Disguised voices: a perceptual experiment

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CIVIL Project

Cualidad Individual de la Voz en la Identificación de Locutores

- 2010

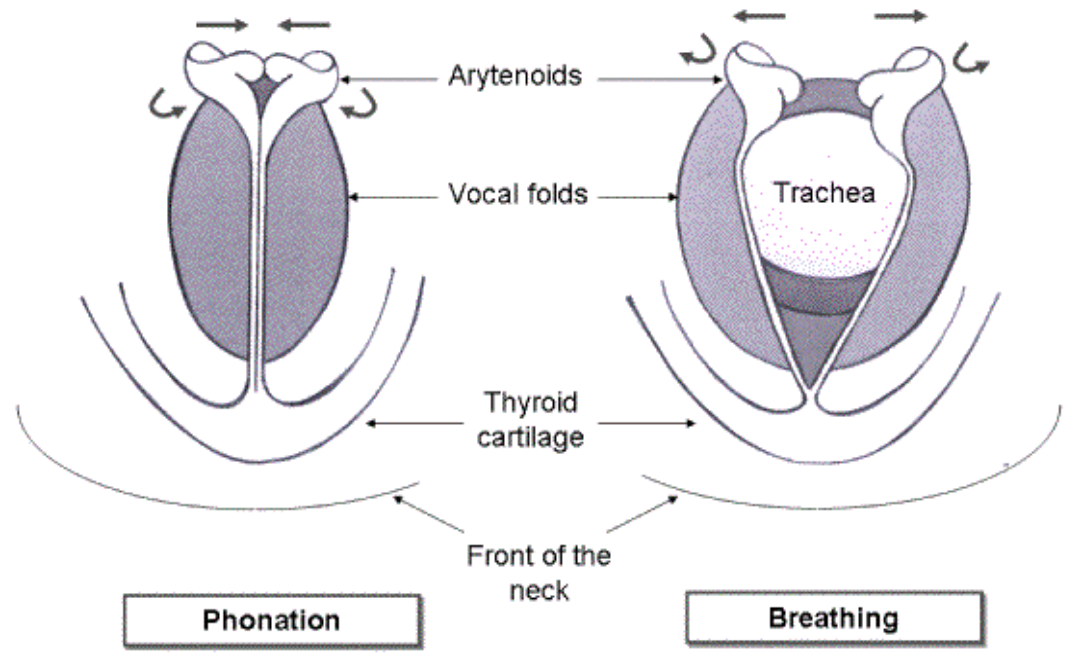
- Phonetics Lab CSIC, Madrid
- Laryngeal settings modification

CIVIL: hypotheses

- Changes in phonation = harmful for speaker recognition
- Idiosyncratic phonetic features (biometric traces):
  - Remain despite the disguise attempts
  - Some laryngeal characteristics cannot be disguised

Types of Phonation

- Phonation = vocal folds vibration



From: http://www.phys.unsw.edu.au/jw/voice.html

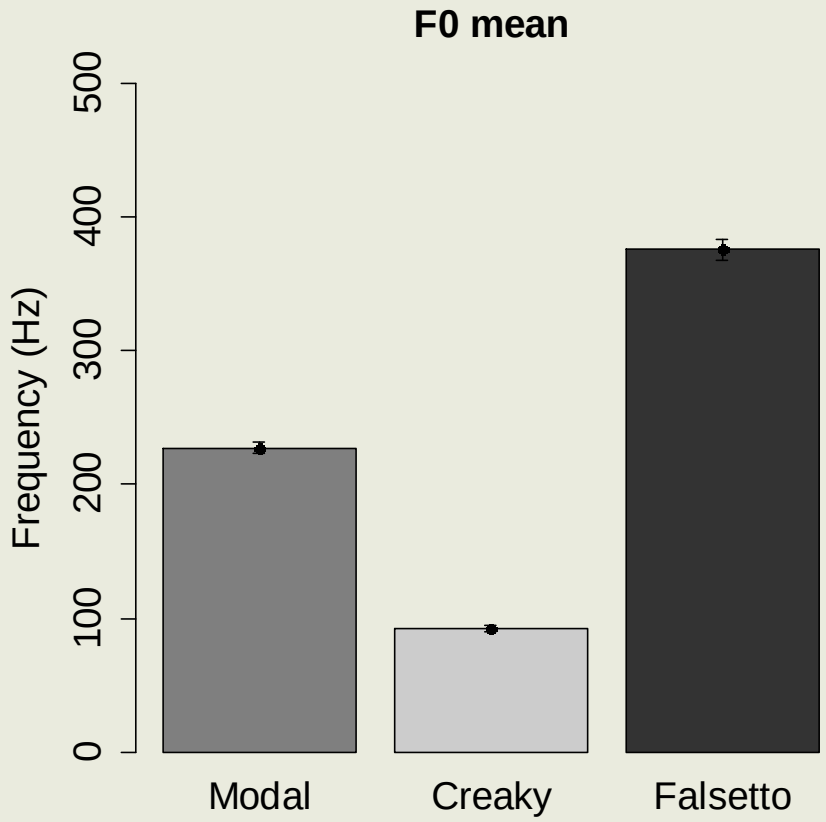
Types of Phonation

- Phonation = vocal folds vibration
- Different states of the vocal folds produce different types of phonation

Falsetto	-adducted	+tense	elongated
Modal	adducted	tense	----------
Creak/y	+adducted	-tense	shortened



Acoustic differences of phonation types



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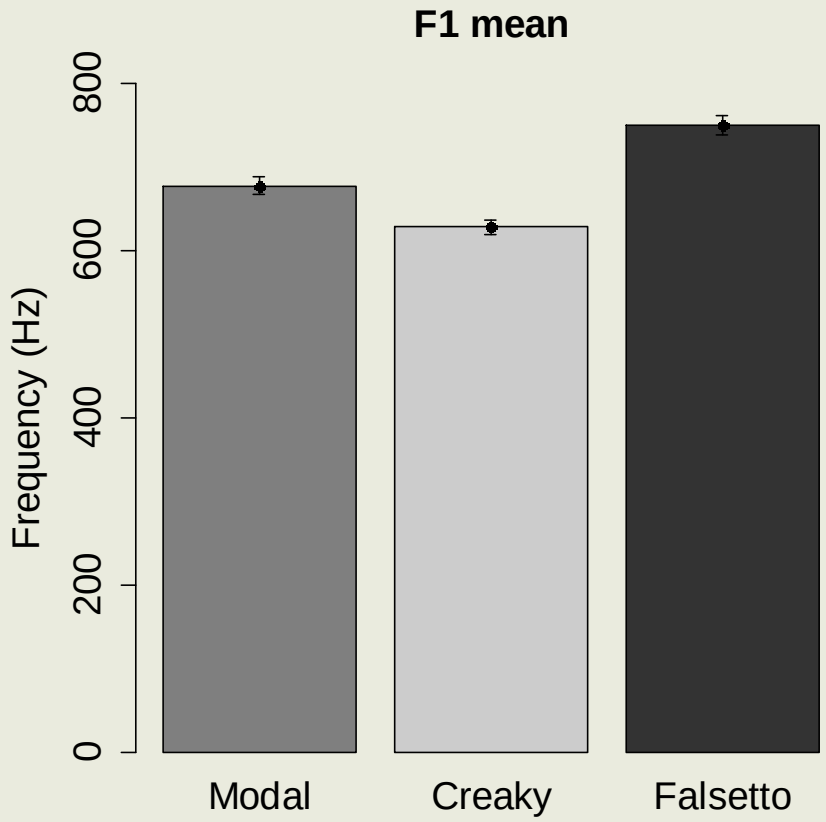

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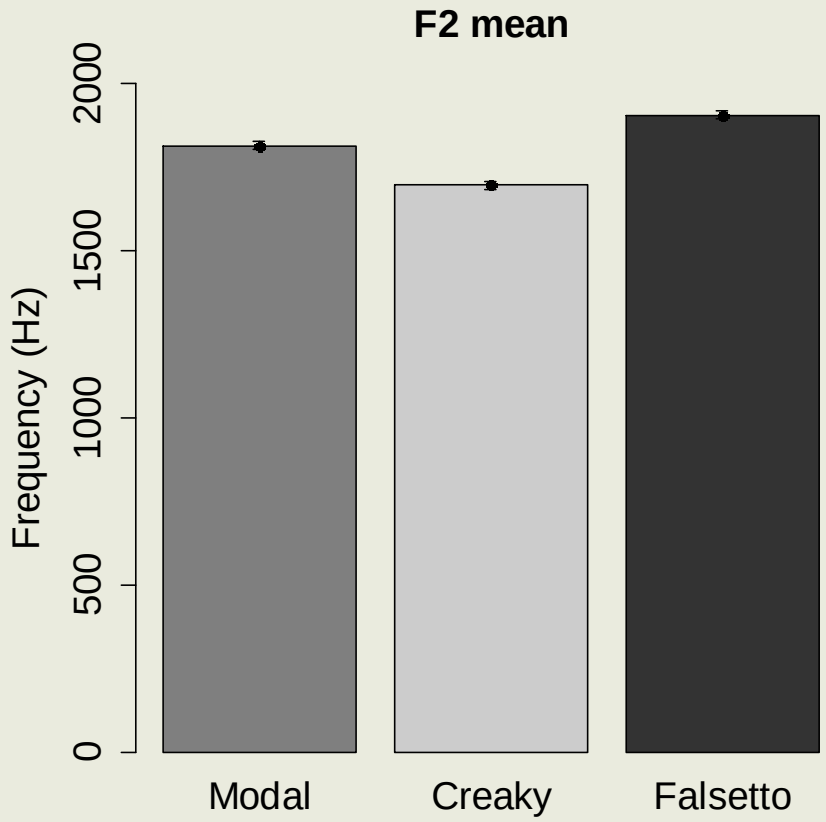

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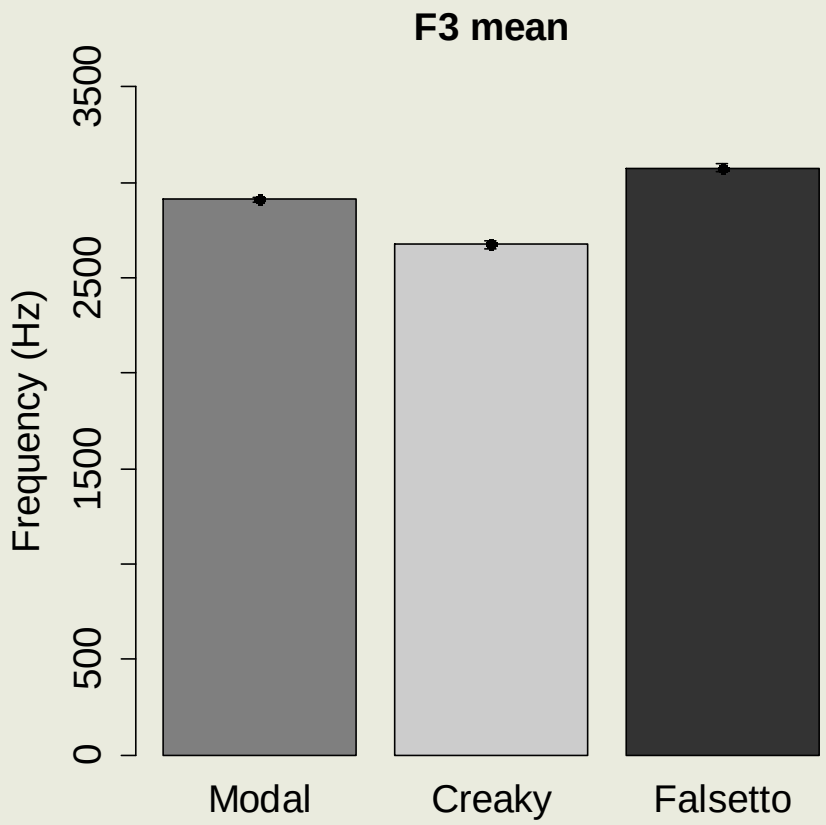

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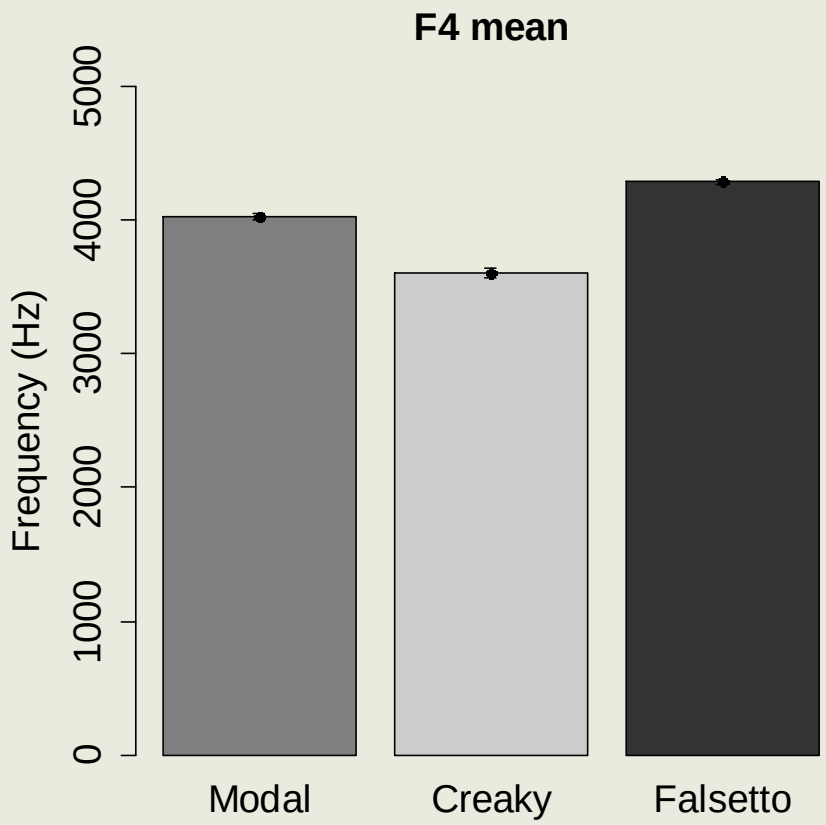

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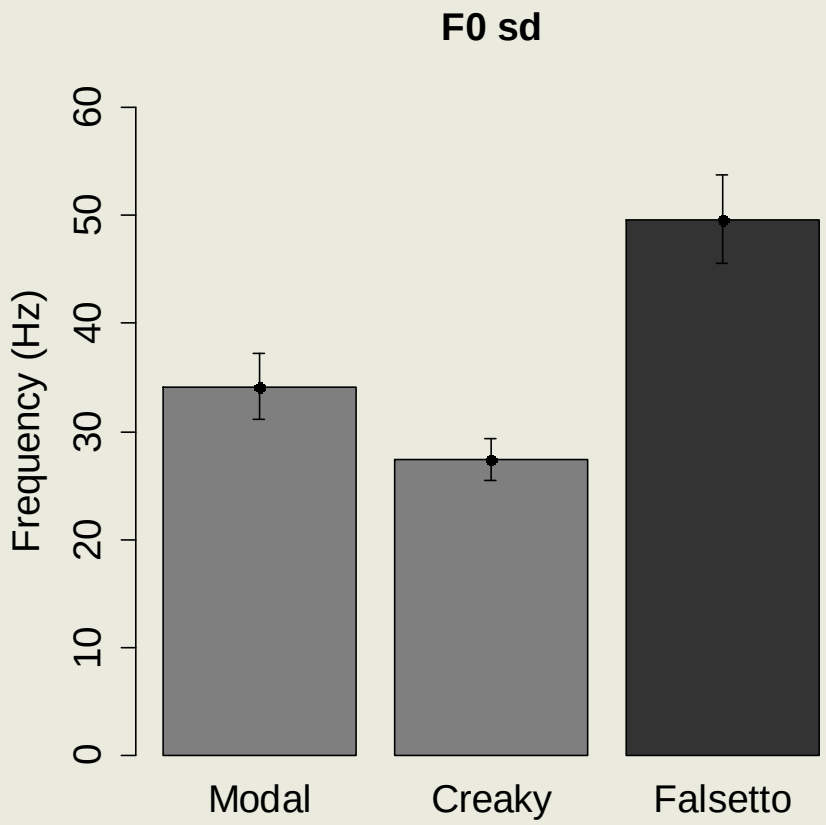

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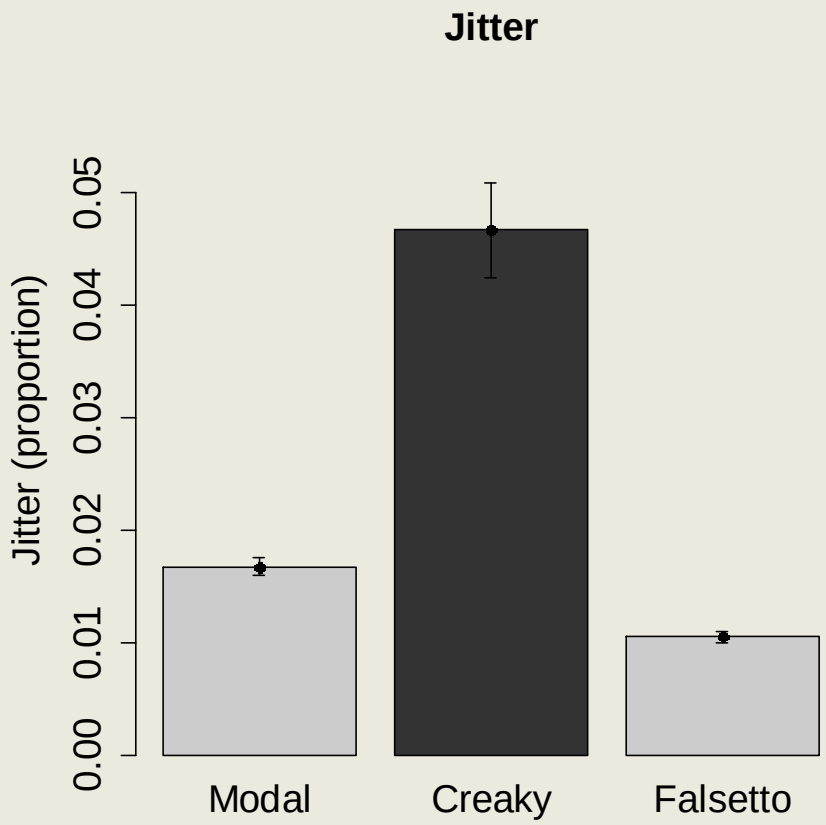

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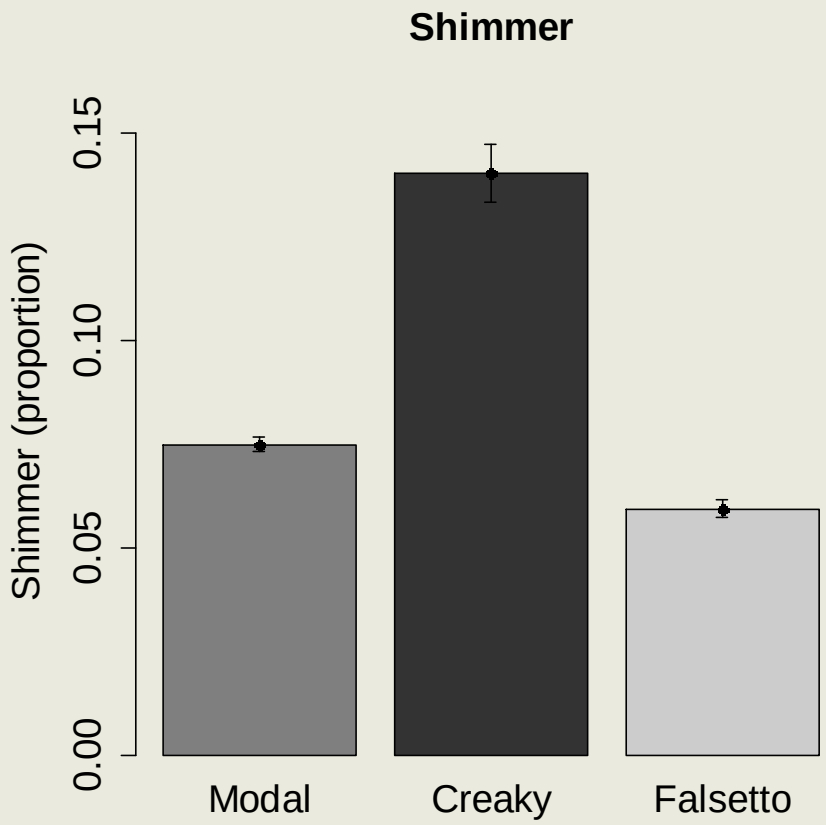

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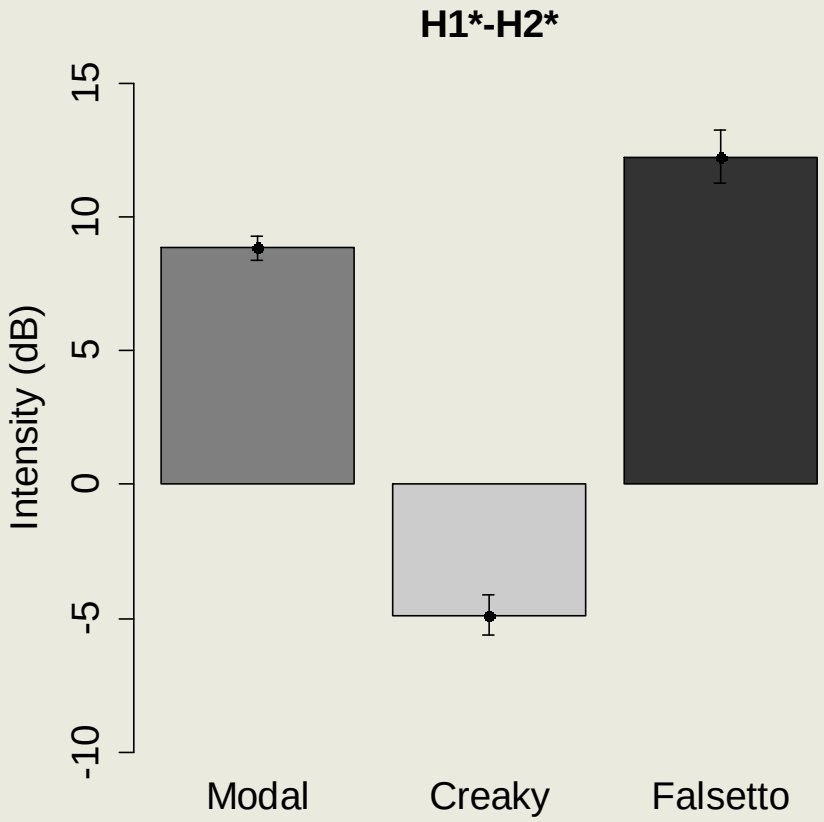

Perceptual experiment RQs

Assuming that phonation types interfere with speaker recognition

- Do listeners recognise disguised voices above chance level? H1 = yes
- Is recognition more affected by a particular phonation type? H2 = falsetto
- Do expert listeners perform better than naïve listeners? H3 = no

Hypotheses

- H1: Listeners are capable of recognising disguised voices over chance level.
  - "Something" in the glottal source remains

Hypotheses

- H2: - Falsetto register is more harmful for voice recognition than creak

  Wagner & Koester (1999)

  Hirson & Duckworth (1993)

  Moosmueller (2001)

  – Different: methodology and results

  – While recognizing, better results with creak than falsetto

Hypotheses

- H3: No performance differences between experts and naïve listeners in disguised voices recognition
  - Voice perception is not analytical but holistic

Experiment design

- Corpus read sentences
- Frame sentence:

“Diga 'CV.CV.CV despacio”

- Open syllable: voice quality not affected

Speakers

- 6 female speakers Standard European Spanish
  - 25-35 years old
  - no speaking nor hearing disorders
  - mantain the phonation type

Recordings

- Equipment
  - Recording booth of the CCHS Phonetics Lab
  - Condenser microphone→ E6i Omnidireccional Earset Microphone
  - Audio Interface →UA-25EX by Roland
  - PC with the software Adobe Audition 1.0 for Windows
- Recording settings:
  - Sample Rate: 44100
  - Resolution: 16-bits
  - Channels: Mono

Test Description

- 120 triplets→ disguised voice (X) + modal voice (A) + modal voice (B)

6 speakers x 2 phonation registers x 2 listening orders x 5 distractors

- Random order of the 120 triplets
  - 0,5 seconds between voices
  - Duration of one triplet: 5-7 seconds
  - Duration of the test: 20-30 minutes

- Each item played up to two times

Subjects

- 61 (14 phoneticians + 47 non-phoneticians)
- Spanish L1
- No hearing disorders
- Not familiar with any of the speakers

Results H1

- One-sample t-test shows that:

  Recognition of disguised voices is above chance, i.e. hit rate > 0.5

  (99.9% confidence level)

  - Creaky: $t(60) = 10.04, p < 0.001$ ***
  - Falsetto: $t(60) = 10.41, p < 0.001$ ***

Results H2

HIT RATE	Creaky	Falsetto
mean	0.59	0.62
sd	0.07	0.09

Please note:

- 8% probability of getting hit rate = 0.59 by chance
- 3% probability of getting hit rate = 0.62 by chance

Results H2

- Two-sample t-test shows that:

  Hit rate is significantly better for falsetto than for creaky voice

  (95% confidence level)

  $t(112) = 2.11, p < 0.05$ *

Results H2

Results H3

HIT RATE	Phonetician	Non-phonetician
Creaky	0.60 (0.06)	0.59 (0.07)
Falsetto	0.62 (0.09)	0.62 (0.09)
No. subjects	14	47

Discussion

- Phonation types DO affect recognition:
  - Hit rates not very high (0.60)

- However, hit rates above chance

Discussion

- Speaker recognition is easier under falsetto than under creaky condition
  - Against H2
  - Possible explanation:
    - Previous studies: male voices
    - Falsetto (male) & creaky (female) introduce greater distortion with respect to normal voice than the other way round. Expectations not met:
      - Creak less expected for female voice prototype
      - Falsetto less expected for male voices prototype
    - Creak has no F0: loss of a crucial acoustic cue

Discussion

- Good performance rates might be due to:
  - musical education
  - ear training

- Rather than:
  - background in phonetics

Further research

- Enlarge corpus:
  - Male voices
  - Spontaneous speech
- Characterise phonation types (acoustically and physiologically)
- Find which traits are speaker-specific
- Check telephone signal influence
- Study temporal parameters

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Many thanks!

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