Gender-based studies on the spoken language of children

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Background

1) **Perception** Adult listeners are able to identify the sex of a speaking child (e.g. Perry et al., 2001; Ingrisano, et al., 1980)
2) **Acoustics** Lower vowel resonances for boys than for girls (e.g. Perry et al., 2001)
3) **Anatomy** - No sex-related differences in vocal tract length (VTL) before puberty (e.g. Fitch et al., 1999; Barbier et al., 2015)
- Prepubertal differences in head measurements (e.g. Meredith, 1953; Dokládal, 1959)
- Positive correlations between VTL and other body dimensions:

Body weight/size ↔ Head size ↔ VTL↔ Tongue size

(Geraedts et al. 2011, Fitch 1999, Stone 2018)

Material

5 ♀ 5 ♂ Age: 6-7 years

The children live 90 km east of Munich

8 single word productions (German) from image naming task

Ultrasound and video recordings for extraction of anatomical dimensions

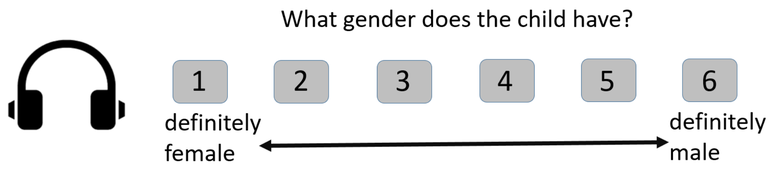
Perception | Acoustics | Anatomy

Hypotheses

1) **Perception**: Listeners are able to correctly identify the biological sex of a 6-7 year-old child better than chance on the basis of words.
2) **Acoustics**: There are significant differences in the vowel formant frequencies and listeners base their judgment on them:
Formants are relatively high -> they select “female”; formants are relatively low -> they select “male”.
3) **Anatomy**: There are significant differences in head and tongue sizes between boys and girls aged 6-7 years.

Method

1) **Perception**: 94 listeners (LMU students, 69 ♀ , 25 ♂)
Judgement of 160 stimuli spoken from the 10 children, one repetition



2) **Acoustics**: Analysis of stressed vowel per word
- Formant calculation with PraatR, manual correction if needed
- Logarithmic frequency
3) **Anatomy**: 3 head dimensions extracted from video data and 2 tongue dimensions extracted from ultrasound data

Results

1) **Perception** Identification rate ≈ 72 % ($p < 0.01$)
2) **Acoustics** Most sex-differences in F3 ($p < 0.01$; **Fig.1**) and listeners base their judgement mostly on F3 ($p < 0.001$; **Fig.2**)

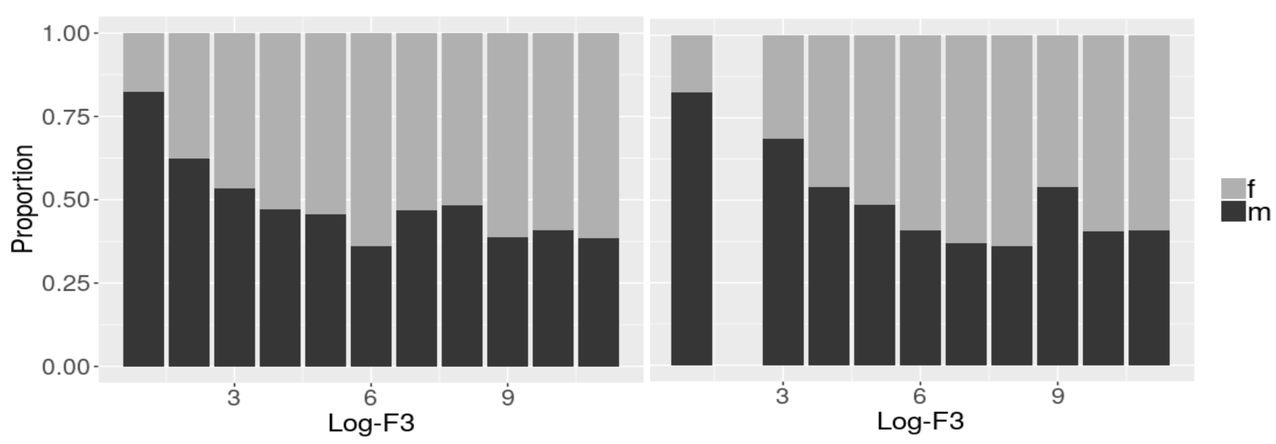
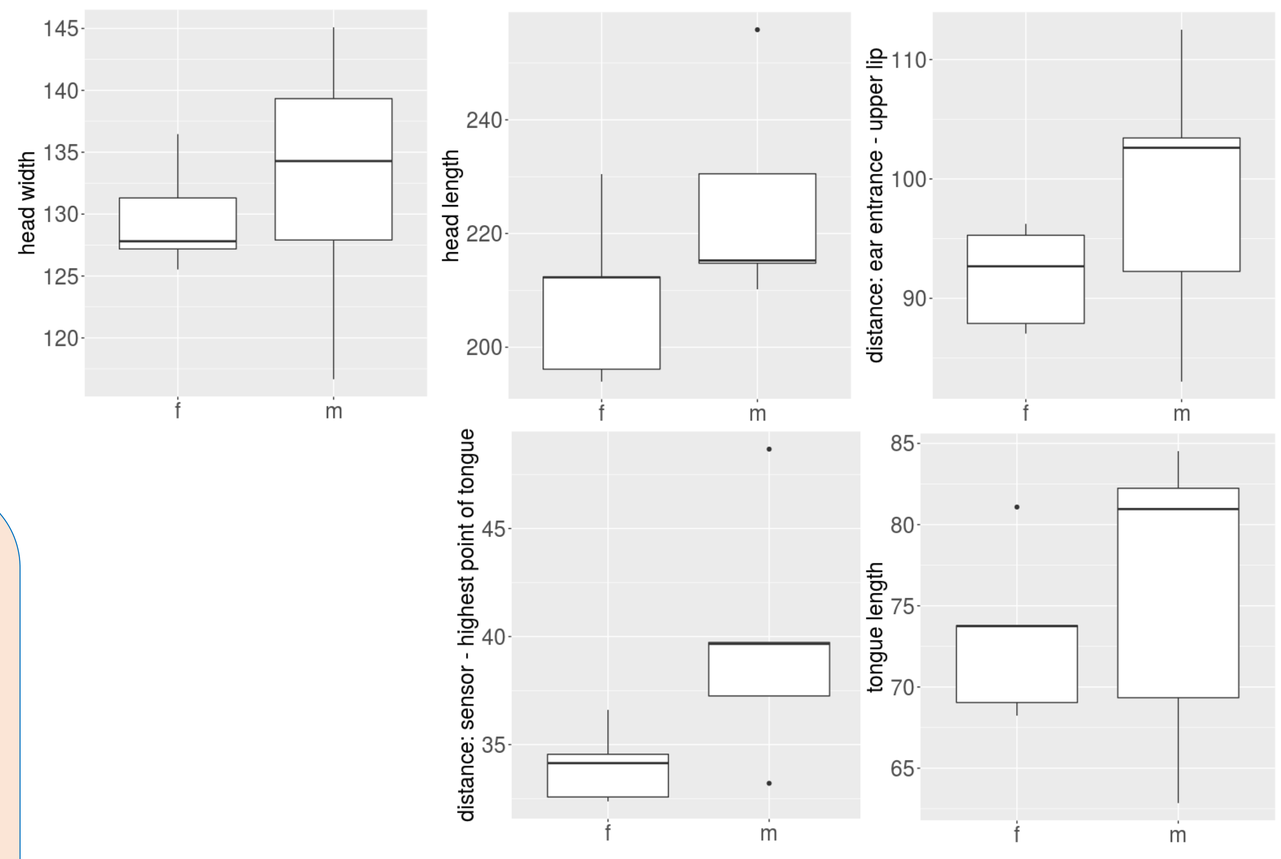


Fig. 1. Logarithmized F3 grouped into 11 bins with increasing height from left to right (x-axis) as a function of the proportions of **f**emale vs. **m**ale *speakers* (y-axis)

Fig. 2. Logarithmized F3 grouped into 11 bins with increasing height from left to right (x-axis) as a function of the proportions of **f**emale vs. **m**ale *answers from the listeners* (y-axis)

3) **Anatomy**

No significant differences ($p > 0.05$) in all 5 measures - but tendency?



Summary & Discussion

1) People can hear if a boy or a girl is speaking.
2) There are differences in vowel formants (esp. F3) between girls and boys aged 6-7 years and listeners base their judgement on them.
3) There are no significant differences in head and tongue sizes that could be linked to a sex-difference in VTL (positive correlation).

<u>Anatomical conditions + learned speech behavior?</u>

What causes the differences in formants (2) that enable sex to be correctly identified perceptively (1) if it’s not the anatomy (3)?
Classical explanation: Sociophonetic factors -> A girl/boy “learns” to sound male/female (Ingrisano, et al. 1980; see also Simpson 2009).
No differences in the anatomy of prepubertal children - or are there?
For example, Vorperian, et al. (2009) find such diff. for particular areas of the vocal tract, but most studies do not. Why?

References

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