

**Fundamental frequency of the female's voice: a cross-country empirical study on its influence on social and sexual selection**

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## **Abstract**

Recent studies demonstrate that voice (in particular, its fundamental frequency -Fo-) may influence on social and sexual selection. Here, we tested how the Fo of female's voice is related to different aspects of social and sexual selection through a novel experimental approach. First, we recorded and measured the Fo of 22 women reading a neutral text in Spanish language. Six of these voices were selected and classified into three categories: voices with a low Fo (<175 Hz), medium Fo (between 175-225 Hz) and high Fo (>225 Hz). Then, these voices were rated by two independent samples including both men and women: one comprised of native Spanish-speakers (n=683) and the other comprised of native Italian non-Spanish-speakers (n=484). Contrarily to what we hypothesized, voices with an average Fo were rated as more feminine and attractive, aroused a greater subjective sexual desire in men, and were more strongly related to the desire to engage in a friendship in women. These findings were independent of the sex of the respondents, as well as of the country in which the study was carried out.

**Keywords:** Female voice; fundamental frequency; femininity; attractiveness; subjective sexual arousal; friendship; cross-country comparison.

## 1. INTRODUCTION

In recent years, scientific research has focused on how voice's properties may be relevant independently of the message to which they give structure: that is, the relevance of the communication channel beyond -or in addition to- the message that is transmitted. In particular, several studies have explored the relationship between the vocal properties of the human voice and its social attractiveness when striking up a friendship, romantic, or sexual relationship, suggesting that fundamental vocal frequency (i.e., one of the most relevant vocal properties) may influence on social and sexual selection (Weusthoff, Baucom, & Hahlweg, 2013). The aim of this study is to test how the fundamental frequency of female's voice is related to different aspects of social and sexual selection through a novel and sound cross-cultural experimental approach.

Fundamental frequency (Fo), perceptually highly correlated with pitch, notably differs in men and women mainly due to anatomical variations. Male's vocal tract is longer than female's, and their vocal folds are thicker and larger; consequently, they vibrate at approximately one-half the frequency of women's during phonation, thus producing a lower fundamental frequency (Puts, Apicella, & Cárdenas, 2012). Unlike male's, female's vocal folds are placed in a smaller vocal tract and are characterised by being thinner and smaller; consequently, female Fo tends to be higher.

Fundamental frequency is measured by cycles per second or Hertz (Hz). A wide variety of parameters have been employed for different empirical purposes, but the most popular and reliable indicator is the mean Fo (Puts, Apicella, et al., 2012; Weusthoff et al., 2013). These parameters can be measured during normal speech or when pronouncing isolated vowels (e.g., /a/ or /i/); anyway, measures derived from both conditions tend to

highly correlate (Natour & Wingate, 2009). Fo oscillates in a range between 75-150 Hz in men and 150-300 Hz in women (Owren & Bachorowski, 2007). Mean Fo also varies according to the spoken language: in a review of studies exploring mean Fo in different languages, Natour and Wingate (2009) found that mean Fo in males ranged from 125 Hz in English-speakers to 160 Hz in Chinese-speakers; in females, this values ranged from 182.3 Hz (English-speakers) to 297.4 Hz (Chinese-speakers). In Spanish-speaking people, mean Fo is around 120 Hz in males and 200 Hz in females (González, Cervera, & Miralles, 2002).

### **1.1 Fundamental frequency and mate selection**

Scientific literature evidences that Fo is relevant during the process of mate selection, both in males and females (Puts, Jones, & Debruine, 2012). In brief, women tend to prefer low-pitched male's voices due to their phylogenetic association with higher levels of testosterone and masculinity in men (Feinberg, Jones, Little, Burt, & Perrett, 2005); on the contrary, men usually prefer high-pitched female's voices that unconsciously associate with femininity, youth, and higher fertility (Feinberg, Debruine, Jones, & Perrett, 2008). This explanation is derived from the evolutionary theoretical framework, which proposes that people are biologically determined to look for mates that increase their probability for reproduction and therefore, for survival of the species (Feinberg, 2008; Puts, Jones, et al., 2012; Rhodes, Simmons, & Peters, 2005; Weusthoff et al., 2013).

Researches on the relationship between female's Fo and attractiveness ratings usually find a linear relationship: i.e., voices with higher pitches tend to be more attractive for male partners (Feinberg et al., 2008). For example, correlation between female's Fo and

attractiveness rating was 0.34 in the study by Feinberg et al. (2008). Borkowska and Pawlowski (2011) found that a high female Fo is sexually suggestive, but only until reaching a certain frequency: in particular, high-pitched voices (around 260 Hz) were more attractive than low (184 Hz) or average (223 Hz), but when voices exceeded 280 Hz, they drastically lost their appeal. The research conducted by Re, O'Connor, Bennett, and Feinberg (2012) found that high female Fo, even in artificially raised voices above normal values (i.e., > 280 Hz), was still more attractive than low-pitched women's voices. Considering the implications of these findings for understanding mating behaviour, the first aim of this research was to confirm whether a high-pitched female voice is considered as more attractive, regardless of whether the judgement is made by a man or a woman. On this point, there is a paucity of research exploring attractiveness judgments in women, even when sex seems to have a remarkable influence on this aspect (Weusthoff et al., 2013). To the extent we know, this is also the first study exploring how Fo influences on attractiveness perception in a Spanish-speaking sample. We hypothesize that, if our results are consistent with previous researches:

**H1:** Female voices with an acute Fo will be judged more feminine and attractive by both men and women than medium or low-pitched voices.

Another limitation of previous research is that the majority of studies conducted so far did not present natural verbalisations (i.e., complete sentences) when participants rated the attractiveness of female voices; instead, participants did so after listening sustained vowels recordings (e.g., Borkowska & Pawlowski, 2011) or isolated words (e.g., the word *hujambo* -hello- in Swahili, Apicella & Feinberg, 2009). This methodology is useful as it allows to isolate the effect of the message content from voice's characteristics, but greatly

limits the ecological validity of the results (in natural contexts, courtship usually implies long communication exchanges). In the present research, we adopted a completely different approach to address this limitation: the voices used in this study verbalise long neutral sentences in Spanish but, in order to separate the effect of the message from the effect of the voice's characteristics, we conducted the study in two independent samples: one comprised of native Spanish speakers (i.e., participants understanding the message's content) and the other comprised of native Italian non-Spanish-speakers (i.e., participants not understanding the message's content). Thus, another objective of the study was to analyse whether a high-pitched female voice is considered or not as more attractive, regardless of whether the respondent understand or not the message's content. If we confirm that  $F_0$  determines attractiveness perception regardless of the understanding or not of the message' content, then the hypothesis that we are predisposed to experience more attraction toward certain frequencies would be confirmed through a sound ecological methodology (Re et al., 2012). So far, few studies have explored this question. In fact, one of the more important gaps in the literature is the lack of cross-cultural studies (Feinberg, 2008). A notable exception is the research carried out by Apicella and Feinberg (2009) analysing pitch preferences of the Hadza (an ethnic group of Central Tanzania fluent in their own language -Hadzane- and in Swahili). Hazda's men were presented with women voices speaking in English (unknown language) and in Swahili (their second language). The results showed that Hazda's men systematically preferred higher-pitched female voices as a potential partner, regardless of the language. These preliminary findings suggest that attractiveness perception for acute women's  $F_0$  is not determined by linguistic comprehension, but it requires replication in different languages and cultural contexts to be

generalizable. If our results are consistent with those obtained in this previous research, we hypothesize that:

**H2:** High-pitched female voices will be judged more feminine and attractive than medium or low-pitched voices, regardless of the country in which the study is carried out.

## **1.2 Fundamental frequency and subjective sexual desire**

Another objective from this research was to find out whether, in addition to femininity and attractiveness, vocal characteristics increase male's subjective sexual desire. It has been demonstrated that there is a bidirectional relationship between attractiveness and subjective sexual desire: that is, perceived attractiveness of a potential partner increases individual's subjective sexual desire and arousal and, at the same time, sexually aroused individuals tend to perceive potential partners as more sexually attractive (Istvan, Griffitt, & Weidner, 1983). For some men, female's voice is highly suggestive, enhancing sexual desire even more than other sensory stimuli. Thus, we can expect a positive correlation between voice's femininity and attractiveness ratings and subjective sexual desire ratings. However, people may also consider a female voice as very feminine or attractive without feeling subjective sexual desire to engage in a sexual intercourse with this woman, thus reflecting the specificity of subjective sexual desire and arousal (Chivers, 2010). Considering that few studies have explored how and to what extent voice's Fo impacts on subjective sexual desire beyond their influence on femininity and attractiveness ratings, this was an additional aim from this research. In particular, we hypothesize that:

**H3:** Male participants will feel more subjective sexual desire for higher-pitched voices, regardless of the country in which the study is carried out.

### **1.3 Fundamental frequency in the intrasexual competition theory**

Whereas in men, characteristics of the female's voice seems to influence on the subjective sexual desire it arouses, the literature suggests that in women, female's voice modulates the desire to build or not a friendship. The intrasexual competition theory proposes that women exhibit extraordinarily intense competition for male investment; consequently, if feminine voices are attractive to men, then women should be sensitive to vocal femininity when assessing possible competitors (Puts, Barndt, Welling, Dawood, & Burriss, 2011). Puts et al. (2011) showed that higher-pitched voices were perceived as more attractive by men, while women rated them as more threatening. These authors concluded that women pay attention to acoustic parameters when evaluating other women in terms of potential competitors. This hypothesis, markedly evolutionary and controversial, constitutes a direct challenge to current social and feminist movements, promoting dynamics of support over competition (Disch & Hawkesworth, 2016). Thus, testing the hypothesis that women will show a low desire to strike up a friendship with women with more feminine and attractive voices seems crucial at an empirical and social level. If our results are consistent with those obtained in previous research, we expect that:

**H4:** Female participants will feel less desire to engage in a friendship with voices rated as more attractive and feminine, regardless of the country in which the study is carried out.

## **2. METHODS**



## 2.1 Voice recording, measurement, and selection

To create audio stimuli for the research, twenty-two voices of Spanish women between 20-30 years old were recorded. All the participants were native Spanish-speakers with a neutral accent. Voices were recorded in a quiet room using a high-quality microphone. Participants were recorded speaking the common Spanish vowels /A/, /E/, /I/, /O/, and /U/ in a sustained tone. They were also asked to read aloud two excerpts of a neutral text (i.e., without emotional or sexual content), extracted from the book «*El amante lesbiano*» (Sampedro, 2000):

**Sentence 1:** *Su voz, inconfundible pero imposible* [Her voice, unmistakable but impossible] (duration ~3.4 seconds).

**Sentence 2:** *Y en esta calma suprema, casi flotante, el cuarto se me llena de claridad y me revela a alguien mirándome sonriente desde la silla* [In this supreme calm, almost floating, the room fills with clarity and reveals someone looking at me smiling from the chair] (duration ~8 seconds).

Once collected, voices were analysed using Praat software (P. Boersma & D. Weenink, [www.praat.org](http://www.praat.org)). We analysed the following parameters: (a) fundamental frequency (Fo); (b) intensity, (c) duration of the vocal emission and; (d) Harmonics-to-Noise Ratio (HNR). The latter was used to quantify the amount of additive noise in the voice signal (usually associated with vocal pathology) (Ferrand, 2002). Voices with higher HNR levels were excluded from the research. Fundamental frequency was assessed by Praat's autocorrelation algorithm with parameters set to a pitch floor of 75 Hz and a pitch ceiling of 500 Hz, with all the other values set to default. These parameters were measured for vowels recording and for the two sentences; no significant differences emerged between these measurements (mean Fo measured by sustained vowels and complete sentences only

differed in ~6 Hz). Thus, based on the higher duration of vocal emission and the equivalence of measured parameters, we finally decided to use the second sentence as stimuli to be presented during the research. In our opinion, this sentence better reflected the acoustic properties of the participants' voice.

The selection of the six voices employed in this research was conducted on the basis of their mean Fo. In particular, we chose two voices with a high Fo (>225 Hz), two with a medium Fo (between 175 and 225 Hz), and two with a low Fo (<175 Hz). These thresholds were established using normative data derived from the research conducted by González et al (2002) in a sample of 86 healthy Spanish women. In this study, authors found that mean female's Fo was 200 Hz ( $SD=24.38$ ). By applying 1  $SD$  above and below this average, we obtained the aforementioned thresholds. Given that Fo seems to follow an almost normal distribution (Horii, 1975), these thresholds let us to identify females with a mean Fo below percentile 16<sup>th</sup> (low Fo), near percentile 50<sup>th</sup> (medium Fo), and above percentile 86<sup>th</sup> (high Fo). Table 1 shows the mean Fo of the six voices included in the study.

INSERT TABLE 1

## **2.2 Voices' rating procedure**

Voices' rating was conducted online through a secured survey platform. We designed two independent surveys: one for the assessment of the Spanish-speaking sample and the other for the Italian-speaking sample. The Italian version was an exact translation of the Spanish survey and included the same Spanish audio stimuli. The surveys comprised two sections. During the first section (*basic sociodemographic data*), participants were asked to report: (1) their sex, (2) age, and (3) sexual orientation. In this section, participants in the Italian study self-reported whether they speak Spanish; those who answered positively were excluded from the research and did not complete the next survey section.

The following section from the survey (*voices' rating*) was different for men and women: for both of them, respondents were presented with exactly the same six voices, but the aspects from the voices to be rated slightly varied. The order in which voices were presented was fully randomized and participants were allowed to listen the voices as often as they wanted before making a judgement. After listening each voice, male respondents were asked to rate the following aspects on a 9-point Likert scale: (1) the femininity of the voice (*1=not feminine at all/10=extremely feminine*); (2) the attractiveness from the voice (*1=very unattractive/10=extremely attractive*); and (3) the degree in which the voice aroused their sexual desire (*1=not at all/10=extremely*). Female participants were asked the same questions about femininity and attractiveness, but the question on sexual desire was replaced by another about the desire to engage in a friendship (*«from 1 to 10, how much would you like to maintain a friendship with the person from the recording?»*).

### **2.3 Recruitment procedure and participants**

Data acquisition was conducted between February and April 2019. The research was conducted through a secured survey platform and participants were enrolled through banners posted on *Facebook*. The survey was advertised as focusing on female voice's attractiveness. One of the researchers (G.C.) fluent in Spanish and Italian was in charge of disseminating the study in different *Facebook* groups, ensuring that the Spanish survey was widespread in Spanish groups (e.g., students from different Spanish universities, discussion groups about Spanish series, etc.) and vice versa. Before accessing the survey, participants confirmed that they were of legal age and gave their informed consent to participate.

During the time the study was accessible, around 1,300 subjects accessed the survey. Initial data derived from the online platform were screened to avoid duplicitous, inconsistent and/or fake responses (e.g., participants reporting >100 years old). Only those

participants who completed 100% of the survey were included. After removals, a total of 1,167 participants were included in the final dataset. The Spanish sample comprised 683 participants (58.5%) and the Italian sample the remaining 484 (41.5%).

Table 2 shows participants' characteristics. Most respondents were females (82.3%) and heterosexuals (86.5%). Average sample age was 33.31 years old. Moderate to large differences emerged in different demographic aspects according to the country where the study was carried out: the Spanish sample was younger than the Italian sample ( $M$  of 28.8 and 39.6 respectively;  $d=0.96$ ) and were characterized by a greater sexual diversity (19.9% non-heterosexual vs 4.6%;  $V=0.22$ ).

INSERT TABLE 2

## **2.4 Data analysis**

We undertook analyses in two steps. First, descriptive analyses were conducted to characterize participants in terms of sociodemographic data using the SPSS statistic package (version 26.0). To compare participants' characteristics in the Spanish and the Italian sample, we performed  $t$  tests (for continuous variables) and chi-square tests (for categorical variables). Two effect size indices (Cohen's  $d$  and Cramer's  $V$ ) were computed by using G\*Power (version 3.1). For Cohen's  $d$ , effect sizes of about .20 were considered small, close to .50 moderate and greater than .80 large (Cohen, 1988); for Cramer's  $V$ , these sizes corresponded to values of .10, .30 and .50 (Ellis, 2010).

Subsequently, we conducted repeated measures ANOVAs (aka within-subjects ANOVAs) followed by post-hoc comparisons in order to test whether differences in judgments about voices femininity, attractiveness, and sexual desire (males)/desire for a friendship (females) according to the Fo category reached or not the statistical significance. Scores in the two voices comprising each Fo category were averaged in order to get a

unique rating per category. Effect size for the differences in this index was assessed by partial eta squared ( $\eta^2$ ), and then transformed to Cohen's  $f$  using G\*Power (Lakens, 2013). For Cohen's  $f$ , effect sizes of about .10 were considered small, close to .25 moderate, and greater than .40 large (Cohen, 1988).

### **3. RESULTS**

#### **3.1 Femininity and attractiveness**

First, we tested whether femininity and attractiveness ratings varied according to the Fo of the presented voices (table 3). Voices with a medium Fo were rated as more feminine and attractive under all the tested conditions. In the total sample, average score on femininity of medium Fo voices was slightly higher than that obtained for high Fo voices ( $M$  of 7.94 and 7.69 respectively), and notably higher than low Fo voices ( $M=6.80$ ). Overall differences reached the statistical significance ( $F=439.18$ ;  $p<.001$ ) and a large effect size (Cohen's  $f=.60$ ). This trend appears regardless of the sex and the country where the study was carried out, in some cases reaching extremely large effect size (Cohen's  $f>.60$ ). We also appreciate a significant interaction effect between femininity ratings and country ( $F=6.016$ ;  $p=.002$ ), meaning that the increase in femininity ratings from voices with a medium Fo was higher among participants from Spain. The interaction between femininity ratings and sex was not significant ( $F=2.077$ ;  $p<.125$ ).

#### INSERT TABLE 3

Differences between medium-pitched voices and the rest of Fo categories were even greater when we assessed attractiveness. In the total sample, average attractiveness of medium Fo voices ( $M=6.32$ ) doubled those obtained for high or low Fo voices ( $M$  of 5.31 and 5.10 respectively), with overall differences reaching the statistical significance

( $F=344.49$ ;  $p<.001$ ) and a large effect size (Cohen's  $f=.53$ ). Once again, we observed the same tendency regardless of the sex and the country where the study was carried out. In this case, a significant interaction effect emerged between attractiveness ratings and both country ( $F=5.49$ ;  $p=.004$ ) and sex ( $F=5.15$ ;  $p=.006$ ): i.e., the increase in attractiveness ratings from voices with a medium Fo was higher among men and participants from Spain.

### **3.2 Subjective sexual desire**

Subsequently, we selected male participants to test whether voice Fo may influence on men subjective sexual desire (table 4). Once again, voices with an average Fo raised higher levels of subjective sexual desire ( $M=5.72$ ). Overall differences in sexual desire ratings according to the Fo category reached the statistical significance and a large effect size in the total sample (Cohen's  $f=.53$ ), as well as for the Spanish (Cohen's  $f=.59$ ) and the Italian sample (Cohen's  $f=.46$ ). The interaction between subjective sexual desire and country was not significant ( $F=1.72$ ;  $p=.180$ ).

INSERT TABLE 4

### **3.3 Desire to engage in a friendship**

Finally, we selected female participants to explore if the Fo category influenced on the desire to engage in a friendship in women (table 5). Women rated voices with an average Fo as the most desired for engaging in a friendship ( $M=6.20$ ). The same tendency was observed regardless of the country where the study was conducted, with overall differences according to the Fo reaching the statistical significance at  $p<.001$  and a large effect size (Cohen's  $f>.40$ ). In this case, the interaction between the desire to engage in a friendship and country was significant ( $F=8.22$ ;  $p<.001$ ), meaning that the increase in the

desire to engage in a friendship for voices with a medium Fo was notable higher among participants from Spain.

INSERT TABLE 5

#### **4. DISCUSSION**

The results of this research are in disagreement with previous studies, which suggested that voices with a high Fo tend to be rated as more feminine, attractive, and to arouse a higher sexual desire (Feinberg et al., 2008). On the contrary, participants in our study showed a clear and systematic preference for average configurations of Fo instead of extreme (high or low) manifestations of this characteristic. At a theoretical level, these findings showing that the most attractive voices are near the average are consistent with alternative evolutionary theories pointing out that phylogenetic pressures favour characteristics close to the mean of the population, favouring prototypical category members (Langlois & Roggman, 1990). This pressure is logical from an evolutionary perspective given that people displaying characteristics close to the mean (especially morphological features) would be less likely to carry harmful genetic mutations and, therefore, would be more preferred by conspecifics (Langlois & Roggman, 1990).

At an empirical level, these results resonate with previous studies suggesting that averageness is more attractive in human faces (Langlois & Roggman, 1990; Little & Hancock, 2002), non-human objects (Halberstadt & Rhodes, 2000, 2003), and music (Repp, 1997). Similarly, Borkowska & Pawlowski (2011) found that the relationship between Fo and attractiveness was not linear; instead, high-pitched voices were rated as more attractive up to an optimal pitch (~280 Hz), dramatically decreasing their

attractiveness after this threshold. These authors argued that very high-pitched voices were unattractive because: (1) such in the case of baby's cry, they became irritating and/or (2) because these voices sounded immature (babyish), thus signalling sexual immaturity and less reproductive value. In our study, the use of voice stimuli oscillating in a natural range of Fo (voices between 170-230 Hz) prevents the generalization of previous explanations (e.g., high-pitched voices in our study did not sound babyish). However, we should consider that this is the first time that sexual attractiveness linked to voice's Fo is explored in a language different from English. As reviewed before, average Fo varies according to the language and ethnicity (Natour & Wingate, 2009), so sexual preferences for voices with a medium Fo instead of high-pitched voices may be conditioned by this aspect. Whereas mean Fo in English monolinguals females is around 185.8 Hz ( $SD=12.97$ ) (Altenberg & Ferrand, 2006), in Spanish-speaking females is around 200 Hz (González et al., 2002). Thus, high-pitched voices in English (i.e., voices with a Fo one  $SD$  above the mean -199 Hz-) actually better match with the average Fo in our study than with the high Fo. Therefore, it is reasonable that the optimal attractiveness point that Borkowska and Pawlowski (2011) placed at 280 Hz in English is around 200 Hz in Spanish-speaking populations. Furthermore, in our study we found that both Italian and Spaniards preferred medium-pitched voices, but this preference was more pronounced among Spaniards. Both languages come from the same linguistic family, and differences in terms of average Fo barely vary in around 5 Hz. Thus, our results support the hypothesis that people –at least, Italian and Spaniards– share a common proneness toward voices around 200 Hz, but also that there is a particular preference toward a determined Fo range according to the Fo of the native language. This hypothesis is consistent with a recent study pointing out that social voice perception contains certain elements invariant across cultures/languages, while others



are modulated by the cultural/linguistic background of the listener (Baus, Mcaleer, Marcoux, Belin, & Costa, 2019).

Contrarily to what we initially hypothesized, women did not feel less desire to engage in a friendship with voices rated as more attractive and feminine (in our study, average-pitched voices); on the contrary, voices with an average  $F_0$  obtained once again better ratings, independent of the country where the study was conducted. This finding goes directly against the intrasexual competition theory proposed by Puts et al. (2011), demonstrating that the most feminine and attractive voices were not perceived as more threatening by other women because of their consideration as potential competitors for male investment. Therefore, our findings downplay the hypothesis of confrontation and competitiveness among women typically proposed by outdated theories, and highlight the relevance of support dynamics between women of more contemporary feminist theories (Disch & Hawkesworth, 2016).

#### **4.1 Limitations**

This study is not without limitations. One limitation of our cross-cultural approach is that we assumed that Italian participants (non-Spanish-speakers) did not understand the message content. However, given similarities between both languages, it is plausible that they understood certain parts of the message, leading to unexpected biases in our results. Furthermore, the limited number of non-heterosexual participants prevents us to analyse the role of sexual orientation in attractiveness ratings. Finally, our study is focused on  $F_0$ , but other acoustical properties (e.g., shimmer or jitter) may be involved in attractiveness ratings (Baus et al., 2019).

## 5. CONCLUSIONS

Contrarily to what we hypothesized, voices with an average Fo were rated as more feminine and attractive, aroused a greater subjective sexual desire in men, and were more strongly related to the desire to engage in a friendship in women. These findings were independent of the sex of the respondents, but more pronounced in males. Furthermore, cross-country equivalence of our findings suggests that the influence of Fo on sexual attractiveness is predisposed regardless the different socio-cultural and linguistic contexts, as proposed by the evolutionary theory of mating behaviour (Feinberg, 2008; Puts, Jones, et al., 2012; Rhodes et al., 2005; Weusthoff et al., 2013). These findings have been obtained from a novel experimental paradigm in which, instead of using limited voice recordings do not representing the communicative dynamics of a real social interaction, we used a complete sentence with sense, rhythm, and sonority.

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Table 1. Mean Fo of voices included in the study

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	Mean Fo
<b>Voices with a high Fo</b>	
Voice 1	232 Hz
Voice 2	232 Hz
<b>Voices with a medium Fo</b>	
Voice 1	190 Hz
Voice 2	199 Hz
<b>Voices with a low Fo</b>	
Voice 1	173 Hz
Voice 2	170 Hz

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Table 2. Participants' characteristics according to the country

	Total sample ( <i>n</i> = 1,167)	Spanish sample ( <i>n</i> = 683)	Italian sample ( <i>n</i> = 484)	Inferential statistic	Effect size
<b>Sex</b>					
Men	17.7% ( <i>n</i> = 206)	15.8% ( <i>n</i> = 108)	20.2% ( <i>n</i> = 98)	$\chi^2 = 3.83$	<i>V</i> = 0.05
Women	82.3% ( <i>n</i> = 961)	84.2% ( <i>n</i> = 575)	79.8% ( <i>n</i> = 386)		
Age ( <i>M</i> and <i>SD</i> )	33.31 ( <i>SD</i> = 12.03)	28.83 ( <i>SD</i> = 8.71)	39.65 ( <i>SD</i> = 13.19)	<i>t</i> = 16.83***	<i>d</i> = 0.96
<b>Sexual orientation</b>					
Heterosexual	86.5% ( <i>n</i> = 1,007)	80.1% ( <i>n</i> = 545)	95.5% ( <i>n</i> = 642)	$\chi^2 = 57.04***$	<i>V</i> = 0.22
Bisexual	6.5% ( <i>n</i> = 76)	9.9% ( <i>n</i> = 67)	1.9% ( <i>n</i> = 9)		
Homosexual	7% ( <i>n</i> = 81)	10% ( <i>n</i> = 68)	2.7% ( <i>n</i> = 13)		

Note: \*\*\**p* < .001

Table 3. Femininity and attractiveness ratings in the total sample and according to the sex and country

	Total sample ( <i>n</i> = 1,167)	Men ( <i>n</i> = 206)	Women ( <i>n</i> = 961)	Spanish sample ( <i>n</i> = 683)	Italian sample ( <i>n</i> = 484)
Femininity (range = 1-10)					
Voices with a high Fo	7.69 ( <i>SD</i> = 1.77) <sup>b, c</sup>	7.84 ( <i>SD</i> = 1.51) <sup>b, c</sup>	7.65 ( <i>SD</i> = 1.82) <sup>b, c</sup>	8.08 ( <i>SD</i> = 1.49) <sup>b, c</sup>	7.13 ( <i>SD</i> = 1.97) <sup>b, c</sup>
Voices with a medium Fo	7.94 ( <i>SD</i> = 1.61) <sup>a, c</sup>	8.04 ( <i>SD</i> = 1.35) <sup>a, c</sup>	7.92 ( <i>SD</i> = 1.66) <sup>a, c</sup>	8.21 ( <i>SD</i> = 1.45) <sup>a, c</sup>	7.57 ( <i>SD</i> = 1.74) <sup>a, c</sup>
Voices with a low Fo	6.80 ( <i>SD</i> = 1.58) <sup>a, b</sup>	6.81 ( <i>SD</i> = 1.58) <sup>a, b</sup>	6.80 ( <i>SD</i> = 1.58) <sup>a, b</sup>	7.02 ( <i>SD</i> = 1.38) <sup>a, b</sup>	6.49 ( <i>SD</i> = 1.78) <sup>a, b</sup>
Inferential statistic	<i>F</i> = 439.18 ( <i>p</i> < .001) <i>f</i> = .60	<i>F</i> = 102.61 ( <i>p</i> < .001) <i>f</i> = .70	<i>F</i> = 340.54 ( <i>p</i> < .001) <i>f</i> = .59	<i>F</i> = 382.77 ( <i>p</i> < .001) <i>f</i> = .73	<i>F</i> = 117.74 ( <i>p</i> < .001) <i>f</i> = .48
Attractiveness (range = 1-10)					
Voices with a high Fo	5.31 ( <i>SD</i> = 1.87) <sup>b, c</sup>	5.69 ( <i>SD</i> = 1.89) <sup>b, c</sup>	5.23 ( <i>SD</i> = 1.86) <sup>b, c</sup>	5.45 ( <i>SD</i> = 1.81) <sup>b, c</sup>	5.11 ( <i>SD</i> = 1.94) <sup>b</sup>
Voices with a medium Fo	6.32 ( <i>SD</i> = 1.84) <sup>a, c</sup>	6.50 ( <i>SD</i> = 1.79) <sup>a, c</sup>	6.29 ( <i>SD</i> = 1.85) <sup>a, c</sup>	6.48 ( <i>SD</i> = 1.83) <sup>a, c</sup>	6.10 ( <i>SD</i> = 1.84) <sup>a, c</sup>
Voices with a low Fo	5.10 ( <i>SD</i> = 1.73) <sup>a, b</sup>	5.14 ( <i>SD</i> = 1.83) <sup>a, b</sup>	5.09 ( <i>SD</i> = 1.71) <sup>a, b</sup>	5.09 ( <i>SD</i> = 1.70) <sup>a, b</sup>	5.11 ( <i>SD</i> = 1.77) <sup>b</sup>
Inferential statistic	<i>F</i> = 344.49 ( <i>p</i> < .001) <i>f</i> = .53	<i>F</i> = 60.05 ( <i>p</i> < .001) <i>f</i> = .53	<i>F</i> = 291.00 ( <i>p</i> < .001) <i>f</i> = .54	<i>F</i> = 251.69 ( <i>p</i> < .001) <i>f</i> = .60	<i>F</i> = 106.78 ( <i>p</i> < .001) <i>f</i> = .46

Note: <sup>a</sup>= Statistically significant in comparison to voices with a high Fo; <sup>b</sup>= Statistically significant in comparison to voices with a medium Fo; <sup>c</sup>=Statistically significant in comparison to voices with a low Fo.



Table 4. Subjective sexual desire ratings in the total sample of men and according to country

	Men ( <i>n</i> = 206)	Spanish men ( <i>n</i> = 108)	Italian men ( <i>n</i> = 98)
Subjective sexual desire (range = 1-10)			
Voices with a high Fo	4.99 (SD = 2.27) <sup>b, c</sup>	5.31 (SD = 2.19) <sup>b, c</sup>	4.63 (SD = 2.31) <sup>b</sup>
Voices with a medium Fo	5.72 (SD = 2.43) <sup>a, c</sup>	5.96 (SD = 2.42) <sup>a, c</sup>	5.45 (SD = 2.42) <sup>a, c</sup>
Voices with a low Fo	4.46 (SD = 2.14) <sup>a, b</sup>	4.55 (SD = 2.04) <sup>a, b</sup>	4.37 (SD = 2.25) <sup>b</sup>
Inferential statistic	<i>F</i> = 58.14 (p<.001) <i>f</i> = .53	<i>F</i> = 39.24 (p<.001) <i>f</i> = .59	<i>F</i> = 21.90 (p<.001) <i>f</i> = .46

Note: <sup>a</sup>= Statistically significant in comparison to voices with a high Fo; <sup>b</sup>= Statistically significant in comparison to voices with a medium Fo; <sup>c</sup>=Statistically significant in comparison to voices with a low Fo.

Table 5. Friendship ratings in the total sample of women and according to country

	Women ( <i>n</i> = 961)	Spanish women ( <i>n</i> = 575)	Italian women ( <i>n</i> = 386)
Desire to engage in a friendship (range = 1-10)			
Voices with a high Fo	5.36 (SD = 1.88) <sup>b, c</sup>	5.61 (SD = 1.74) <sup>b, c</sup>	4.99 (SD = 2.02) <sup>b</sup>
Voices with a medium Fo	6.20 (SD = 1.84) <sup>a, c</sup>	6.47 (SD = 1.68) <sup>a, c</sup>	5.80 (SD = 1.99) <sup>a, c</sup>
Voices with a low Fo	5.58 (SD = 1.85) <sup>a, b</sup>	5.88 (SD = 1.75) <sup>a, b</sup>	5.14 (SD = 1.91) <sup>b</sup>
Inferential statistic	<i>F</i> = 180.08 ( <i>p</i> < .001) <i>f</i> = .43	<i>F</i> = 120.33 ( <i>p</i> < .001) <i>f</i> = .45	<i>F</i> = 63.02 ( <i>p</i> < .001) <i>f</i> = .40

Note: <sup>a</sup>= Statistically significant in comparison to voices with a high Fo; <sup>b</sup>= Statistically significant in comparison to voices with a medium Fo; <sup>c</sup>=Statistically significant in comparison to voices with a low Fo.