Evolution of human pitch: Preliminary analyses in the French population using INA audiovisual archives of Vox Pops

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The human **voice** is the medium of **verbal communication**...  
... but it is does not simply convey semantic information.

Acoustic properties are also reliable cues for:

- Emotional and affective state  
  (e.g. joy, fear, anxiety...)
- Interest and intention
- Biological and social characteristics  
  (e.g. sex, age, cultural and social origins...)

**Context**
**Background**

**Sexual dimorphism in the human voice ≠ Anatomy of the vocal apparatus**

Vocal folds: 15-20 mm ♂ / 9-13 mm ♀
Vocal tract: 17-18 cm ♂ / 14.5 cm ♀

**Effects of androgens at puberty → Sexual maturation**

**Distribution of voice pitch**

_Barkat-Defradas & Suire (2020)_
Context

But beyond physio-anatomical variations between sexes and between populations sometimes due to the environment...

→ Part of the prosody may be **socially learned**

Simpson, 2009

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**In men:**
- American English 105.6 Hz
- German 118 Hz
- Spanish 124.6 Hz
- French 125 Hz
- Mandarin Chinese 129 Hz
- Bulgarian 160 Hz
- Polish 163 Hz

**In women:**
- German 210 Hz
- American English 211 Hz
- British English 217 Hz
- Japanese 224 Hz
- Polish 266 Hz
- Bulgarian 272 Hz

Traunmüller & Eriksson (1995)
Difference in voice pitch observed between Japanese (~230 Hz) and Dutch women (~190 Hz)

→ Vocal behaviors comply to social expectations linked to their gender

**In Japan:**
- femininity → “modesty”, “innocence” and “psychological dependence”
- using a higher pitch by women to convey impression of “docility” and “weakness”

**In the Netherlands:**
- femininity → “independence” and “hard-working”
- preference for women with lower-pitched voices, perceptually associated with “self-confidence” and “leadership”

Japanese and Dutch men show preferences towards culturally congruent voices related to the values attributed to femininity
State of the art

Interestingly, some studies suggest that changes in voice pitch have occurred...

1) Recordings of 28 Australian women in 1945 were compared to recordings of another group of Australian women in 1993
   → voice pitch around 23 Hz lower
   
   Pemberton, McCormack, & Russell, 1998

2) Voice pitch of French male journalists has also lowered over the past ~50 years

   de Mareuil, Rillard, & Allauzen, 2012

Has voice pitch evolved through time?
the FIAT/IFTA study

1) Offer an original systematic analysis of how the human vocal pitch has evolved over time (1940-2019)

2) Highlight how audiovisual archives (INA) can shed light on the evolution of human social behaviors (i.e. speech)
Methods

Which speakers to analyze?
In order to be representative of the general population
→ speakers interviewed during Vox Pops

From 1940 to 2019:
Selecting suitable speakers in TV news/shows from the Institut National de l’Audiovisuel database
Methods

- excerpts containing high background noise or chaotic vocalizations were discarded
  (e.g. screaming, shouting, laughing, crying...)

→ 96 video clips retained(.wav files)
Methods

Manual segmentation then **acoustic analyses** → **Praat**

**Acoustic measures:**
- Mean voice pitch ($F_0_{\text{mean}}$)
- Vocal range ($F_0_{\text{min}}$ and $F_0_{\text{max}}$)
- Intonation ($F_0_{\text{sd}}$ and $F_0_{\text{CV}}$)
## Methods

### Number of analyzed speakers per sex and decade

<table>
<thead>
<tr>
<th>Decade</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940 – 1959</td>
<td>27</td>
<td>48</td>
</tr>
<tr>
<td>1960 – 1969</td>
<td>49</td>
<td>37</td>
</tr>
<tr>
<td>1970 – 1979</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>1980 – 1989</td>
<td>62</td>
<td>83</td>
</tr>
<tr>
<td>1990 – 1999</td>
<td>42</td>
<td>62</td>
</tr>
<tr>
<td>2000 – 2009</td>
<td>49</td>
<td>56</td>
</tr>
<tr>
<td>2010 – 2019</td>
<td>62</td>
<td>72</td>
</tr>
</tbody>
</table>

In total 341 women + 432 men unique speakers

Speech samples averaged a duration of 4.7 seconds (± 4.6)
Results

Voice pitch (F0 = vocal height)

- **Lower** in women between 1940 – 1959
- **Higher** in women after 1940 – 1959 → but remains constant afterwards.
- In men, no significant increase or decrease → remained **constant over almost ~80 y.**
Results

Voice pitch modulation ($F_{0sd}$) : intonation

- Pitch variation ($F_{0sd}$) did not significantly vary in both women and men across time
Results

Voice pitch modulation (corrected for vocal height) \( CV = \frac{F_0_{sd}}{F_0_{mean}} \)

- Women’s CV was only significantly lower between 1940-1959 and 2000-2009 → voices became relatively more monotonous over time

- Women’s \( F_0_{CV} \) overlapped the values observed for men between 1970–1979 and 1990–1999.

- Values of \( F_0_{CV} \) for men did not significantly change over time.
Results

Vocal range ($F_{0\text{min}} - F_{0\text{max}}$)

Increase in vocal range $\rightarrow$ simultaneous increase in $F_{0\text{max}}$ and decrease in $F_{0\text{min}}$
Discussion

Voice pitch ($F_0_{\text{mean}}$) in both men and women has little evolved over time.

1) Not a reliable acoustic parameter to study?
   → static cue vs. dynamic vocal cues ($F_0_{\text{sd}}$ $F_0_{\text{min-max}}$ $F_0_{\text{CV}}$)

2) Effect of age and social class not controlled for (unavailable information)
   → influence acoustic parameters

Further study on age range identification and clothing styles to infer social class (visual cues)
Discussion

Vocal range ($F_{0\text{min}} - F_{0\text{max}}$): increases over time in both sexes

1) With mean voice pitch remaining constant
   → Two types of vocal modulation profiles?

2) Higher pitch in some women
   → Maintaining stereotypes of ‘femininity’ by high-social classes?

3) Lower pitch in some women
   → Adaptive response to socio-economic fluctuations + cultural shift
   → Women endorse more and more traits usually displayed by men
      (i.e. female masculinisation hypothesis)
First names « masculinization »  Waist-to-Hip ratio « masculinization »

Suire et al. (2019)

Other changes:

- More ‘clever’
- More ‘powerful’
- More oriented towards professional careers
- Higher social statuses
- More competitive
- Less eager to have children

Cashdan et al. (2008)
Conclusion

Future perspectives

1) Socio-historical analyses on the evolution of gender representations

2) Comparative research
   → Social roles associated to each gender/sex in different cultures
   → Are preferences for voice quality culturally-dependent (i.e. congruent with cultural norms)
Acknowledgements

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Thank you for your attention

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To go further →

Voice Attractiveness: Studies on Sexy, Likable, and Charismatic Speakers