

The Frequency Code: the perception of ‘dominance/submissiveness’ dimension in female voices.

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Starting from the comparative studies on human and non-human behaviours (Darwin 1876, Morton 1976), John Ohala (1984, 1985) developed an ethological model called ‘The Frequency Code’, later revised in a paralinguistic perspective by Gussenhoven (2002). According to Ohala, there is a close relationship among the physical size of most animals (large vs small), the vocal pitch height of their vocalizations (low vs. high sounds) and the level of dominance/submissiveness conveyed. The Frequency Code is biologically determined, but animals exploit it to increase the degree of competition and physical dominance. Morton (1976) showed how some birds and mammals use low-frequency sounds in hostile situations, in order to achieve physical dominance and seem as dangerous and large as possible, and high-frequency sounds in more pleasant or non-threat situations, in order to give the impression, also apparent, of being small and vulnerable.

A very similar condition was observed in humans. The human voice is characterized by a relevant sexual dimorphism. Male and female voices have different fundamental frequency (f_0), a clear consequence of the different size of vocal folds. The sexual dimorphism depends on larynx, being 50 % larger in adult males than in adult females and 15-20 % longer and on the resonant frequencies (Simpson & Ericsson 2007, Simpson 2009). This is why adult males have low-pitch voice and low formant frequencies as compared to adult females.

There is a correlation between pitch and the expression of power and affective relations (Ohala 1984, Chen *et al.*, 2004; Puts *et al.*, 2006). Also in humans, low-pitch voices are generally associated with high level of dominance, aggressiveness and threat, while high-pitched voices normally convey a meaning of submission, appeasement and politeness. Nevertheless, in humans the scenario is more complex, given that the pitch also contributes to the realization of the intonational structure of the utterances and to the expression of the emotional states. In addition, in humans the fundamental frequency is indirectly used to convey information about social dominance (leadership, persuasion, interpersonal power). For this reason, the lower pitch, typical of men’s voices, communicates a paralinguistic meaning of dominance and power, whereas high-pitched voices, typically those of female speakers, are generally associated with lower degree of physical and social dominance.

This research field has been studied by different point of views. Many studies have been conducted on acoustic differences between female and male speech. For instance, several previous studies have focused on how voice conveys personality traits, social stereotypes or charisma (among others, Scherer 1972, Henton 1989, Rosenberg & Hirschberg 2009).

In Italian language, a number of studies have focused on formant frequency differences between men, women and children (Ferrero *et al.* 1995, 1996), others have examined the prosodic markers of charismatic voice in political speech (Signorello & Demolin 2013, Signorello 2014). To date, there are no studies on the perception of dominance/submissiveness dimension in female or male human voices.

The present research aims to explore the possible relationship between pitch variation and its paralinguistic interpretation with reference to some specific personality traits. We tested how female voice pitch is related to perceptions of dominance. In particular, we asked to what extent

listeners are able to interpret pitch variations in the speech, in accordance with the Frequency Code. To this purpose, two corpora have been analyzed. We recorded samples of semi-spontaneous speech and read speech produced by five female adults of Bari Italian, ranging from age 22 to 25. In order to neutralize all possible semantic effects, all subjects have been invited to read a same short text and to describe a simple cooking recipe. The participants have been carefully chosen in order to ensure the production of different voices; we selected two low-pitch voices, a medium pitch voice and two high pitch voices.

An acoustic analysis was performed; for each subject we measured the following parameters: mean, max and min f₀, f₀ range (in ST), mean intensity, formant frequencies (F1, F2), speech rate.

Subsequently, we conducted an auditory test by asking to a group of Italian listeners to evaluate the voices in terms of five semantic scales. We used the following pairs of adjectives: large/small, dominant/submitted, self-confident/not self-confident, aggressive/vulnerable, desirous of goodwill/not desirous of goodwill; no explanation of these meanings was given. Listeners marked their judgments on a *Visual Analogue Scale* (VAS, Chen *et al.* 2004). It is a graduate scale, vertically or horizontally oriented, 100 mm long, generally adopted in clinical research, for analysing something that is not easy to measured, such as pain or mood. We divided the VAS in 10 parts, in order to simplify listeners' judgment and the researcher's work. Two opposite adjectives are placed on the two ends of the line. Listeners were asked to mark on the line the point that best represents the interpretation of the adjective considered. The results have been obtained by measuring the millimetres from the left end of the line to the point marked by the listener with a slash. The data obtained have been analyzed and compared with the acoustic findings; the statistical significance has been examined via Anova and correlation tests.

We assume that a different pitch voice has a predictable effect in the listeners' perception, in terms of social meanings for dominance and submissiveness.

The findings collected so far seem to confirm the predictions of the Frequency Code: low-pitch voices increased ratings of dominance and self-confidence than high-pitched ones. Nevertheless, the transmission of these paralinguistic meanings is affected by other prosodic aspects, such as speech rate or intensity. Data concerning these last aspects will be discussed in details.

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