from Sweden (Johnson, 1984), integrating both ethnomusicology and vocal physiology perspectives of voice production. With the present study, the author expects to have contributed to an effective integration between qualitative and quantitative methods of voice assessment, without disregarding the social, historical and cultural environments in which this type of singing is integrated.

Present research was conducted in a specific geographical/cultural region, Viana do Castelo district, where performance studies about folklore are sparse, particularly considering singing performance. However, the same applies to the whole Portuguese territory. For this reason there was the need to begin this study by drawing a generic profile of the AM region´s FG population. This region's FGs presented similar demographic characteristics as the ones described by Castelo Branco, Neves et al. (2003), in a national survey, namely groups of 30 to 50 members, comprising a balanced distribution of members in gender and age groups (including youth and young adults). However, results show that, approximately 15 years later, there are around 100 FGs in AM, with almost 5 000 active members, including 700 female singers, 200 of which are soloist *cantadeiras*. These numbers may be used as indicators to estimate the possible impact of this study in the research field. Considering the existence of other regions in the north of Portugal which share some similar perceptual singing features with AM (e.g. BM and Douro Litoral), results of this study may contribute to the understanding of an even wider number of folk singers.

The FG profiles have naturally changed since the beginning of the folk movement. Today, although there is a high number of young elements in the FGs, these younger generations cultural views are naturally influenced by numerous demographical, social, educational and economical factors (Barreto & Pontes, 2007; Rosa & Chitas, 2010). Testimonies reported in present study confirm this phenomenon, describing a limited ability of younger generations to perform the old-days folklore. On the other hand, results also show that this same young generations have a deeper educational level, which might contribute to lead Portuguese folklore to a new level.

Analysing the activities published by the Federadion of Portuguese Folklore during the development of this research, one may see a changing tendency, considering the existence of a congress for young folklorists, and several traditional (non-performance) activities organised by modern FGs. Many FGs seem no longer to consider themselves exclusively as performance groups, but rather as active associations which work to recover and experience a wide range of traditional activities. Still, there is a lack of specific actions to reverse the tendency of changing many folklore components, as for example singing. Female singing was shown to be one of the most representative components of AM folklore, placing the *cantadeiras* as one of the elements in the centre of the FGs' identity representativeness. Thus, it seems ideal to use singing as "the grounding seed" to keep old traditional practices within AM folklore.

The evolution of the *cantadeira*'s activity through the folklorization period is scarcely described in the literature. We found that the polyphonic singing, the most common vocal folk expression in the beginning of 20th century, was widely abandoned by most AM FGs. Consequently, the repertoire and performance contexts of the *cantadeira*'s vocal expression is actually limited and influenced by the performance (non-traditional) dynamic of the FGs, and the characteristics of its repertoire (mostly choreographic), dancing and instrumental accompaniment. These aspects should be taken into account when analysing our results, as current voice performance of many modern *cantadeiras* is probably a mix of traditional (genuine) features, with FGs' idiosyncrasies, and other personal and external influences.

At several moments during the current research, the existence of an AM folk vocal profile (or stereotype) was questioned. The differences between the old polyphonic singing and current singing in FGs seem to be very important when defining contemporary AM vocal folk profile. However, although relevant, these differences were not explored in the present study, as the aim was to study voice function of *cantadeiras* performing exclusively in current FGs. Therefore, even though some reports evidenced local differences, modern perceptual voice profile here presented seems rather consistent in AM region.

Perceptually, to sing AM folk style, *cantadeiras* need to: sing in high pitches, loud, applying a typical timbre (thin or bright voice), in chest register. Song lyrics must be intelligible, and sung with an old accent characteristic of the region. Vocal effort is normally associated with this type of singing, although it should be avoided when achieving extreme high levels, as well as head register, otherwise voice loses its typical characteristics. Reports show that this vocal hability is easier to find in older *cantadeiras* than in younger ones. Also, in many FGs there are reports of a recurrent difficulty in finding female singers with proper voices for folk singing: thus, how typical (or representative) a voice sounds seems to be a common concern when choosing a *cantadeira*.

This difficulty in finding a representative *cantadeira* seems to be corroborated by the results obtained from the LTs: only three singers obtained high rates of representativeness (>60%). Thus, it seems that, in the future, a completely different way of singing will characterise this style; the impacts of such changes in performance practices and the role of the *cantadeiras* in the FGs seem therefore worthwhile to investigate in future research.

Considering voice function, the primary goal of this investigation, there are evidences that most representative *cantadeiras* use a pressed phonation. This observation is corroborated by several measures, namely: elevated values of Psub, $Q_{contact}$ and alpha, and reduced $(H1\text{-}H2)_{LTAS}$, when compared with those for less representative *cantadeiras*. These results are further corroborated by a predominant use of chest register, confirming the perceptual descriptions obtained in the semi-structured interviews.

Evidence of vocal effort in folk singing is possibly one of the most (un)expected finding. Excessive vocal effort was reported as a common and typical characteristic of AM *cantadeiras* by several participants in the interviews, especially in some AM areas. In fact, the *cantadeira* rated with higher values for representativeness was the one presenting highest vocal pressedness and high glottal adduction. Therefore, some questions remain to be answered, namely the determination of the voice effort threshold between a higher and lower typical voice, and its implications for vocal health.

High loudness is certainly one of the trademarks of AM *cantadeiras*. In this study, this feature was found to be relevant, but PCA revealed that it was not the strongest quality to distinguish *cantadeiras*' voice quality. In fact, both highest and lowest typical *cantadeiras* achieved high Leq levels. Vocal loudness, is a perceptual and subjective attribute, which may sometimes be mistaken with certain other features, as voice timbre. In this particular style, a typical timbre is described as "thin voice" or "bright voice". The most evident cases of such qualities were the *cantadeira* in the pilot study (Chapter 4) and the *cantadeira* possessing the highest LT values (S18, in Chapter 6). They both presented high levels of spectral energy in the highest region of the spectra (between 1 and 4 kHz), as evidenced in LTAS curves, as well as elevated alpha and reduced $(H1\text{-}H2)_{LTAS}$ values. However, it would be important to include analysis of possible applied resonance strategies, as formant tuning or formant cluster. Such strategies have been reported in some traditional singing styles, and could also explain some of the AM folk singing characteristics. These type of analysis will constitute a continuation of this research project. Methods as inverse filtering will be applied to investigate whether, alike the recently studied Persian singers, AM *cantadeiras* place a formant on the closest partial to achieve a particular timbre when singing (Biglari, 2012).

High pitch is also a relevant feature, which might contribute to define typical AM folk singing. However, this parameter was not included in the perceptual assessments, where the reference song was used. Alternatively, results on chosen songs revealed that *cantadeiras*

mostly used the medium region of their vocal range to sing. Although some methodological aspects might be pointed, as those songs were sung with no accompaniment, this was an unexpected result, as reports describe their singing as high pitched. Again, timbre characteristics may be influencing how people perceive pitch in AM folk singers. Also, intelligibility and accent, two features mentioned as important when considering style representativeness, were not formally investigated, as they are mostly associated with speech/articulatory patterns, than voice characteristics. This would be another interesting question to be explored as a continuation to the present investigation.

Although the final sample in this study included merely 10 *cantadeiras*, which constitutes about 5% of the total population in AM, some considerations are possible to be made concerning what vocal features may be representative of this style of folk singing, and also how these are related to perception of a representative voice. A summary of data triangulation is presented in Table 29, including perceptual assessments of voices, physiological and acoustical voice analysis, and statistical methods.

Table 29. Data triangulation summarising vocal features regarded as representative of AM female solo folk singing

Qualitative data			**Quantitative data**	
Groups	***Group definition***	***Voice descriptions***	***Voice features***	***Groups***
Very typical voices	Singers which have similar voices as the old days' *cantadeiras*: they are rare and very difficult to find	High pitch Strong loudness Typical timbre (thin/bright) Chest register Voice effort (non-excessive) *[Good intelligibility]*	Extremely high Psub, $Q_{contact}$ and Leq High alpha Low $(H1-H2)_{LTAS}$ and CAx	PCA-II (n=1)
Typical voices	Singers with good voices for folklore, but different from the old days' *cantadeiras*		High Psub, $Q_{contact}$, Leq and alpha Low $(H1-H2)_{LTAS}$ and CAx	PCA-III (n=5)
Less typical voices	Singers with good voices, but inappropriate for AM folk singing	Voice effort (excessive) Head register (falsetto) in the highest tones *[Reduced intelligibility]*	Lower Psub, $Q_{contact}$ Leq and alpha High $(H1-H2)_{LTAS}$ Very low CAx	PCA-I (n=4)

From triangulating all results of initial datasets, one might suggest that: a) 10% (n=1) of the studied sample were *cantadeiras* with very typical voices; b) 50% (n=5) had typical voices; and c) 40% (n=4) had less typical voices. Considering the sample size (n = 10 *cantadeiras*), the evidence to assume that this distribution is the same found in the AM population of

cantadeiras is limited to a 70% confidence level. In fact, to conclude about a population of 190 *cantadeiras* in AM (Chapter 3), a sample of 128 *cantadeiras* would be necessary to obtain a confidence level of 95%, which constitutes a remarkably difficult achievement, considering the dispersion of these singers in AM region.

The single singer (S18) constituting group PCA-II seems to correspond to the most traditional voice in the whole study sample, a "very typical voice", fulfilling the characteristics pointed out as most relevant when perceptually describing the voice of a AM female folk solo singer: a very loud voice, with a predominance of chest register and a bright voice timbre. The fact that only one singer stood up as the most representative of this singing style might constitute an evidence of the reports from the interviews, describing how difficult is to find a representative voice of AM female solo folk singing nowadays.

Cantadeiras grouped as PCA-III obtained a wider range of vocal characteristics. These singers may correspond to the most common type of voices found today in modern FGs, which we named "typical voices". These singers present "good" voices, but apparently they miss some important typical vocal features, such as very high Psub, $Q_{contact}$ and Leq, that is, a certain degree of vocal pressedness, loudness, and possibly some other still undetermined resonance strategies.

Cantadeiras grouped as PCA-I apparently possess some voice features associated with voice qualities which were previously described to mischaracterise AM folk style, as it is the case of applying head register (i.e. low Psub and $Q_{contact}$, especially for higher notes). Evidence of vocal effort, another feature perceptually reported as representative of this style, was not found for these singers. They mostly sung with lower Psub than the remaining singers, and eventually had adequate voices to sing other styles (as church music). Still, they are the *cantadeiras* of several FGs, which might support the reports of a tendency for finding less representative voices of AM singing in nowadays FGs.

Cantadeiras' age was repeatedly mentioned in the interviews as a factor which might be associated with the representativeness level of the *cantadeiras*: older *cantadeiras* were claimed to possess the most typical voices. This variable was not objectively studied in this research. However, a wide dispersion was found for the singers' age, independently of their PCA group or LT classification, suggesting that more and less-representative voices seem to appear in all ages.

Furthermore, AM female solo folk singing style remains being transmitted and learned by oral tradition, so both older and younger *cantadeiras* have an important role to play. Currently, most young *cantadeiras* learn to sing with older singers, as they did in the past. Yet, natural performance contexts no longer exist, as the contact with traditional activities is scarce, and singing is limited to the FGs' rehearsals and performances. Thus, it is possible that, in order to preserve FGs activity and identity, most typical *cantadeiras* keep their activity as singers until quite advanced ages. This might constitute a last opportunity for younger generations to learn with them. By disclosing this phenomenon, the current research may have contributed, not only to the understanding of AM *cantadeiras*' voice function, but also indirectly contribute to recognise how oral traditions in this regions may be revitalised. Programs combining formal and informal learning processes might be a welcomed way of preserving and disseminating traditional folk singing styles among younger FGs' members.

Responding to the question on how far is AM female solo folk singing from other non-classical and traditional singing styles, most *cantadeiras* with representative voices were shown to share vocal characteristics with those singers who belt. Some characteristics, such as LTAS configuration and vocal folds contact, are also shared with styles such as *country* singing (from USA), Croatian *ojkanje* and *pop-rock*.

Pressed phonation was confirmed to be one of the most important features in typical AM folk voices, which might itself constitute a risk behaviour for voice disorders. In fact, a considerable number of *cantadeiras* were reported as having history of voice problems. Thus, determining the prevalence of voice problems within this population seems to be another relevant aspect to be pursued in future investigations.

Other risk factors were reported besides vocal abuse, associated with lack of instrumental adjustments and tuning of the songs according to the *cantadeiras* vocal possibilities, sound competition between voice and instruments, as well as non-optimised managing of amplification systems often used in performances and not in rehearsals. Although *cantadeiras* are regarded by their FGs as being one of the most important elements, their vocal health is frequently neglected, in favour of accomplishing other important performance aspects. Perhaps there should be programs designed to care of the *cantadeira*'s voice, involving not only the *cantadeiras*, but all members of FGs, because singing, as a multidimensional behaviour, directly depends on all remaining elements in a folk performance.

7.2. LIMITATIONS

The present investigation was a novel one considering that, for the first time in the literature, there are perceptual and objective descriptions of vocal performance of AM female solo folk singers, *cantadeiras*.

In general, the research methods applied seemed appropriated as they provided means to accomplish initial aims here proposed. Moreover, the methodological diversity provided the author great opportunities of development as a researcher. In fact, an entire chapter was dedicated to testing and validating the results of a recording protocol especially designed for analysing AM *cantadeiras* singing. Yet, not always conditions existed to accomplish all recommendations pointed out in the literature. For example, in the case of the LT, a pre-test was carried out, but a pilot study was shown to be necessary, in order to improve the LT structure, possibly including a previous training process, with extra vocal references. In this way, maybe the differences found in the raters consistency between both LT versions used (LT_A and LT_B) could have been reduced.

Also, although rigorous procedures were followed in multichannel voice recordings for the larger sample size of *cantadeiras* that were analysed (n = 10), some occasional cases existed where the signal quality (oral pressure or ELG) did not allow analysis. Additionally, although task 7 from the pilot study (repetitions of [pæ][39]) was modified in final protocol (repetitions of [pa][40]), *cantadeiras* maintained some difficulties in producing different loudness levels, especially in the softest phonation. As much variability was found between singers, this task was not used, and PTP and CTP measures were not analysed. Perhaps in future research, investigations of loudness control in non-formally trained singers should include real-time visual feedback of voice, as a mean to assist singers in varying level of phonation while maintaining pitch. Nevertheless, the final recording protocol applied seems to be indicated for non-classic and traditional singing styles.

[39] Repetitions of [pæ] sung as diminuendos in low, medium and high pitches
[40] Repetitions of [pa] in three tones (low, medium and high) each one in three different loudness levels (loud, medium and soft)

7.3. CONCLUSIONS AND POSSIBLE DIRECTIONS FOR FUTURE WORK

7.3.1. CONCLUSIONS

The main goal of this research was to describe the physiological and acoustical phenomena underlying female folk singing from AM, contextualising them within the performance practices of this style and the perceptions of those who are actively engaged with this singing style. In order to achieve this goal, *cantadeiras* (soloist female folk singers) performing in GFs of Viana do Castelo region (corresponding to 10 districts of the north of Portugal) were studied, selected from 95 identified FGs (in 2011). The selection of these groups was done in several phases: (i) 78 (88%) were included in a preliminary telephone questionnaire; and (ii) 23 FGs were considered for surveys, semi-structured interviews, voice recordings, and to carry out LTs. In the latter process, three other FGs from Viana do Castelo and Braga were included to allow the validation of the interviews and LTs. At the end, the voices of 16 *cantadeiras* were recorded and assessed for representativeness of this singing style in a LT. From these 16 singers, 10 were recorded in a multichannel hybrid system for acoustic and physiologic voice assessments.

According to the perceptions of those who perform AM folklore regularly, *cantadeiras* are expected to sing in a high pitch tessitura, loud, with a thin/bright timbre although using chest voice predominantly. Song lyrics must be intelligible, and sung with regional and old accent. Voice effort is acceptable in a non-excessive level. When confronting these perceptual evaluations on how a typical *cantadeira* voice should sound with physiological and acoustical evaluations of voice production, the perceptual findings were, to some extent, corroborated. Most representative *cantadeiras* presented voice features compatible with pressed phonation and high glottal adduction (high Psub, high $Q_{contact}$, high alpha, and low $(H1\text{-}H2)_{LTAS}$). Loudness, although relevant, was found to be secondary, as low typical *cantadeiras* also achieve high Leq levels. Additionally, multiple regression analysis determined Psub for pitch F#4 and Leq as the two physiological and acoustical parameters most important to predict the LT classifications.

The number of *cantadeiras* rated as representative in the LT was low: only three (in 16) obtained results above 60%, and six obtained classifications below 29%, thus considered as less representative. PCA allowed a regroupment of the *cantadeiras* according with their voice source and acoustical characteristics. The results showed a single singer, the one with higher LT classification, as being the most representative of AM female

solo folk singing. These results corroborate the reports of the interviews, claiming that currently, FGs find difficulties in recruiting *cantadeiras* with voices that are representative of the expected timbre for folk singing. In fact, results point for dramatic changes in the living and performing contexts of the FGs and their *cantadeiras*, which might result in the eminent loss of some traditional features in the *cantadeiras'* singing characteristics.

Performance activities were studied, and some relevant factors for voice use and health were identified, namely the competition between voice and instruments (especially the concertina), the lack of song adaptation to the vocal range and tessitura of the singers, the poor amplification system, the absence of voice warm-ups, and the limited shift between *cantadeiras* within the FG. Phonatory pressedness was confirmed to exist in typical AM *cantadeiras*, as a physiological sign of voice effort. This may constitute as a risk factor for voice disorders, which were identified in a considerable number of *cantadeiras* in the questionnaires and interviews.

Voice characteristics in AM were also compared with other non-classical and traditional styles. Similarities were found mostly with *belting*, a voice quality used in several styles, but mostly associated with musical theatre. Also, few characteristics were shared with traditional styles from USA (*country*), Croatia (*ojikanje*), and non-classical styles, as *pop-rock*.

7.3.2. FUTURE STUDIES

As a consequence of the results of the present investigation, several future studies emerged as important to be carried out in the near future, to allow for further conclusions when describing *cantadeiras*' singing. Some of the most relevant are the following:

- Exploring resonance strategies used by AM folk *cantadeiras*, by carrying out inverse filtering;
- Determining vocal effort in AM folk *cantadeiras*, to assess what is the exposure risk to vocal disorders related to vocal abuse in these singers;
- Analysing speech acoustic patterns of *cantadeiras* and women from AM, to investigate in what extent these can be related with expected representative vocal patterns within this region

- Determining the prevalence of voice disorders in AM folk *cantadeiras*, from an epidemiologic perspective.

It is therefore an intention of the author of this thesis to give continuity to this work, and provide further answers to the just described small studies, further analysing the rich dataset gathered.

In addition, and being professionally a speech pathologist and voice practitioner, the author believes that there are practical implications coming from the present study that can further assist in the maintenance of AM singing traditions.

Several FG members, directors and *cantadeiras* recognise the need of individual or group singing orientation, looking for professional help (e.g. singing teachers). However, adjusting voice teaching to folklore needs is not an easy task, even for professionals. This educational approach, although formal, should consider pedagogical approaches close to those used in teaching of non-classical singing styles, as these seem to share some vocal characteristics with folk singing. Voice training should be simple and oriented to people with reduced musical education background. A singing teacher should adapt to the physiologic characteristics of each *cantadeira*, and develop the most relevant voice features for AM region. Several methods exist (McDonald Klimek, 2005a, 2005b; Sadolin, 2013; Soto-Morettini, 2006) which may provide useful tools to understand and develop the AM folk singing representative timbre. Furthermore, adapting voice health prevention programs (Hazlett, Duffy, & Moorhead, 2011) to this population could be appropriated for some FGs, especially those with higher history of voice disorders in their *cantadeiras*.

The human voice is also a musical instrument, and specific features of traditional singing voice in AM seem to be disappearing. Similarly to what happened with the revitalization of the concertina in the 1990's, stimulation of the female traditional singing, as a cultural inheritance should be done. Although insufficient to provide an adequate strategy for such important program, the present thesis points at some relevant aspects such as: a) include a multidisciplinary team, involving ethnomusicologists, voice practitioners, and folklorists, when taking care of this type of voice; b) implement educational events at a regional level, actively involving several cultural and folklore related entities, including all FGs member, rather than only their *cantadeiras*; c) promote inter-generation sharing between *cantadeiras*, especially between older and younger generations, including contact with rural activities and singing in natural contexts.

Considering these practical applications, this research may be of special interest for a group of individuals and entities, namely:

a) Folk groups – Especially for executive and musical directors, it is important to recognise the *cantadeiras*' role in FGs, their voice characteristics, and how voice quality and health may be influenced. Adopting adequate strategies in the FGs may contribute to find and preserve representative voices of the region, and contribute to their longevity.

b) *Cantadeiras* – *Cantadeiras* themselves would certainly benefit from understanding how their voice works, and how different factors may affect them. It is fundamental that *cantadeiras* are able to maintain their vocal identity and individuality, but also to know how to connect themselves to a regional traditional identity. Understanding the *cantadeiras*' non-vocal roles in the FGs may also facilitate their personal and artistic development.

c) Voice practitioners – The present research may be of particularly use to professionals who work in the voice field, namely singing teachers, speech therapists, or other voice practitioners. These professionals may apply the results of this work to further fundament their practices, especially when dealing with AM folk *cantadeiras*, contributing to help them to achieve a proper voice quality without losing their traditional identity.

d) Researchers and voice scientists – Contributes of present research may be useful to study other styles in Portugal. In the last decade *Fado* and *Cante Alentejano* were classified as UNESCO Intangible Cultural Heritage, confirming the growing importance given to traditional singing styles. Thus, to describe them using an up-to-date multidisciplinary approach seems wise.

e) Folklore and culture promotion entities – The scientific approach presented here may encourage relevant entities as FFP, INATEL, Culture and Education departments of Municipal Councils, or others, to organise and support specific programs to stimulate folklore in AM and other regions. Only if national and local organizations are sensitive to these questions can a genuine sonority such as the one of AM female folk singing be preserved.

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APPENDIX 1

RESEARCH APPROVAL BY THE ETHIC AND DEONTOLOGY COUNCIL OF AVEIRO UNIVERSITY

conselho de ética e deontologia universidade de aveiro theoria poiesis praxis

PROCESSO n.º 4/2014

REQUERENTE : Prof.ª Doutora Filipa Lã

DESIGNAÇÃO DO PROJETO: "Canto tradicional Minhoto: uma perspectiva multidimensional".

INVESTIGADOR RESPONSÁVEL: Prof.ª Doutora Filipa Lã

RELATOR: António José Arsénia Nogueira

RELATORES ADJUNTOS: Professor Armando Pinho, Professor Luis Machado de Abreu e Drª Isabel Cunha Gil

PARECER

1. O estudo submetido a parecer da Comissão Permanente do Conselho de Ética e Deontologia tem como requerente uma investigadora do Departamento de Comunicação e Arte da Universidade de Aveiro e do Instituto de Etnomusicologia – Música e Dança (polo da Universidade de Aveiro). Com este projeto, pretendem contribuir para a compreensão do canto tradicional, com destaque para o estudo das relações entre padrões culturais, comportamentos sociais, fatores geográficos e características vocais dos habitantes de diferentes regiões do país.

2. O estudo apresentado tem como objetivo específico averiguar se as relações supracitadas existem tendo em conta a compreensão fisiológica e aerodinâmica e acústica da voz do Alto Minho. Pretendem ainda atingir-se diversos objetivos secundários, procurando dar resposta às seguintes questões:

2.1. Quais as características fisiológicas, aerodinâmicas e acústicas intrínsecas ao desempenho e interpretações vocais de reportório folclórico do Alto Minho?

2.2. Foram estas características estáveis ao longo do tempo?

2.3. Que aspetos socioculturais, históricos e geográficos poderão estar na base das características vocais encontradas?

2.4. Existem aspetos comuns no desempenho vocal do folclore do Alto Minho com o desempenho vocal do folclore de outros países?

2.5. Poderão estas práticas vocais ter implicações na saúde vocal das suas intérpretes?

3. Para se alcançarem os objetivos mencionados em 2. recorrer-se-á a metodologia experimental aplicada a uma amostra englobando, potencialmente, um total de 95 grupos folclóricos distribuídos por 10 concelhos do Alto Minho. A abordagem experimental envolverá a realização de entrevistas e o desenvolvimento e aplicação de um protocolo para recolha de dados vocais de forma a definir o reportório e as tarefas vocais relevantes ao estudo.

4. Segundo está declarado na documentação apresentada:

4.2. Os participantes serão previamente informados de todos os procedimentos, a eles cabendo a decisão de participar ou não no estudo. Os que decidam participar darão por escrito o seu consentimento informado, podendo a qualquer momento desistir;

4.3. Os dados recolhidos nos questionários e nas folhas de registo serão identificados com um nome fictício não se estabelecendo qualquer relação com o conhecimento informado;

4.4. As declarações de consentimento informado serão entregues à investigadora principal e guardados à parte dos formulários onde se fez o registo dos dados e que ficarão na posse do aluno de doutoramento, de modo a proteger o anonimato de todos os registos;

4.5. A informação recolhida será mantida num repositório, com acesso restrito por palavra chave, ao qual apenas os investigadores autorizados do projeto terão acesso.

5. O pedido de parecer suscitou algumas dúvidas, por parte da Comissão Permanente do CED, as quais foram transmitidas ao investigador responsável. A resposta a estas dúvidas permitiu identificar claramente quais as questões éticas que se pretendia ver abordadas e relativamente às quais se verificou que:

a) Não existem riscos associados ao processo de recolha de dados no que respeita à saúde dos participantes, nomeadamente das várias fases de gravação áudio e multicanal da voz; os métodos de análise de sinal biológico utilizados não constituem risco à saúde humana;

b) Os participantes são devidamente informados sobre todos os objetivos e procedimentos envolvidos no estudo, participando de livre vontade no estudo, sem qualquer espécie de compensação/remuneração;

c) A confidencialidade dos dados fornecidos pelos participantes está salvaguardada, nomeadamente no que respeita a gravações, entrevistas e questionários.

6. Concluída a leitura e análise de todos os documentos que descrevem, fundamentam e explicam os objetivos, métodos e procedimentos que a investigação pretende seguir:

6.1. Cumpridos os procedimentos descritos, respeitadas as recomendações e assegurada a proteção do anonimato dos dados recolhidos, entende-se que ficam salvaguardados os direitos dos participantes e se verifica a conformidade do estudo com os princípios e as normas éticas aplicáveis. Por ser assim, a Comissão Permanente do CED dá parecer favorável à realização do projeto intitulado "Canto tradicional Minhoto: uma perspectiva multidimensional".

N. B. - O pedido de parecer e os elementos que o instruíram são constituídos por 22 páginas.

Aveiro, 24 de Setembro de 2014

Os Relatores:

APPENDIX 2

LIST OF FOLK GROUPS IN ALTO MINHO

LIST OF FOLK GROUPS IN ALTO MINHO

Code	District (Concelho)	Group name
AV1	Arcos de Valdevez	Rancho Folclórico de S. Paio
AV2	Arcos de Valdevez	Rancho Folclórico de S. Pedro de Souto
AV3	Arcos de Valdevez	Rancho Folclórico da Associação Recreativa de Paçô
AV4	Arcos de Valdevez	Rancho Típico e Folclórico de Vilela
AV5	Arcos de Valdevez	Rancho Folclórico de Stª. Marinha Prozelo
AV6	Arcos de Valdevez	Rancho Folclórico da Associação Danças e Cantares de S. Jorge
AV7	Arcos de Valdevez	Grupo de Danças e Jogos Tradicionais de Sistelo
AV8	Arcos de Valdevez	Rancho Folclórico de S. Pedro do Vale
AV9	Arcos de Valdevez	Rancho Folclórico da Associação Estrela do Norte Gondoriz
AV10	Arcos de Valdevez	Rancho Folclórico Etnográfico da Associação Recreativa e Cultural de S. João de Rio Frio
AV11	Arcos de Valdevez	Rancho Folclórico e Cultural das Lavradeiras S. Pedro do Vale
AV12	Arcos de Valdevez	Rancho Folclórico de Eiras
AV13	Arcos de Valdevez	Rancho Folclórico da Associação de Vilarinho das Quartas
CA1	Caminha	Rancho Folclórico de Seixas
CA2	Caminha	Rancho Folclórico de Dem
CA3	Caminha	Rancho Folclórico das Lavradeiras de Gondar - GARCEA
CA4	Caminha	Grupo Etnográfico de Vila Praia de Âncora
CA5	Caminha	Grupo de Danças e Cantares do Centro Cultural e Recreativo de Argela
CA6	Caminha	Associação de Danças e Cantares Genuínos da Serra d' Arga
CA7	Caminha	Grupo de Cantares Tradicionais de Âncora
ME1	Melgaço	Rancho Folclórico de Paderne
MO1	Monção	Rancho Folclórico da Casa do Povo de Barbeita
MO2	Monção	Rancho folclórico das Lavradeiras de S. Pedro de Merufe
MO3	Monção	Rancho Folclórico dos Moleirinhos do Gadanha
MO4	Monção	Associação Sociocultural Recreativa de Pinheiros
MO5	Monção	Grupo de Danças e Cantares de Mazedo
MO6	Monção	Rancho Folclórico de Santa Maria de Moreira
MO7	Monção	Rancho Folclórico “Os Amigos de Longos Vales”
MO8	Monção	Rancho Folclórico “Estrelas dos Vales”
MO9	Monção	Grupo Folclórico de São Mamede de Troviscoso
PB1	Ponte da Barca	Rancho Folclórico e Etnográfico de Ponte da Barca

Code	District (Concelho)	Group name
PB2	Ponte da Barca	Grupo Cultural Recreativo dos Lavradores do Paço do Lima - Racho Infantil e Juvenil
PB3	Ponte da Barca	Grupo Folclórico de Cuide de Vila Verde
PB4	Ponte da Barca	Rancho Folclórico de Paço Vedro Magalhães
PB5	Ponte da Barca	Grupo Folclórico de São Martinho de Crasto
PB6	Ponte da Barca	Rancho Folclórico de Vila Nova de Muía
PB7	Ponte da Barca	Rancho Folclórico das Lavradeiras de Oleiros
PB8	Ponte da Barca	Rancho Folclórico de Lindoso
PB9	Ponte da Barca	Rancho Folclórico e Etnográfico de Entre Ambos-os-Rios
PB10	Ponte da Barca	Rancho Folclórico de Vila Chã Santiago
PB11	Ponte da Barca	Rancho Folclórico de Bravães
PB12	Ponte da Barca	Rancho Folclórico de S. João
PC1	Paredes de Coura	Grupo Folclórico Camponês de Bico
PC2	Paredes de Coura	Grupo Folclórico de Rubiães
PC3	Paredes de Coura	Grupo Etnográfico da Associação Cultural Recreativa Desportiva de Paredes de Coura
PL1	Ponte de Lima	Rancho Folclórico de S. Martinho da Gandra
PL2	Ponte de Lima	Rancho Folclórico da Correlhã
PL3	Ponte de Lima	Grupo Folclórico de Santa Marta de Serdedelo
PL4	Ponte de Lima	Grupo das Espedeladeiras de Rebordões Souto
PL5	Ponte de Lima	Grupo Folclórico União Desportivo e Cultural da Gemieira
PL6	Ponte de Lima	Grupo Folclórico da Associação Cultural e Recreativa de Calheiros
PL7	Ponte de Lima	Grupo Folclórico das Lavradeiras de Gondufe
PL8	Ponte de Lima	Rancho Infantil da Correlhã
PL9	Ponte de Lima	Rancho Infantil de Freixo
PL10	Ponte de Lima	Grupo Danças e Cantares do Neiva Sandiães
PL11	Ponte de Lima	Rancho Folclórico Etnográfico da Casa do Povo de Poiares
PL12	Ponte de Lima	Grupo Cultural e Recreativo de Dnaças e Cantares de Ponte de Lima
PL13	Ponte de Lima	Associação Cultural Desportiva e Recreativa Rancho Folclórico da Ribeira
PL14	Ponte de Lima	Rusga Típica da Correlhã
PL15	Ponte de Lima	Grupo Folclórico Danças e Cantares de Vitorino de Piães
PL16	Ponte de Lima	Grupo Etnográfico de Refóios
VA1	Valença	Grupo Folclórico de Ganfei
VA2	Valença	Grupo Cultural e Recreativo os Camponeses Minhotos
VA3	Valença	Rancho Infantil e Juvenil de Friestas
VA4	Valença	Rancho Folclórico de São Julião

Code	District (Concelho)	Group name
VC1	Viana do Castelo	Grupo de Danças e Cantares da Casa do Povo de Vila Nova de Anha
VC2	Viana do Castelo	Grupo Folclórico de Castelo do Neiva
VC3	Viana do Castelo	Grupo Folclórico de Chafé
VC4	Viana do Castelo	Grupo Folclórico "S.Paulo" de Barroselas
VC5	Viana do Castelo	Grupo Folclórico Cultural Danças e Cantares de Carreço
VC6	Viana do Castelo	Grupo Folclórico e Etnográfico de Castelo do Neiva
VC7	Viana do Castelo	Grupo Folclórico da Casa do Povo de Lanheses
VC8	Viana do Castelo	Grupo de Danças e Cantares de Perre
VC9	Viana do Castelo	Grupo de Danças e Cantares de Torre
VC10	Viana do Castelo	Rancho Folclórico das Lavradeiras de Vila Franca
VC11	Viana do Castelo	Ronda Típica de Carreço
VC12	Viana do Castelo	Grupo Folclórico de Santa Marta de Portuzelo
VC13	Viana do Castelo	Grupo Folclórico de Alvarães
VC14	Viana do Castelo	Grupo Etnográfico de Areosa
VC15	Viana do Castelo	Grupo Folclórico das Bordadeiras da Casa do Povo de Cardielos
VC16	Viana do Castelo	Rancho Folclórico das Terras de Geraz do Lima
VC17	Viana do Castelo	Rancho Folclórico do Centro Desportivo e Cultural de Outeiro
VC18	Viana do Castelo	Escola de Folclore de Santa Marta de Portuzelo
VC19	Viana do Castelo	Rancho Regional das Lavradeiras de Carreço
VC20	Viana do Castelo	Rancho Danças e Cantares de Afife
VC21	Viana do Castelo	Grupo Folclórico de Viana do Castelo
VC22	Viana do Castelo	Grupo Folclórico das Lavradeiras da Meadela
VC23	Viana do Castelo	Ronda Típica da Meadela
VC24	Viana do Castelo	Grupo de Danças e Cantares de Serreleis
VC25	Viana do Castelo	Grupo das Cantadeiras do Vale do Neiva
VC26	Viana do Castelo	Grupo Etnográfico de S.Lourenço da Montaria
VC27	Viana do Castelo	Rancho Folclórico Serradores do Monte de Vila Fria
VNC1	Vila Nova de Cerveira	Rancho Folclórico e Etnográfico de Reboreda
VNC2	Vila Nova de Cerveira	Rancho Folclórico e Infantil de Gondarém
VNC3	Vila Nova de Cerveira	Rancho Folclórico de Sopo

APPENDIX 3

HAND IN SURVEY FOR FOLK GROUP DIRECTORS

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PROJECTO DE DOUTORAMENTO
Compreensão da Performance Vocal de Folclore Minhoto

QUESTIONÁRIO DE CARACTERIZAÇÃO DO GRUPO

Formulário A

Este questionário destina-se à recolha de dados do projecto de Doutoramento intitulado "*Compreensão da Performance Vocal de Folclore Minhoto*", estudo que visa a caracterização da actividade vocal de cantores solistas de folclore minhoto, do ponto de vista funcional, aerodinâmico e fisiológico. Assim, pretende-se contribuir para a melhor compreensão deste estilo vocal, numa perspectiva holística de performance artística articulada ao desempenho e saúde vocais.

Os dados obtidos destinam-se particularmente à caracterização geral dos grupos folclóricos e/ou etnográficos seleccionados para este estudo, pelo que este questionário deverá ser respondido pelo(s) Ensaiador(es) e/ou Dirigente(s) de Grupo. As fases posteriores do estudo estão dependentes da análise destes dados, pelo que se solicita que o questionário seja preenchido com a maior brevidade possível.

Nome do Grupo	Clique aqui para introduzir texto.				
Dirigente(s)	Nome	Clique aqui para introduzir texto.	Contacto	…	
	Nome	Clique aqui para introduzir texto.	Contacto	…	
Ensaiador(es)	Nome	Clique aqui para introduzir texto.	Contacto	…	
	Nome	Clique aqui para introduzir texto.	Contacto	…	

Colocar uma cruz [x] nos elementos que contribuíram para responder ao questionário

1) Quantos elementos constituem o grupo?
(Se não souber ao certo indique um número aproximado)

a) Homens Clique aqui para introduzir número.
b) Mulheres Clique aqui para introduzir número.
c) TOTAL Clique aqui para introduzir número.

2) Quantos elementos estão associados a cada função?
(Se for necessário pode repetir elementos em funções diferentes)

a) Instrumentos Clique aqui para introduzir número.
b) Dança Clique aqui para introduzir número.
c) Canto (solistas) Clique aqui para introduzir número.
d) Canto (coros) Clique aqui para introduzir número.
e) Outros Clique aqui para introduzir número.

Se preencheu a opção "e) Outros" indique quais as funções
Clique aqui para introduzir texto.

3) Que músicas/canções são mais frequentemente interpretadas pelo grupo?
Clique aqui para introduzir texto.

4) Do repertório do grupo indique as músicas/canções que considere serem mais representativas da região do Minho.
Clique aqui para introduzir texto.

5) Qual a periodicidade dos ensaios?

Clique aqui para introduzir texto.

6) Qual a duração média dos ensaios?
Clique aqui para introduzir texto.

7) Quantas músicas/canções ensaiam (em média) por ensaio?
Clique aqui para introduzir texto.

8) Qual a periodicidade das actuações?
Clique aqui para introduzir texto.

9) Qual da duração média das actuações?
Clique aqui para introduzir texto.

10) Quantas músicas/canções apresentam (em média) em cada actuação?
Clique aqui para introduzir texto.

11) Como é estruturado normalmente o ensaio (partes, tipo de músicas, disposição do grupo, local, amplificação, etc.)?
Clique aqui para introduzir texto.

12) Como é estruturada normalmente a actuação (partes, tipo de músicas, disposição do grupo, local, amplificação, etc.)?
Clique aqui para introduzir texto.

13) É realizado algum tipo de preparação ou aquecimento vocal antes dos ensaios e/ou actuações? Se sim, como é realizado?
Clique aqui para introduzir texto.

14) Identifique os instrumentos incluídos no acompanhamento musical do grupo.

Instrumento	Quantidade	Número de músicas em que o instrumento é usado
---	---	---
---	---	---
---	---	---
---	---	---
---	---	---
---	---	---
---	---	---

15) O repertório é afinado predominantemente em alguma(s) tonalidade(s)?
Clique aqui para introduzir texto.

16) É comum haver alteração da tonalidade da peça por causa das características vocais dos cantores? Se sim, com que regularidade (em média) é feita?
Clique aqui para introduzir texto.

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PROJECTO DE DOUTORAMENTO
Compreensão da Performance Vocal de Folclore Minhoto

17) Identifique os solistas do grupo (nome, idade, número de músicas nas quais faz solos).

Nome	Idade	Número de músicas nas quais faz solos
---	---	---
---	---	---
---	---	---
---	---	---
---	---	---

18) Na história do grupo há registo de algum cantor ter sido obrigado a deixar de cantar devido a problemas de voz? Se sim, foi uma situação permanente ou transitória?

Clique aqui para introduzir texto.

APPENDIX 4

INFORMED CONSENT DECLARATION

FOR VOICE RECORDINGS

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PROJECTO DE DOUTORAMENTO
Compreensão da Performance Vocal de Folclore Minhoto

GRAVAÇÃO AUDIO INDIVIDUAL

Formulário C

Este procedimento de gravação é parte integrante do sistema de recolha de dados do projecto de Doutoramento intitulado "*Compreensão da Performance Vocal de Folclore Minhoto*". Sumariamente, este estudo pretende caracterizar a actividade vocal de cantoras solistas (cantadeiras) de canto folclórico minhoto, contribuindo para a sua melhor compreensão e determinação do impacto que pode ter ao nível da saúde vocal.

Solicita-se que colabore activamente na recolha de dados que deverá demorar cerca de 10 a 15 minutos. A gravação áudio é um processo de registo de voz não invasivo, pelo que não apresenta qualquer risco para a sua saúde. Ser-lhe-ão solicitadas várias tarefas de fala e canto que lhe serão devidamente explicadas durante o processo. Se precisar de ajuda ou quiser interromper o processo por alguma razão por favor comunique com o investigador presente.

A participação nesta gravação é livre e garante-se o anonimato e confidencialidade de toda a informação. Os dados serão usados exclusivamente para fins de investigação, podendo ser divulgados para fins científicos.

Investigador responsável: **André Araújo**

Contacto: canto.minhoto@gmail.com / a32448@ua.pt

TERMO DE CONSENTIMENTO INFORMADO

Conforme a lei 67/98 de 26 de Outubro e a "Declaração de Helsínquia" da Associação Médica Mundial (Helsínquia 1964; Tóquio 1975; Veneza 1983; Hong Kong 1989; Somerset West 1996, Edimburgo 2000; Washington 2002, Tóquio 2004, Seul 2008).

Designação do Estudo: **Compreensão da Performance Vocal de Folclore Minhoto**

Eu, abaixo-assinado (indicar nome completo)

_____

a) Fui informado de que o Projecto de Investigação acima mencionado se destina a caracterizar a actividade vocal de cantoras solistas (cantadeiras) de canto folclórico minhoto, contribuindo para a sua melhor compreensão e determinação do impacto que pode ter ao nível da saúde vocal.

b) Sei que neste estudo está prevista a realização de gravações, tendo-me sido explicado em que consistem e qual o seu propósito.

c) Foi-me garantido que todos os dados relativos à identificação dos Participantes neste estudo são confidenciais e que será mantido o anonimato.

d) Sei que posso recusar-me a participar ou interromper a qualquer momento a participação no estudo, sem nenhum tipo de penalização por este facto.

e) Compreendi a informação que me foi dada, tive oportunidade de fazer perguntas e as minhas dúvidas foram esclarecidas.

f) Aceito participar de livre vontade no estudo acima mencionado.

g) Autorizo a divulgação dos resultados obtidos no meio científico, garantindo o anonimato.

Data Assinatura

___/___/____ _____

APPENDIX 5

INDIVIDUAL QUESTIONNAIRE AND LISTENING TEST PROTOCOL

TESTE PERCEPTUAL AUDITIVO

Formulário C

Caro participante

O questionário seguidamente apresentado pretende a recolha de dados para o meu projeto de Doutoramento intitulado "*Caracterização das Vozes de Folclore do Alto Minho*". Sumariamente, este estudo tem por objetivo caracterizar o desempenho vocal de cantoras solistas de folclore minhoto (cantadeiras), visando: (i) contribuir para a compreensão dos fenómenos vocais que melhor caracterizam este estilo de canto tipicamente português; (ii) avaliar a sua relação com a evolução das atividades socioculturais das zonas rurais que lhe deram origem; e (iii) determinar possíveis impactos destas práticas na saúde vocal dos seus intérpretes.

No ato do preenchimento deste inquérito será convidado a ouvir um CD com 23 excertos do refrão da canção "Oh Rosinha do Meio", nas vozes de Cantadeiras do Alto Minho.

Após a audição de cada excerto apresentado, gostaríamos que avaliasse perceptualmente o *quanto esse excerto constitui um exemplo típico de uma Cantadeira de folclore do Alto Minho*.

Agradecemos ainda que, no seguimento do teste, responda a um conjunto de questões sobre o tema deste estudo.

Este teste percetual auditivo é completamente anónimo. O tratamento de dados será realizado com o maior respeito e os seus resultados serão usados apenas para efeitos de investigação.

Gratos pela sua participação.

Os meus cumprimentos,

André Araújo
Estudante de Doutoramento em Música
Departamento de Comunicação e Arte
Universidade de Aveiro
Campus Universitário de Santiago
3810-193 Aveiro
Telf. 96 2101183
E-mail: canto.minhoto@gmail.com / a32448@ua.pt

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PROJECTO DE DOUTORAMENTO
Caracterização das Vozes de Folclore do Alto Minho

A preencher pelo investigador

Questionário nº

A. IDENTIFICAÇÃO

1. Nome: _____

2. Idade: _____ anos

3. Sexo: Feminino [ ] Masculino [ ]

4. Residência: Concelho: _____ Localidade: _____

5. Habilitações: [ ] Sem habilitações literárias
[ ] 1º Ciclo do Ensino Básico (4º ano ou equivalente)
[ ] 2º Ciclo do Ensino Básico (6º ano ou equivalente)
[ ] 3º Ciclo do Ensino Básico (9º ano ou equivalente)
[ ] Ensino Secundário (12º ano ou equivalente)
[ ] Licenciatura Qual? _____
[ ] Mestrado Qual? _____
[ ] Doutoramento Qual? _____
[ ] Outro Qual? _____

6. Profissão: _____

7. Grupo Folclórico/Etnográfico: _____

8. Função no grupo (pode indicar mais do que uma):
[ ] Instrumentista ..... Que instrumento(s)? _____
[ ] Dançarino(a)
[ ] Cantador/Cantadeira nos coros
[ ] Cantador/Cantadeira solista
[ ] Outra ..... Especifique a função. _____

9. No total, quantos anos de experiência artística/musical possui neste ou noutros grupos folclóricos/etnográficos? _____ anos

10. Possui outras experiências artísticas/musicais noutros meios para além deste grupo folclórico/etnográfico?
[ ] NÃO, apenas neste grupo.
[ ] SIM, tenho outras experiências
Se respondeu que SIM, indique quais:
_____
_____
_____

Formulário C

A preencher pelo investigador

Teste nº

B. TESTE PERCETUAL AUDITIVO

INSTRUÇÕES DE RESPOSTA

Por favor ouça com atenção os excertos que se seguem (no total 23), classificando cada um relativamente **à sua representatividade enquanto exemplo típico de uma Cantadeira de folclore do Alto Minho**, colocando uma marca vertical perpendicular à linha horizontal apresentada para cada excerto, tendo em conta que: (i) quanto mais próximo do início do lado esquerdo da linha horizontal colocar a marca, mais a sua classificação penderá para uma cantadeira que "possui uma voz que não é em nada um exemplo típico de *Cantadeira* de folclore do Alto Minho"; (ii) quanto mais próximo do início do lado direito da linha horizontal colocar a marca, mais a sua classificação penderá para "possui uma voz que é extremamente típica de *Cantadeira* de folclore do Alto Minho".

Eis um exemplo de como deverá preencher este teste percetual auditivo:

Excerto A
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

Excerto B
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

1. Excerto #1
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

2. Excerto #2
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

3. Excerto #3
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

4. Excerto #4
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

5. Excerto #5
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

6. Excerto #6
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

7. Excerto #7
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

8. Excerto #8
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

9. Excerto #9
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

universidade de aveiro

PROJECTO DE DOUTORAMENTO
Caracterização das Vozes de Folclore do Alto Minho

10. Excerto #10
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

11. Excerto #11
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

12. Excerto #12
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

13. Excerto #13
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

14. Excerto #14
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

15. Excerto #15
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

16. Excerto #16
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

17. Excerto #17
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

18. Excerto #18
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

19. Excerto #19
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

20. Excerto #20
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

21. Excerto #21
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

22. Excerto #22
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

23. Excerto #23
(Voz nada típica para folclore) ——— (Voz extremamente típica para folclore)

MUITO OBRIGADO PELA COLABORAÇÃO

Formulário C