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# Human Vocal Attractiveness in British English as Perceived by Chinese University Students

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## Abstract

Vocal attractiveness, as an important indicator of personal traits, was hardly explored from the perspective of foreign listeners. In this study, both English native speakers and Chinese university students were asked to evaluate synthetic English utterances with manipulated voice quality, formant dispersion, pitch shift and pitch range in same-sex and opposite-sex contexts.

While some deviant features are shown in the results, English and Chinese subjects followed the principle of body size projection to varying degrees, with preferences for breathiness of female voice to signal a small body size, and narrower formant distribution of male voices to signal a large body size. Breathiness was also preferred for male voices to reduce implied aggressiveness by other body-size indicators. However, noteworthy differences between the two groups existed. Overall, Chinese subjects gave higher mean ratings to both genders and demonstrated weakened dimorphic characteristics of preferences compared to English subjects. Furthermore, for the same-sex voices, English women and Chinese men provided significantly lower ratings than their opposite gender within the same group.

The cross-linguistic differences shown in these results could be due to various linguistic, cultural, psychological, and educational factors, which require further examination due to technical limitations on the synthesis of female voices.

**Index Terms**: vocal attractiveness, perceptual differences, mate choice

## 1. Introduction

With a model of "auditory face" [1, pp. 711] and the vocal attractiveness stereotype known as "What sounds beautiful is good" [2, pp. 67], voice exerts a tangible impact on a wide range of realistic or virtual settings [3]. Generally, voice conveys information such as one's age, gender, and identity [1] as well as affective state [4], and acts as an integral part of social activities such as interviews, elections, dating and so on [3, 5-7]. More specifically, it is a significant secondary sexual characteristic that is perceived to reflect individuals' health condition [8], physical strength [9], reproductive potential [10, 11], etc., which may affect sexual selection [12-14]. Numerous researchers have discovered the importance of vocal attractiveness and investigated this topic from different angles, such as its specific representation and characteristics in Western countries [14] and Japan [15], the influence of social interest [16] and self-enhancement [17] on the perception of it, and the unbalanced ratings of it in various gender contexts [12], etc.

Among the studies, the prevailing view is that a female voice sounds more attractive when it is breathy and moderately high-pitched, and a male voice sounds more attractive when it is breathy and low-pitched [12, 14, 17]. This point echoes the body-size projection theory, which originates from Morton's theory of animal calls [18]. In Morton's mechanism, birds and mammals use vocal traits that reflect body size to influence the receivers. More specifically, harsh sounds with low frequency are used to project a large body size, to threaten the receiver that the sender is likely to win the fight. Inversely, pure-tone like sounds with higher frequency are used to project a small body size, to indicate the sender's lack of threat in order to signal submission [18]. Morton's theory was extended into human speech by Ohala [19], who also added vocal track length as a third acoustic dimension to project body size.

Xu et al. [14] further suggested that the pure-tone like sound quality can also be achieved through breathy voice in human speech. Normal speech requires complex spectral patterns [20] that cannot be generated with a pure-tone voice source, and the next closest thing would be a breathy voice whose increased spectral slope approximates a pure tone at the fundamental frequency [14]. Such breathiness may be a major property that makes a female voice sound attractive [14].

Probably due to the intrinsic attractive nature of female voices, male listeners typically view other male voices as less attractive, while both genders have similar ratings of female voices [12]. Body-size projection can therefore link up previous research findings that show the relation of vocal attractiveness to sexual dimorphism, health, youthfulness and other desirable characteristics in mate choice [12]. However, cultural and linguistic factors may also influence vocal attractiveness [15]. As argued by Pisanski et al. [13], mate preferences in which vocal attractiveness plays an important role are the product of a combination of local ecology, social environment, personal experiences and life history.

The study of vocal attractiveness has focused, however, mainly on the perception of individuals who are native speakers of the same language. Not much is known about whether discrepancies between listeners' native language and the stimuli language would have much impact on the perception of attractiveness. There is even less research that simultaneously examines the combined effects of gender, culture and language. The current study is an attempt to start to fill this research gap.


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## 2. Methodology and results

### 2.1 Stimuli

We created a synthetic utterance "You are feeling mellow", which was modeled after the original utterance spoken by a 16-year-old southern British male in an emotionally neutral voice, retrieved from the IViE corpus [21]. The base stimuli for the experiment were generated by VocalTractLab, an articulatory speech synthesizer [22] by manually adjusting the articulatory parameters to mimic the original human recording. Then three versions of the utterance were generated with different voice qualities- pressed, modal and breathy, by manipulating parameters of a two-mass glottal model in the vocal folds in VocalTractLab as done in Xu et al. [14].

Next, the "ChangeGender" function in Praat [23] was used to convert the male base sentences to three female base sentences, with a formant shift of 1.2 and a pitch shift of 12 semitones [15]. Lastly, these base sentences were further modified in terms of formant dispersion, pitch shift and pitch range (Table 1) with a Praat script. A total of 162 stimuli (3 voice qualities × 2 genders × 3 formant shift ratios × 3 pitch shifts × 3 pitch ranges) were generated.

Table 1: *Values of Praat parameters used to generate the final stimuli*

| Body size projection | Voice quality | Formant shift ratio | Pitch shift | Pitch range – Ratio to base |
|---|---|---|---|---|
| Small | Breathy | 1.1 | +3 st | 2 |
| Medium | Neutral | 1 | 0 | 1 |
| Large | Pressed | 0.9 | -3 st | 0.5 |

To verify that different voice qualities were effectively synthesized in the three base sentences, energy-band values were extracted with ProsodyPro [14, 24].

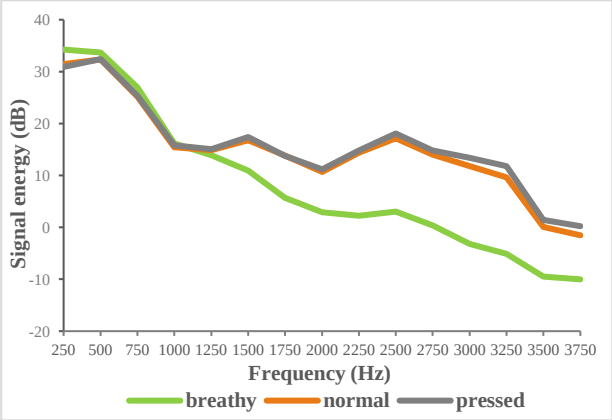


Figure 1: *Band energy profiles of voice qualities*

The energy-band profiles shown in Figure 1 each comprised of energy values of 15 overlapping spectral bands of 500-Hz bandwidth [14]. These energy band profiles demonstrate that more spectral energy is concentrated towards the lower frequency as voice quality changes from pressed to breathy.

Table 2: *Acoustic measurements of voice qualities*

| Intended voice | h1-h2 | H1-A1 | H1-A3 | Center of spectral gravity |
|---|---|---|---|---|
| Breathy | 2.88 | 5.36 | 36.78 | 385.18 |
| Normal | 6.03 | 4.89 | 19.37 | 567.54 |
| Pressed | 3.87 | 2.16 | 17.7 | 653.71 |

As can be seen in Table 2, as the intended voice quality changes from breathy to pressed, h1-h2, H1-A1 and H1-A3 all show declining values (except h1-h2 of normal voice). Additionally, the center of spectral gravity shifts upward in frequency across the three voice qualities. Both of them point to a reduced spectral tilt. This means that different voice qualities were generated as intended.

### 2.2 Subjects

Native English speakers with British accent (N=40, 20 females) and Chinese university students as Chinese natives (N=40, 20 females) were recruited in the experiment. They are heterosexual and have not been diagnosed with any speech or hearing impairment through the screening of Prolific, a website that connects researchers with subjects for online studies. All subjects read an information sheet and signed a consent form before the experiment. After participation, they were paid a small compensation for their time.

### 2.3 Experimental procedures

All audios of stimuli were set into Gorilla randomly. Subjects were asked to use a high-quality headphone set at a comfortable listening level throughout the experiment, and judge the vocal attractiveness of 162 stimuli from both genders on a 1-5 rating scale, where "1" is "Very Unattractive" and "5" is "Very Attractive". All stimuli were randomized for each subject and were played only once, and the subjects' response time was unlimited.

### 2.4 Statistical analysis

One-way repeated measures ANOVA was performed to investigate whether voice quality, formant dispersion, pitch range shift and pitch range had a significant influence on subjects' ratings. Post-hoc Bonferroni test was then used to confirm the results. Mann-Whitney U test and t-test were conducted to explore the effect of the gender context.

### 2.5 Ratings by English subjects

After ratings of each stimulus given by 40 English subjects were averaged, the mean of average ratings of 81 female voices is 2.09, and that of male voices is 2.68. To investigate more specific perceived attractiveness affected by four acoustic factors, the vocal attractiveness of two genders in these dimensions was calculated respectively and presented in Figures 2 and 3.

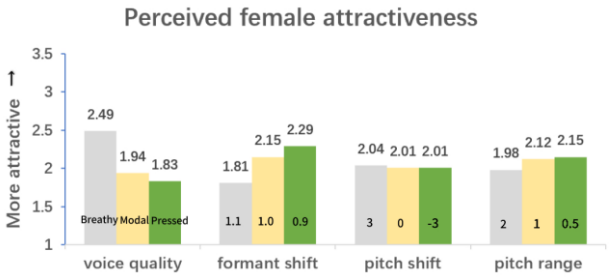


Figure 2: *Perceived female attractiveness by English subjects*

From Figure 2, breathy voices were perceived as the most attractive, followed by modal voices and lastly pressed voices. On formant shift, the downward ratio monotonically increased the attractiveness of female voices. On pitch shift, it mainly led to differences between higher pitch (median pitch = 1) and medial or lowered pitch (median pitch = 0, -1). And on pitch range, normal (F0 range = 1) and narrow pitch ranges (F0 range = 0.5) were essentially judged as more attractive than wide range (F0 range = 2).

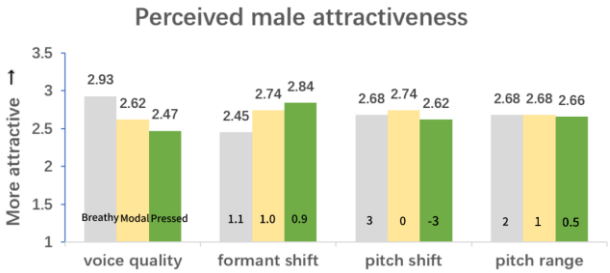


Figure 3: *Perceived male attractiveness by English subjects*

From Figure 3, the rising breathiness in male voices monotonically increased the attractiveness, and so did the downward formant shift ratios. For pitch shift, male voices with normal pitch (median pitch = 0) were judged as more attractive than lowered and raised pitch (median pitch = 1, -1). Lastly, for pitch range, expanded and normal ranges (F0 range = 2, 1) led to a slight increase in attractiveness.

According to a one-way repeated measures ANOVA test, there were significant differences across the three degrees of breathiness in female voices ($F(2, 78) = 46.00$, $p < .001$). Hence, voice quality significantly affected the attractiveness of female voices. A post-hoc Bonferroni test showed that breathy voices significantly differed from both modal ($p < .001$) and pressed ($p < .001$) voices, but there was no significance difference between the latter two ($p = .356$). Formant dispersion also had a significant effect ($F(2, 78) = 14.509$, $p < .001$), although not in the right direction, as the least dispersed formants were heard as the most attractive. There was no significant effect of either pitch shift or pitch range.

For the male voices, voice quality had a significant effect ($F(2, 78) = 33.331$, $p < .001$). The main effect of formant shift was also significant ($F(2, 78) = 20.245$, $p < .001$), and it was in the right direction for male voices. As the pattern shown in female voices, there was no significant effect of pitch shift or pitch range.

Additionally, when evaluating the attractiveness of female voices, English men generally showed higher ratings than English women (2.1690 > 2.0016). And male voices scored higher from English women than from men (2.6846 > 2.6659). Since significance was found between ratings divided by the listeners' genders when judging female voices ($p = .017$) but not male voices ($p = .702$), the gender context worked as a critical factor for English subjects to judge female attractiveness, in which English men as raters tended to give higher ratings than English women.

### 2.6 Ratings by Chinese subjects

In the Chinese listener group, male voices received a higher mean value than female voices (3.0443 > 2.2543).

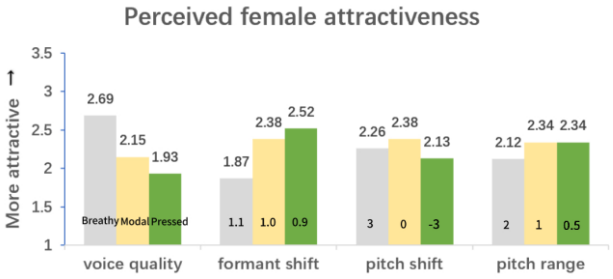


Figure 4: *Perceived female attractiveness by Chinese subjects*

From Figure 4, the upward breathiness and downward formant shift ratio monotonically increased female attractiveness. On pitch shift, medium pitch (median pitch = 0) scored the highest, while lower pitch (median pitch = -1) the lowest. On pitch range, differences only existed between wide pitch range (F0 range = 2) and medial or narrow range (F0 range = 1, 0.5).

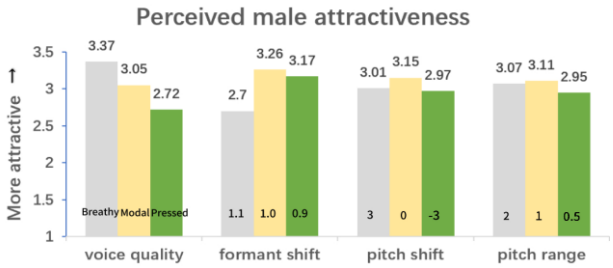


Figure 5: *Perceived male attractiveness by Chinese subjects*

From Figure 5, increasing breathiness in male voices still added to their attractiveness, whereas voices with medial formant distribution (ratio = 1), pitch shift (median pitch = 0) and pitch range (F0 range = 1) were rated as most attractive. In addition, narrow formant distribution (ratio = 0.9) and wide pitch range (F0 range = 2) also received relatively high ratings.

Through statistical analysis, for female vocal attractiveness perceived by Chinese subjects, voice quality as well as formant dispersion were significant factors ($F(2, 78) = 32.515$, $p < .001$, $F(2, 78) = 23.794$, $p < .001$), whereas no significant effect of pitch shift ($p = .154$) or pitch range ($p = .187$) were found. When perceiving male voices, voice quality and formant dispersion were still significant indicators ($F(2, 78) = 28.004$, $p < .001$, $F(2, 78) = 20.820$, $p < .001$), unlike the differences brought by pitch shift and pitch range ($p = .234$, $p = .416$).

In terms of gender context, for female voices, Chinese women gave comparatively higher mean ratings than men (2.2602 > 2.2485). A t-test showed no significant effect of Chinese listeners' gender on their perception of female vocal attractiveness ($p = .977$). For male voices, Chinese women also gave a higher mean value (3.1873 > 2.901), and gender context was significant in Chinese subjects' evaluation of male vocal attractiveness ($p < .001$).

## 3. Discussion

In terms of similarities, English and Chinese subjects partially conformed to the body-size projection theory due to their preferences for breathiness, and narrower formant distribution of male voices. Breathy voice quality of men would reduce aggressiveness implied by other body-size indicators [14, 25]. Additionally, the evaluation of medial-pitched male voices was the highest in both English and Chinese subjects. This phenomenon, coupled with women's specially favored formants dispersion that was not as wide as before [14, 26], might be interpreted by the mix-gender setting of raters and speakers and the neutralization of rater-speaker competition. Moreover, the higher mean ranking of female and male stimuli were all from their opposite gender, with female voices rated by Chinese women being a single exception. This is consistent with the logic of "opposites attract" or "complementarity" agreed by some interpersonal psychologists [27-29].

As for the differences between the two language groups, first, Chinese subjects as a group provided significantly higher ratings than English subjects no matter for female or male stimuli. One reason could be that Chinese subjects showed more interest in English speech sounds than native speakers, which is manifested as rating English voices as generally more attractive. It is also possible that Chinese subjects gave a generous rating when exposed to a foreign language or speech stimuli that they were not familiar with (as the one "You are feeling mellow"), whereas English subjects as native speakers have experienced abundant samples of such stimuli and cultivated a mature evaluation system, and hence were more likely to be rigorous in their judgments. Moreover, Chinese subjects might prioritize more superficial aspects when evaluating attractiveness, such as pronunciation accuracy and speech fluency as parts of their language learning experience [30]. Once these basic requirements were met as in the study, the perceived attractiveness would be congruously upgraded at a great level. Unlike them, English subjects may likely have focused more on the fine distinction of regional accents, intonation patterns [31, 32], etc., so their judgments might tend to be more critical. Conceivably, the unnaturalness of synthetic stimuli would be more obvious to the English ears.

Second, the dimorphic characteristics have been further weakened in the attractiveness perception of Chinese subjects compared to English subjects. Across cultural and linguistic backgrounds, Chinese university students showed a less explicit tendency to a high pitch of English women and narrowly distributed formants of English men. Instead, medial pitch of female voices and medial formant dispersion of male voices were rated as most attractive for them. On the level of language itself, Mandarin Chinese generally has a higher maximum and mean f0 than English [33]. Because of the exposure to English with a predominately lower pitch than their native language, Chinese subjects might have the expectation that pitch in English speech should generally be lower pitched, and gave higher ratings to those that matched their expectations. From previous findings that listeners with various language backgrounds did not use identical strategies to determine the gender of voices [34] with different accuracies in gender identification of foreign speech [35], it was also likely that Chinese subjects found it harder to accurately and quickly identify the gender of the English speaker, so that they gave neutral or even reversed choices for voices that were not clearly gender-specific. In addition, Chinese subjects have much less exposure to English stimuli, which may make them less sensitive to the fine nuances in the acoustic signals. In this case, the perceptual boundary between the medial scale of a certain dimension and some of its contrasts could be blurred, adding to the randomness of their results. From another perspective of the cultural context, harmony and balance are typically valued in Chinese culture [36, 37]; in the traditional appreciation of Chinese music, maintaining a harmonious balance of sounds is also emphasized [38], which could extend to Chinese subjects' preferences for certain moderate acoustic characteristics as shown here.

While all the above speculations may seem somewhat reasonable, they cannot explain why English listeners also perceived the female voice with low formant dispersion as being more attractive (Figure 2). There are two possibilities that we could think of. The first is that, impressionistically, some female voices we created as stimuli were prone to be judged as the male voice by both English and Chinese subjects. As a result, such a tendency interfered with the perception process of the female voice and produced some preferences typical for male voices. The second possibility is that our subjects perceived the female stimuli as older. Is it possible that for an older woman, having a lengthened vocal tract just like in a male voice would actually sound more attractive? Since the experiment did not include a gender identification task, we could not tell whether this has happened.

## 4. Conclusions

### 4.1 Main findings

To conclude, on English female voices, those that are higher pitched and breathy were preferred by Chinese students, although the pitch effect was not significant; and on English male voices, those that are medially pitched and breathy were preferred by Chinese students, which is basically in line with the tendency of English natives. However, Chinese subjects generally gave higher mean ratings and showed weaker dimorphic preferences for these voices compared to English subjects. Moreover, on English female voices, Chinese men gave slightly lower ratings than did women; while on English male voices, Chinese men gave significantly lower ratings than did women. This indicates that the gender context was a notable factor affecting English vocal attractiveness for Chinese university students, which was represented differently in English natives.

### 4.2 Limitations

A major limitation is that the synthetic base female stimuli converted from male voices sounded less ideal than male stimuli. This may have made the listeners misperceive more female utterances as the male voice, thus producing deviant perceptual results. Because no gender or age identification task was included in the experiment, we cannot come to any clear conclusion about the exact mechanism of this phenomenon. Future research will be needed to examine the effects of perceived speaker gender and age on vocal attractiveness.

## 5. Acknowledgements

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