The Irrintzi and Other Folk Cries High Pich and Loud Emission. Can We Learn Something?

*Ana Martínez-Arellano, †Arantza Campo, *Beatriz del Rio, *Octavio Garaycochea, and *Secundino Fernandez,
*†*Pamplona, Spain*

Summary: Introduction. In various cultures there are vocal sounds and cries associated with the folk tradition.
All these cries are emitted in a single breath, have a high frequency and are loud. They are consequently audible over long distances and cut through other vocal expressions or other sounds generated by instruments.
Objectives. The objective of this work is to acoustically analyze some of these folkloric cries and study elements common to all of them.
Methods. In this study, *Irrintzi, Aturuxo, Tzagrit, ululation Darfur* and *Kurava* cries were subjected to descriptive acoustic spectrographic analysis, and the resulting descriptions were compared both quantitatively, in terms of various acoustic parameters, and qualitatively, in terms of spectrographic characteristics and the way the cries sound.
Results. All of the cries contained high frequencies. Spectrograms of the cries revealed that they had a common pattern: a lower initial frequency ascends rapidly (the attack) and is then maintained throughout a stable phase of the emission (the body) before a final drop in frequency (the ending or coda). The body is the longest phase.
Conclusions. This initial study of five sounds of folk tradition has opened up a wealth of acoustic and cultural discoveries. Broader studies are now needed to determine if the characteristics we have reported are common to other cries, to look for other similarities, and to delve into meanings, implications and possible applications.
In-depth understanding of the mechanism of emission of traditional cries could provide tools for voice re-education in patients with dysphonia due to vocal strain (muscle tension dysphonia, vocal nodules, etc.), for improving voice quality, and for increasing the efficiency of vocal performance.
Key Words: Irrintzi—Acoustic analysis—Vocal technique.

INTRODUCTION

In various cultures there are vocal sounds and cries associated with folk tradition. Such articulations have been used for centuries as a means of communication and expression in diverse situations, whether to notify others about pressing matters, to warn of imminent danger or as a manifestation of happiness or sorrow in everyday life or in ceremonies.

What is common to all these cries is that they are emitted in a single breath, have a high frequency and are loud. They are consequently audible over long distances and cut through other vocal expressions or other sounds generated by instruments.

Reports of these cries exist back to antiquity in the hieroglyphics of the pyramids and in the texts of Ancient Greece. They are usually denominated as "*ululation*", from the Latin *"ululo,"* which was a strident, high-pitched undulating sound similar to a howl.[1−5]

Usually, this type of cry or shriek is regarded as an expression of happiness in celebration of good news or as an expression of fury, pain or lamentation. Jews, Muslims, and orthodox Christians have incorporated these cries in some of their religious rites, as expressions of celebration or rejoicing.

Various names are used for ululations, depending on their origin: *ululatio, udhalili, ililta, guda, sigalagala, kupururudza, ululudhvani, kulavai, zaghareet, salguta or sarguta, tzagrit*, etc.[6−9]

Within this category of vocal articulation is the *irrintzi* of the Basque-Navarre people. Don Jose Mª Iribarren defines the irrintzi as "an ululating cry, a mixture of shriek and guffaw, given by the mountain-dwellers of the region. In this sense it is similar to the aturuxu of the [Spanish] Galicians.*"*[10] According to tradition, the *irrintzi* was used, in a rural context, as a means of communication between valleys, with the message encoded in the frequency and duration of the sound emitted.[11−14]

In clinical practice, it is usual to receive patients with problems due to voice use either over long periods of time in noisy environments (the case with teachers, commentators, actors, etc.) or at high frequencies (singers and people working with young children, etc.). Such vocal strain causes laryngeal pathology including nodules, polyps and hyperfunction disorders, such as, muscle tension dysphonia, that is in many cases a serious problem with side effects on the work life or social life of the people affected.[15−18]

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Author contribution: *AM-A:* 0000-0002-9365-0912, *AC:* 0000-0001-9700-4355, *BdR:* 0000-0003-2787-9951, *SF:* 0000-0002-3858-0034
From the *Department of Otolaryngology Head and Neck Surgery, Clinica Universidad de Navarra, Universidad de Navarra, Pamplona, Spain; and the †Department of Pulmonology, Clinica Universidad de Navarra, Universidad de Navarra, Pamplona, Spain.
Address correspondence and reprint requests to: Secundino Fernandez, Dpt. Otolaryngology Head and Neck Surgery, Clinica Universidad de Navarra, Universidad of Navarra, Avda. Pio XII, 36, 31008, Pamplona, Spain E-mail: sfgonzalez@unav.es
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Irrintzis and other folk cries are emitted at high volume and high frequency, and so emitters would be expected to be at risk of suffering from vocal pathology.

In the bibliographic review carried out, no article has been found that links the presence of vocal pathology with the emission of these cries. In our clinical practice, we found no voice problems related to these emissions and the irrintzilaris that were examined did not present any pathology.

~~However,~~ *irrintzi* ~~emitters do not present such pathology, and in clinical practice voice problems related to these emissions are not encountered~~. This fact led us to wonder whether knowledge of the mechanism of emission might be used to help patients with vocal strain pathology. In particular, better knowledge of these emissions and how they are generated may be of use in vocal reeducation for patients with dysphonia and/or as a way to improve vocal performance for people who frequently have to use their voices in noisy environments, at high volume or at high frequency.

Because the acoustic characteristics of the *irrintzi* and other such cries have not been described, we set out to collect and analyze audio samples. The objective was to study similarities and differences, looking for common characteristics that might indicate the nature of a specific vocal technique used for emission.

In this preliminary study, *irrintzi, aturuxo, tzagrit, ululation Darfur,* and *kurava* cries, an example of each, were subjected to descriptive acoustic spectrographic analysis, and the resulting descriptions were compared both quantitatively, in terms of various acoustic parameters, and qualitatively, in terms of spectrographic characteristics and the way the cries sound.

MATERIALS AND METHODS

We studied, by spectrography, an audio recording representative of each of the emissions: *irrintzi, aturuxo, tzagrit, Darfur ululation,* and *kurava ululation.* All of the emissions were by women (nowadays this kind of folkloric shouting is usually performed by women)~~, none of whom were suffering from any vocal alteration.~~ Prior to the audio recording, laryngeal nasofibroscopy was performed on the subjects who emitted the irrintzi, aturuxo and tzagrit, and no pathology or alteration was observed. In the case of the Darfur and Kurava ululation, as they are commercial recordings, it is not possible to ensure that they are free of pathology.

The irrintzi was recorded in the voice laboratory in the otorhinolaryngology department at the *Clínica Universidad de Navarra,* on an Apple G4 computer with a condenser microphone placed 1 m from the emitter. The *tzagrit* and *aturuxo* samples were recorded with an Olympus Digital Voice Recorder VN-731 at 1 m from the emitter. For the *ululation Darfur* and the *kurava* (from Kerala, India), we used commercially available recordings.

All audio recordings had a sampling rate of 44 kHz and a bit-depth of 16 bits and were free of extraneous or background sounds. Data was saved uncompressed (.wav format).

Spectrographic analysis (using Sound Scope II software) was carried out in the time domain with a narrowband filter (45 Hz, FFT 1.024), over the range 50 Hz to 20 kHz to study harmonics.

For the *irrintzi* and *tzagrit*, sound intensity was registered on an Iso-Tech SLM-1352A sound level meter placed at a distance of 1 m from the emitter.

RESULTS

Below is a brief description, by ear, of the cries:

- In the *irrintzi*, there is a series of rapid alternations between the phonemes [α]-[i], finishing in a prolonged [i] with variations in tone and intensity.
- The *aturuxo*, from Galicia in Spain, sounds like a stable, high-frequency phoneme [α], finishing with a wavering in which an [α] is preceded by an aspirate and followed by a final [i].
- The *tzagrit* sounds similar to a [u] intercalated with a soft [r].
- The Darfur ululation is similar to a trill [iαi] in which, at the end, the [α] and then the [i] are lengthened
- The Kurava ululation, from Kerala, is similar to the *tzagrit*, sounding similar to variations of a [u].

All of the cries contained high frequencies. Spectrograms of the cries revealed that they had a common pattern: a lower initial frequency ascends rapidly (the attack) and is then maintained throughout a stable phase of the emission (the body) before a final drop in frequency (the ending or coda). The body is the longest phase.

In the *irrintzi* spectrogram (Figure 1, n° 1), the body has a characteristic M-shaped distribution of harmonics, with some irregularities. The body ends with a sharp rise in frequency followed by a silence before the ending with the typical drop in frequency.

In the *aturuxo* spectrogram (Figure 1, n° 2), the attack stabilizes at a very high frequency that is held during the body with stable harmonics until the final part in which there are some undulating variations.

The spectrogram of the *tzagrit* (Figure 1, n° 3) shows, after the usual ascending attack, a zone of irregularity in the harmonics, which is followed by a rise in frequency and then a gentle drop.

The characteristic feature of the body part of the spectrogram of the Darfur ululation (Figure 1, n° 4) is the groupings of undulations in the harmonics, which are separated by short, flatter segments.

The recording of the Kurava ululation (from the Kurava tribe of Kerala) (Figure 1, n° 5) was of lower quality than the other recordings, and consequently the spectrogram was less precise. The overall pattern is apparently the same, and the central body part of the spectrogram has a zone of small irregularities similar to that seen for the *tzagrit*.

All of the recordings, with the exception of that of the Kurava ululation, had harmonics with the frequencies up to

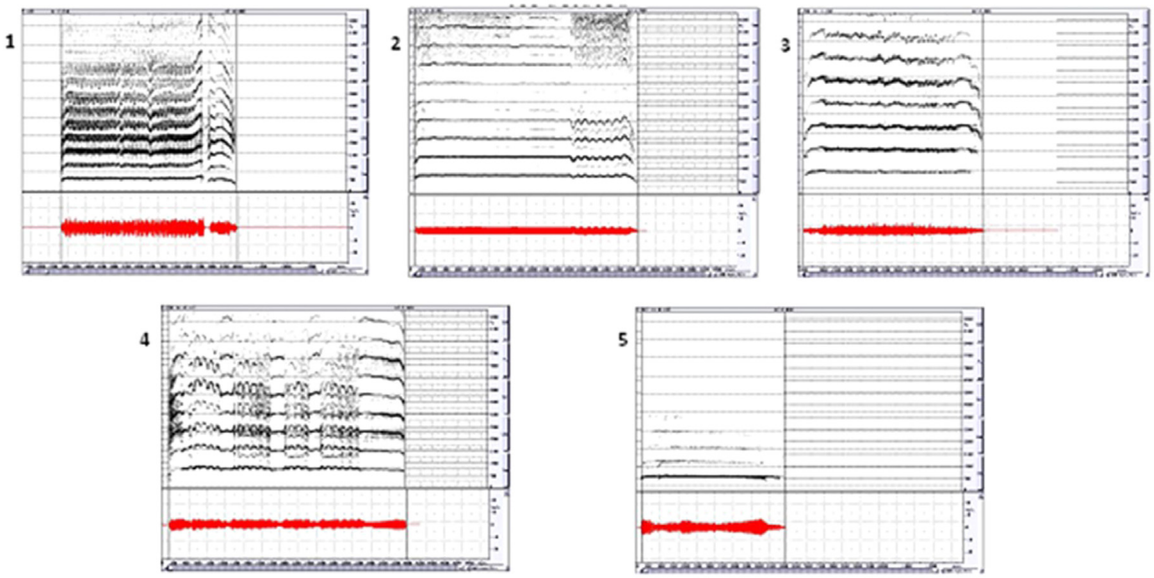

FIGURE 1. Example spectrograms of complete folk cries: 1, *irrintzi*; 2, *aturuxo*; 3, *tzagrit*; 4, Darfur ululation; and 5, Kurava ululation. Note that time scale division on the abscissa is 500 ms for *irrintzi, tzagrit* and Kurava ululation but 200 ms for *aturuxo* and Darfur ululation.

10,000 Hz. The *irrintzi, tzagrit* , and Kurava ululation emissions were the longest, lasting for about seven seconds.

The *irrintzi* and *tzagrit*, recordings of which were made in our laboratory, had sound levels of about 100 dB as measured by the sound meter at a distance of one meter. For the other cries, the intensity was also high, but because we were working with the recordings, it was not possible to obtain the basal intensity as reference.

The cries were analyzed section by section and compared. The attack phase was similar in all cries: there was a rapid rise in frequency over a period of between 0.08 and 0.4 seconds (Table 1). The *tzagrit* had the highest-pitched attack, and the fundamental frequency F_0 was at all times above 900 Hz. This frequency is above the upper limit for which our analysis software could calculate the statistical average F_0; therefore, we estimated it manually be measuring the frequency at various points of the first harmonic. The aturuxo had the smallest rise in frequency: 219 Hz. The Darfur ululation had the biggest rise: 372 Hz, going from 700 Hz to 1072 Hz in 0.2 seconds.

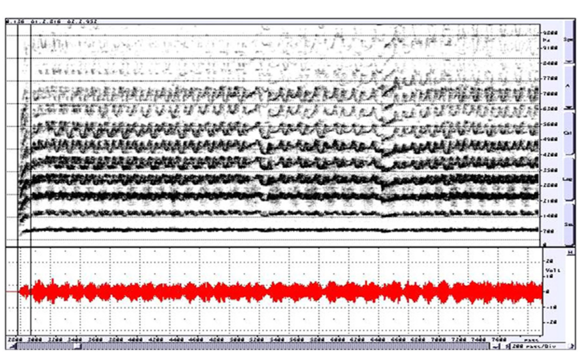

FIGURE 2. Spectrogram of an irrintzi, showing characteristic M-shaped motif in the distribution of harmonics.

The body was the longest phase in all the cries analyzed. The most prolonged body was 5.5 seconds long (Table 1). The spectrogram of the *irrintzi* body comprised a repeated M-shaped motif with two zones in which the M was altered. Alterations were more evident the higher the harmonic (Figure 2). This morphology has not been reported before for any vocal sound.

The spectrograms of the *tzagrit* and the Kurava ululation showed harmonics with irregularities with no specific pattern. The spectrogram of the Darfur ululation Darfur had zones with undulating harmonics separated by harmonics of more rectilinear shape. The body part of the *aturuxo* spectrogram was similar to that of a sustained vowel. In all cases, the frequencies observed in the body part of the cries were higher than those in the attack part (Table 1).

Endings were distinct for each cry although a decrease in frequency was common to all. In particular, there was an initial increase in f_0 and then a decrease, which was less abrupt in the *irrintzi* (which had an intercalated silence) and the *tzagrit*. For the *aturuxo*, the undulating harmonic spectrum of the ending was the most distinctive part of the whole spectrogram. For all cries studied, the highest f_0 values were in the ending (Table 1). The size of the decrease in frequency was pronounced in the *irrintzi* and the *aturuxo*.

DISCUSSION

The analysis of samples recorded in our voice laboratory or obtained as recordings from other sources did not pose any significant problems or significantly bias evaluation or interpretation of the results.

Cries of folk tradition are typically emitted in the context of fiestas and celebrations, and it is the high volume and high f_0 of the cries that enables them to be heard above the

TABLE 1.
Characteristics of the Parts of the Different Folk Cries: Duration; Mean, Maximum and Minimum Fundamental Frequency; and the Increase in Frequency Over the Course of Emission

folk cry	Duration	Mean F_0 (Hz)	F_0 Range (Hz)	Increase (Hz)
Irrintzi (KG I2)	0.14 s	677.47	437.5-787.5	350
Aturuxo	0.08 s	882	831.25-1050	218.75
Tzagrit	0.4 s	>1006	1006.25-1290.62	284.37
Darfur	0.2 s	394.69	700-1071.87	371.87
Kurava	0.08 s	738.36	590.62-831.12	240.5
Irrintzi (KG I2)	5.32 s	761.83	612.5-875	262.5
Aturuxo	2.44 s	>1000	984.37-1093.75	109.37
Tzagrit	5.67 s	626.74	1181.25-1312.5	131.25
Darfur	2.94 s	546.77	984.37-1246.87	262.5
Kurava	5.50 s	803.03	700-875	175
Irrintzi (KG I2)	1.73 s	728.50	350-1006.25	656.25
Aturuxo	1.12 s	557.80	1093.75-546.87	546.87
Tzagrit	1.19 s	492.74	1181.25-1312.5	131.25
Darfur	0.71 s	>920	918.75-1115.62	196.87
Kurava	0.28 s	688.49	678.12-875	196.87

surrounding noises (voices or musical instruments) and to be heard over long distances.

A three-part structure is similar to all the cries studied, although each cry has its own distinct characteristics. The *irrintzi's* main distinctive characteristic is its unique repeated M-shaped motif in the spectrogramprobably related to the vowels The F1 and F2 formants are similar to each other in sound emission [α] due to the configuration of the vocal tract, which is narrow in the pharynx and wide in the oral cavity. In sound emission [i], on the other hand, the configuration of the vocal tract, which is wide in the pharynx and narrow in the oral cavity, makes F1 and F2 different. The rapid and repeated change of the configuration of the vocal tract during the emission of an irrintzi is what we think determines the peculiar morphology of M of the harmonics in the spectrogram in the time domain.

The *aturuxo*, in contrast to all the other cries, only contains ululation in the final part. The *tzagrit* and the Kurava ululation are similar to each other. The Darfur ululation is characterized by zones of undulating variations in harmonics separated by intervals with a more flat harmonic distribution.

The M-shaped motif in the sonogram of the *irrintzi* was not detected in any of the other cries. It would be potentially useful to unravel the physiological mechanisms that make the resonance of the *irrintzi* so peculiar and that make the harmonic pattern so distinctive because this phonatory technique makes it possible to emit high frequency sounds at high volume in an efficient manner that does not pose any risk of damage to the vocal apparatus.

All of the cries studied are loud and at a high frequency. ~~butdo not engender pathology~~. They are heard above ambient noise. There are no published studies on the pathology in these individuals. In our experience, dysphonia in irrintzilaris is not a reason for consultation. We have examined many of them and none of them presented laryngeal pathology or reported dysphonia. We infer that apparently their emission does not generate pathology. It would be interesting to examine the emitters of this type of folkloric shouts to confirm this fact. Consequently, knowledge of their characteristics and of how they are generated might provide vocal techniques that could be adapted for speech in noisy environments (by teachers, salespersons, etc.) and that could make it easier to emit high frequencies (when singing).

The harmonic spectrum of sustained vowel sounds or fragments of speech articulated or sung with good vocal technique can typically go as high as 6 kHz. The traditional folk cries studied here were found to have harmonics up to 10 kHz, which indicates better use of acoustic energy.

Emission of the *irrintzi* and the *tzagrit*, which we observed during the recording in our laboratory, required no forceful physiological mechanism: no forced expiration. On the contrary, to produce the sound, emitters are relaxed in their whole body, and this helps to control the flow of air.

This initial study of five sounds of folk tradition has opened up a wealth of acoustic and cultural discoveries. Broader studies are now needed to confirm that they do not engender vocal pathology, to determine if the characteristics we have reported are common to other cries, to look for other similarities, to study the vocal technique they use (breathing, anchoring, use of resonators,...), to see if there are differences depending on the sex of the transmitter, if the vocal register has an influence, and to delve into meanings, implications and possible applications.

In-depth understanding of the mechanism of emission of traditional cries could provide tools for voice re-education in patients with dysphonia due to vocal strain (muscle tension dysphonia, vocal nodules, etc.), for improving voice quality, and for increasing the efficiency of vocal performance.

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ETHICS COMMITTEE

No ethical objections were observed by the Ethics Committee of the University of Navarra.

AUTHOR AGREEMENT STATEMENT

We the undersigned declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We understand that the Corresponding Author is the sole contact for the Editorial process. He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs Signed by all authors as follows:

DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at doi:10.1016/j.jvoice.2022.08.019.

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