INTONATION AND VARIATION:

THE MULTICIPLICITY OF FORMS AND SENSES

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Abstract

This work focuses on the multiplicity of forms which the intonation patterns may have and the multiple senses they express. The background for discussing these issues is vocal gestuality taken as an index of the biological, psychological and social characteristics of the speaker. The intonation sound patterns vary according to sociolinguistic features, dialect type and speech style and they are used to express modalities, regional and social characteristics, propositional and social attitudes and affective states. The intervening factors in the relation between form and meaning are numerous and they interfere with the perception of the intonation patterns. Results from acoustic and perceptual experiments in several languages are presented and their contribution to the study of the communicative functions and variability of intonation are discussed.

Mots-clé

intonation, variety, vocal gestuality, form and function

ENTOAÇÃO E VARIAÇÃO: A MULTIPLICIDADE DE FORMAS E SENTIDOS

Resumo

Nesta comunicação o foco sobre a entoação recai sobre a multiplicidade de formas e sentidos que os padrões entoacionais podem, respectivamente assumir e expressar, o que implica necessariamente em se colocar como pano de fundo a gestualidade vocal como um índice das características biológicas, psicológicas e sociais do falante. Os padrões entoacionais variam de acordo com características sociolinguísticas, dialetais e estilísticas e são usados para expressar modalidades, características regionais e sociais, atitudes proposicionais e sociais e estados afetivos. São muitos os fatores intervenientes nessa relação entre forma e sentido que afetam a percepção dos padrões entoacionais. Resultados de experimentos acústicos e perceptivos em línguas diversas são apresentados e discutidas suas contribuições para o estudo da variação entoacional e da compreensão de funções comunicativas da entoação.

Palavras-chave

entoação, variação, gestualidade vocal, forma e função

1. Introduction

Speech can be viewed as vocal gestuality and as such it has the symbolic, indexical, metaphoric and iconic potential to convey meanings. Symbolically, the gesture conveys grammatical information, indexically, it conveys, although unintentionally, pragmatic information, metaphorically, it can be used to understand something in terms of another (Cienki 1998) and iconically, it can be used to represent an object, a person, a phenomenon either as a whole, group or a single characteristic they might have.

Due to the extreme plasticity of the phonatory system the organs of speech can modify the shape and extension of the cavities involved in the production of sounds and a great variety of sounds, the phonic segments, can be produced.

In speech prosodic elements interact with the phonic segments and a multiplicity of forms and meanings is derived. The term "forms" is used to refer to the phonetic configurations and the expression "meaning effects" to the meanings which can be assigned to speech signals based on the properties of the phonic matter. When we listen to someone speaking, the way he speaks cues inferences about his physiological,

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psychological and social conditions. In this way, attitudes, emotions, personality traits, age, sex, region are inferred from speech.

Among the prosodic elements, intonation plays an important role in spoken communication and the results of the research on intonation can be applied in several fields. In technology, it has been applied to speech synthesis, speech recognition, speaker and language identification systems. In the field of health sciences for rehabilitating vocal disturbances and identifying psychiatric disorders and for educational purposes in the training of pronunciation in foreign languages, in helping hearing-impaired subjects to speak and in teaching of oratory skills. Granström (1997) provides an overview of the applications of intonation research and Chun (2002) discusses discourse intonation research in the L2 context.

A thorough review of intonation studies can be found in Botinis, Granström & Möbius (2001). In their paper they discuss the developments and paradigms of intonation research. Intonation has been defined in the literature in a great number of ways depending on the theoretical assumptions adopted by the researcher. Vaissière (2005) provides a keen review of the role of intonation in speech perception, discussing syntactic and informational structuring, grammatical, communicative and interactional functions. A great number of works on the intonation patterns of Romance languages (Zerling & Moutinho 2002; Moutinho 2004; Moutinho, Coimbra & Fernández Rei 2009, 2015, to name a few) has been developed under the cross-linguistic research project on intonation, the *Atlas Multimédia Prosodique de l'Espace Roman* (Contini et al. 2002).

Intonation has been defined in many different ways depending on the theoretical orientation or perspective taken into account. In this work we adopt Bolinger's (1986) definition of intonation as a laryngeal gesture since it is accordingly to a view of the speech production system involves vocal and visual gestuality, a system capable of conveying linguistic, paralinguistic and extralinguistic information. As one can infer from the works by Bolinger (1989), Fonagy (1983), Ladd et al. (1985), Hirschberg & Ward (1992), Bänziger & Scherer (2005), among others, intonation as the melody of speech   presents a virtual modality of gestuality (Bolinger 1986, 1989; Fonagy 2000; Vaissière 2005).

In judging intonational patterns, listeners' attention is directed not only to pitch rising and lowering but also to the visual inspection of the upper part of the face (Lansing & McConkie 1999) mainly to the rising and lowering movements of the eyes, eye brows and head which often accompanies pitch movements. In the ninth episode of the first season of "Friends" there is a scene in which the utterance "Got the keys" is produced in interrogative and declarative modalities. The actors use bodily movements (arms, hands eyebrows, head) to accompany the rising and lowering pitch as they argue about who had the keys. In the expression of emotions, vocal and visual gestures are also found to coalesce (Fontes & Madureira 2015).

From a production point of view intonation is related to the rate of vibration of the vocal folds and its main correlates in the acoustic and perceptual dimensions are respectively the fundamental frequency (f0) and pitch. As Gussenhoven (2015: 3) points out "form-meaning relations in expressive uses of vocal pitch are grounded in anatomical and physiological effects on vocal fold vibration".

The objective of this work is to explore the multiplicity of forms which the intonation patterns can take on and the meanings they can express. As the background to this exploratory study, vocal gestuality, taken as an index of the biological, psychological and social characteristics of the speaker, is evoked.

In order to discuss how form-meaning interacts in intonation patterns, the frequency codes (Ohala 1983, 1984, 1997; Bolinger 1989; Morton 1977, 1994); the size code (Xu & Chuenwattanapranithi 2007); the respiratory code (Gussenhoven 2015) which was in Gussenhoven (2002) referred as the production code, the effort code (Gussenhoven 2002 and 2004) and the sirenic code (Gussenhoven 2015) are invoked here. According to Gussenhoven (2015) "intonation systems of languages are biased towards the form-meaning relations based on these biological codes".

2. The biological codes and relations between sound and sense

The communicative power of the biological codes as revealed by means of experiments (Ohala 1982; Chuenwattanapranithi et al. 2008; Pitcher, Mesoudi &

McElligott 2013) provides evidence in favor of the close relation between sound and meaning. The direct links between sound and meaning characterize sound symbolism (Hinton et al. 1994). Sound symbolism explains the fact that properties such as size, color, texture, form, length can be assigned to sounds. The fact the sounds are sense-impressive and meaning-expressive is taken to be the foundation of speech expressivity (Madureira 2011). Although expressivity in the speech signal is successfully recognized, its acoustic correlates are difficult to establish (Barbosa 2009, 2012). This poses questions on the nature of acoustic coding in meaning expression.

Gussenhoven (2002, 2004, 2015) argues that the biological codes not only express paralinguistic and extralinguistic meanings but also grammaticalized meanings in intonational phonology.

The frequency code (Ohala 1984, 1986, 1997; Bolinger 1989) as applied to human vocalizations by Ohala is an extrapolation of Morton's ethological theory (Morton 1977) which defends that animals' vocalizations can be interpreted as related to the surviving instinct of the species. Morton's theory has evolved from the observation of animals' vocalizations in hostile situations: the aggressors were found to emit low-pitched sounds and the victims high-pitched sounds. The larger the animal the more aggressive it sounds. In animal conflicts Morton observed that both visual (erection of feathers, elevation of tail and wings and other movements of the body) and acoustic (grave sounds) displays were used by animals to convey an impression of bigger size. Small animals produce acute sounds are not threatening.

The size code as proposed in an experimental study by Xu & Chuenwattanapranithi (2007) provides further evidence for the frequency code since stimuli synthesized with a statistically lengthened vocal tract and lower pitch simulating the vocal tract of a large person were perceived by the research subjects as more threatening and dominant and the opposite was true for the stimuli synthesized with a statistically shortened vocal tract which were perceived as submissive.

A bigger vocal tract produces lower frequency formant frequencies and the lower rate of vibration of the vocal folds is related physiologically to larger and thicker vocal folds and consequently a bigger vocal tract (Chuenwattanapranithi et al. 2006, 2008).

The effort code (Gussenhoven 2002, 2004, 2015) has to do with articulatory effort effects on pitch. The greater the articulatory effort the greater the tendency towards articulatory precision and greater prominence achieved by wider pitch range. The kinds of meanings which have been mentioned in the phonetic literature (Chen et al. 2002) to be associated with the greater degrees of articulatory effort are emphasis, arousal and surprise and with lower degrees of effort tranquility, disinterest and apathy.

The production code relates the declining fundamental frequency as a consequence of decreasing in subglottal air pressure to pitch contours which start with high pitch and ends with low pitch. At the beginning of utterances subglottal air pressure rises and at the end it declines. The kinds of meanings which might be associated with high subglottal pressure and increase in respiratory rate are: continuity, activation, arousal, animation speakers' involvement and maintenance. With low subglottal pressure and decrease in respiratory rate, potential meanings to be associated are: finality and weakness. At the beginning of phonological unities high pitch signals new topics (Gussenhoven 2015).

The sirenic code is introduced by Gussenhoven (2015) to explain the meaning potential of the breathy voice, considering its linguistic (interrogative marker), paralinguistic (low arousal and seduction) and extralinguistic (feminine sexiness) uses. Breathy voice is characterized by inefficient vocal fold vibration since the vocal folds do not abduct completely and consequently the air flow escapes through the glottis and causes turbulence. Breathy voices share with high-pitched voices characteristics such as feminine, fragile, submissive, uncertain and both of them are found in interrogative statements, what is interpreted by Gussenhoven as supporting the conception behind the Frequency Code that vocal features expressing femininity are also used to ask questions.

In expressive speech, the perception of strength and weakness in power relations can be correlated to the size of the larynx and vocal folds and the rate of vibrations of the vocal folds. Low pitch is associated with larger larynx and bigger vocal folds and can be used to express anger, strength, threat and big things while high pitch is associated with smaller larynx and vocal folds and can be used to signal fragility,

submission and small things. In grammatical uses high pitch is the usual mark of interrogative languages.

The biological codes help understanding how listeners infer modalities, attitudes, emotions, moods, personality, age, sex, social condition, regional origin from the speech acoustic signal since they provide evidences of the analogies which can be made based on physical, and physiological and psychological characteristics.

3. Intonation and the rationale behind speech expressivity

Vaissière (2005) argues that carrying out perception tests is the best way to start intonation studies since they can provide trustworthy behavior data about the perceptual and functional equivalence within the same language and between languages and dialects. She defends that perceptual testing is a requirement for the building of intonation models.

Intonation is a symptom of how we feel about what we say and how we feel when we say it (Bolinger 1989). This statement can be interpreted in relation to the degree of arousal of the organism. Fundamental frequency values vary depending on the degree of tenseness of the vocal folds and this reflects the activation (arousal) degree of the organism: the greater the tenseness, the higher the fundamental frequency and the greater the activation is.

Vocal expressions of emotions which are characterized by a highly activated organism such as joy and hot anger exhibit higher fundamental frequency values and emotions which involve a less activated organism such as sadness and grief exhibit lower fundamental frequency values as pointed out in Kaiser (1962), van Bezooijen (1984), Scherer (1986), Banse & Scherer (1996), Johnstone & Scherer (2000), Scherer, Banse & Wallbott (2001), Yuan, Shen & Chen (2002), Lee & Narayanan (2004), Juslin et Scherer (2005), Scherer (2005), Fontes (2014) and Tamuri (2014), to name a few. Yildirim et al. (2004) got higher values for sadness than for neutral speech.

Two intonation contours which differ according to the speed of change or directionality of the fundamental frequency can display dialectal or attitudinal

differences (Fonagy 1987), higher angularity being correlated with higher degree of aggressiveness. Speech stimuli exhibiting a decrease in fundamental frequency values in a short interval of time in imperative sentences in Spanish and Portuguese were judged to be more dictatorial and rough than those in which the decrease extended over a longer interval of time as showed by Lapastina (2010).

4. Intonation and meaning expression

Intonation is sufficient to convey meanings even in cases in which the discursive context has been removed and sentences are presented in isolation to listeners in perceptual tests. Two examples are given here to illustrate this.

The first example concerns the same sentence produced in a positive way and in a negative way by a male speaker in an interview program entitled "Diálogos Impertinentes" (Wise Dialogues) produced by the TV staff of the Pontifical Catholic University of São Paulo and broadcasted from 1995 to 2007 by the University Channel. The speaker says: " Quando eu era criança as pessoas costumavam dizer: Olha como esse menino está gordinho!" (When I was a child people used to say: Look how this boy is chubby!). "Agora as pessoas dizem: Olha como esse menino está gordinho!" (Now people say: Look how this boy is chubby!). The first repetition displays a positive appraisal and the second a negative one. When asked to judge these two sentences in isolation the listeners were able to judge if they conveyed a negative or positive appraisal.

The investigation of the fundamental frequency contour of these repetitions shows differences related to the temporal interval in which fundamental frequency values increase in the first word of the sentence, differences in register and pitch span between the two repetitions and contrasts between medial and late medial peak alignment. The fundamental frequency values decrease in a shorter temporal interval in the second repetition (150 ms between the highest and the lowest fundamental frequency value) than in the first (183 ms between the highest and the lowest

fundamental frequency value). Figure 1 shows waveform, the wideband spectrogram and the fundamental frequency trace.

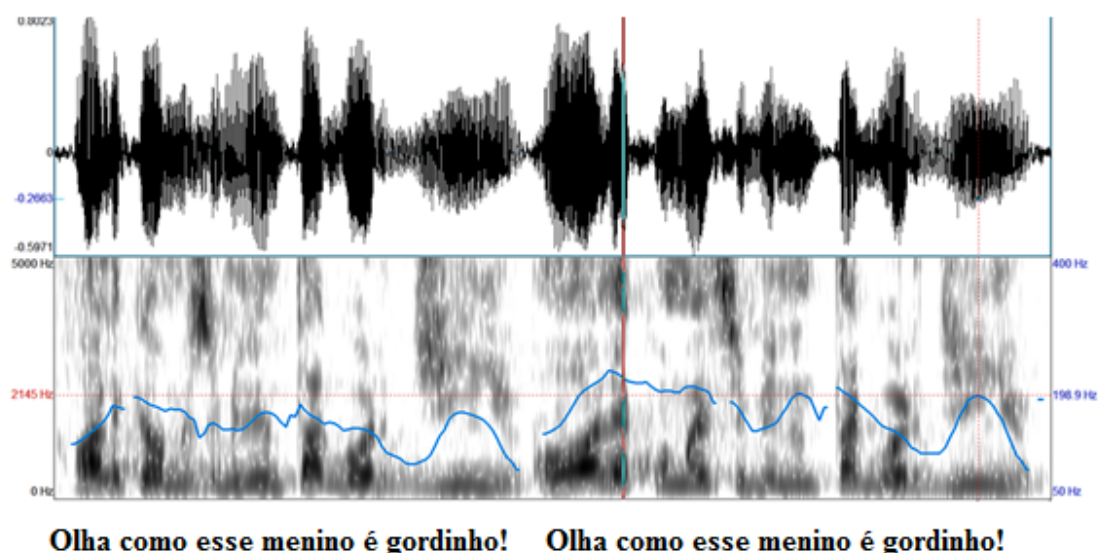Olha como esse menino é gordinho!   Olha como esse menino é gordinho!

Figure 1. Waveform, wideband spectrogram with superimposed fundamental frequency contours of two repetitions of a sentence, contrasting positive (on the left side) and negative (on the right) appraisals.

The second example concerns two equivalent statements. These statements were produced by a male speaker, a Brazilian journalist and professional news announcer. They are: *A seleção brasileira jogou hoje contra a Itália: o time brasileiro deu uma goleada: 4 a zero* 'The Brazilian team played against Italy: the Brazilian team 4-0 the Italian team'; *A seleção brasileira jogou hoje contra a Argentina: o time argentino deu uma goleada: 4 a zero* 'The Brazilian team played against Argentina: the Argentinean team 4 - 0 the Brazilian team'.

The first parts of the statements were presented to a group of listeners to judge the second part, that is, to the guess the result of the game. Just listening to the first part in which the scores were not given, listeners were able to detect the winner team. Figure 2 displays the fundamental frequency traces of the first parts of the two statements. A pointed line is placed before the phrases *contra a Itáli*a 'against Italy' and *contra a Argentina* 'against Argentina'. Intonation contours were found to differ and their differences were perceptually relevant for the listeners to infer that the speaker was pleased or not by the result.
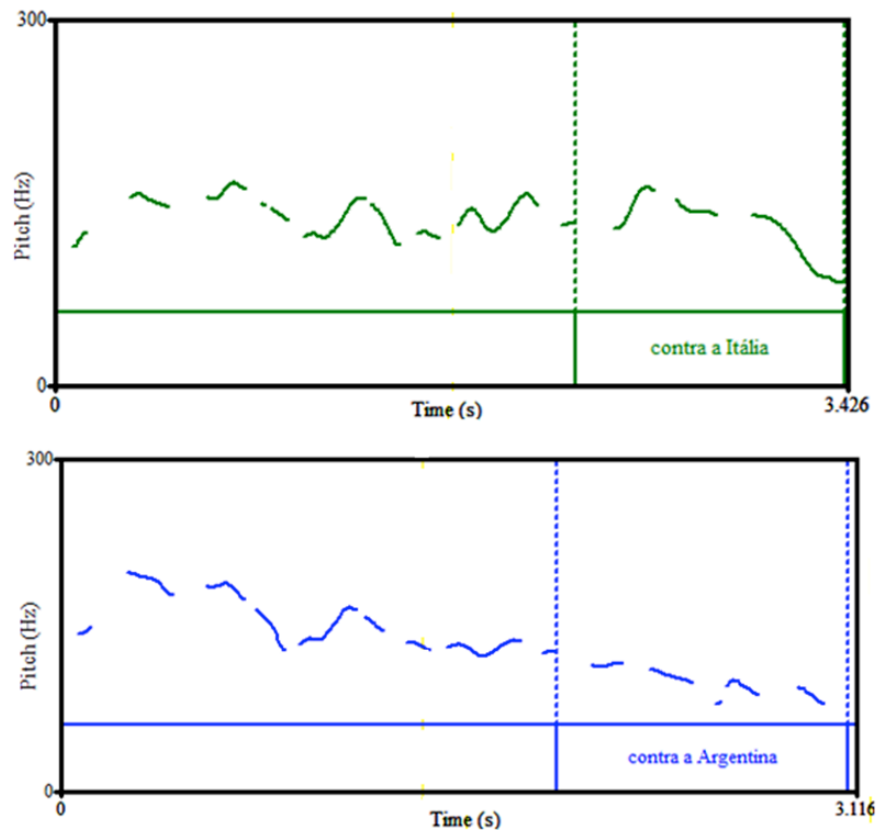
Figure 2. Fundamental frequency contours of two statements announcing the results of soccer matches by a male Brazilian news announcer. The upper and part of the figure displays the part of the statement preceding the announcement of a positive result for the Brazilian team while the lower part displays the part of the statement preceding a negative result for the Brazilian team.

These two examples display modal, iconic and metaphorical uses of intonation which can plausibly be interpreted according to the biological codes since these codes are aspects of the principles which underpin motivated signs which eventually become conventionalized.

5. Meaning-expressing intonation aspects

Three intonation aspects express meanings: the pitch contour, the alignment of peaks and valleys and the pitch extension (Rietveld & Chen 2006) even in the absence of contextual cues.

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The pitch contour can express grammatical, pragmatic, attitudinal, affective, sociolinguistic and discursive meanings. Chun (2002) and Vaissière (2005) provide quite comprehensive tables, indicating the meanings and functions of intonation and provide the references of the works which explore them. Wichmann (2000), and Fujisaki & Hirose (2003), Rilliard et al. (2013, 2014) and Moraes & Rilliard (2014) provide a thorough discussion of attitudinal prosody production and perception characteristics.

The alignments refer to the temporal synchronizations of the peak and the valley in relation to the phonic segments. Studies on the alignment of the fundamental frequency peaks to phonic segments between languages and dialects are found in Kügler (2004), Arvaniti & Garding (2007) and Ladd et al. (2009).

Kohler (2006) argues that intonation contours differ according to the temporal synchronization of the fundamental frequency with the timing of the vocal tract, what makes him propose types of synchronizations which turn out to be perceptually and pragmatically relevant in studies conducted in German and other languages: early peak, medial peak, late peak, early valley and late valley.

The study of the fundamental frequency shifts (Kohler 1987, 1990, 2006) revealed distinctive peak/valley fundamental frequency *loci* in relation to the stressed syllable. In experiments conducted by Kohler (2005, 2006) early peaks (in the vowel onset) were found to indicate finality, medial peaks (in the middle of the stressed vowel) to convey openness and late peaks (in the offset of the vowel) add emphasis and convey surprise. Early valleys (before the stressed vowel) and late valleys (within the stressed vowel) were analyzed in perceptual experiments.

The perceptual categories of early and medial peaks are affected by the external synchronization of the fundamental frequency with the timing of the vocal tract and the internal timing of pitch contours, that is, by the rate of change of the rising and lowering of the global pitch contours.

Differences among synchronizations, interactions between the global contour and the internal timing of the pitch contours, types of configurations which differ according to a gradual or abrupt rise of fundamental frequency can result in different

meaning effects and in diverse language and dialect characteristics and therefore are relevant to sociophonetic studies.

The pitch range (Nadeu & Prieto 2011) can comprise variations related to the register, that is, the rising or lowering of the pitch contour and the extension, that is the span between the high and low pitch.

There are few systematic investigations comparing pitch ranges used by speakers from different languages or dialects (Thomas 2011). The pitch range is proportional to the degree of the speaker's involvement: small pitch variations are associated with disgust, cold anger, fear and sadness and great variations to happiness, surprise, hot anger, pleasantness and dynamicity.

Kohler (2006) raises strong criticisms against phonological models which prioritize the linguistic form over the phonetic substance and have a dichotomic view of phonology-phonetics. He criticizes their methodological procedures of representing the intonation by sequences of tones associated to specific syllables and frontiers and projecting these tones subsequently in a temporal scale by means of the phonetic alignment of maximum and minimum fundamental frequency values in relation to segments. He considers this *post hoc* projection to be a gradient measurement taken in discrete unities.

Dynamic non-dichotomic models are needed to account for the gradience involved in intonation and other prosodic elements.

6. Conclusion

As Nolan (1999) points out "the devil is in the phonetic detail" and in intonation studies the phonetic details are challenging since they bring about a multiplicity of forms and meanings which demand, from the speech scientists, the search for global methods to describe and interpret intonation, including its physiological, acoustic and perceptual levels and the consideration of the "whole spectrum of communicative functions (expressive, attitudinal, interactive and stylistic)" (Kohler 2006: 47).

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This search is thought to be favored by a non-dichotomic view of phonology-phonetics and a dynamic and gestural approach to intonation which takes into account the communicative power of the biological codes.

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