Perceptual estimation of talker height from children's voices

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Introduction

We examined the ability of listeners to estimate the height of the speaker from /hVd/ syllables spoken by children between 5 and 18 years. 23 college students judged the height and sex of the talker; a separate group of 24 listeners judged age and sex. Perceptual estimates of height were moderately correlated with actual height. However, when listeners misidentified the sex of the talker, the accuracy of their height judgments was also lower, with a tendency to perceive older girls as shorter than their actual height. A similar pattern was found for age judgments. Consistent with our recent findings concerning the perception of talker age[1], listeners' judgments of talker height appear to incorporate assumptions about talker sex.

Method

Stimuli

- **Age** 5-18 years (14 age levels)
- **Sex** 3 males & 3 females per age level
- **Talker** 14 x 3 x 2 = 84 talkers, drawn from a vowel database of 208 speakers[2]
- **Vowel** /hid/ and /had/

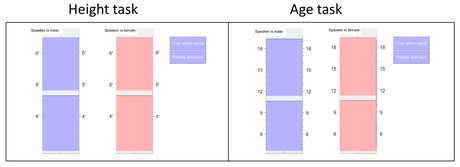
Listeners

- **Height** estimates + speaker sex (N=23)
- **Age** estimates + speaker sex (N=24)

Procedure

- Each listener heard 168 stimuli, with syllables randomly interspersed. Stimuli were presented monaurally over headphones using Tucker-Davis System 3 and RP2.1 hardware.
- Listeners used a Matlab slider to indicate height or age and sex of the talker on each trial.

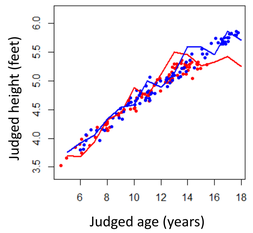
Height task Age task



Results

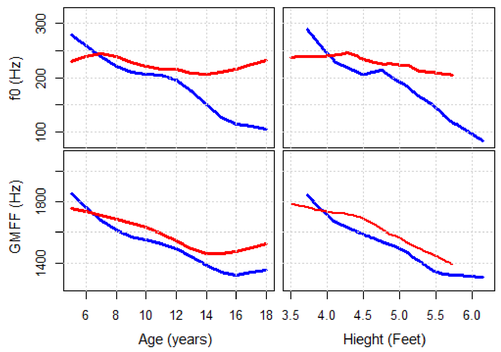
How accurately can listeners determine the height and age of the talker from children's speech?

Points indicate judged height and age for each syllable, averaged across listeners. Solid lines indicate actual height (left) and age (bottom) of speakers in the sample, with males in blue, females in red.



- Age and height are closely related.
- Perceived height and age correspond closely to actual height and age.
- Listeners do not identify any female speakers as older than 16 years on average.

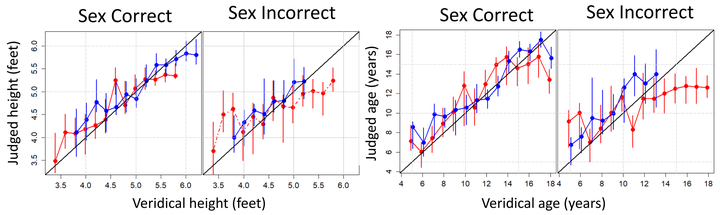
Acoustical properties related to height and age



Acoustical measurements (mean F0 and GMFF, the geometric mean frequency of the lowest 3 formants) for the stimuli in the experiment. Age judgments of children's voices can be accurately predicted using these two measures[1].

- With increasing height and age, F0 is relatively flat for girls, but decreases continuously for boys.
- GMFF decreases continuously by age and height for males. It seems to stop decreasing at around 13 years of age for females. GMFF appears to decrease across all female height groups.

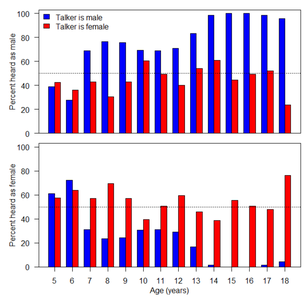
Are height and age judgments affected by perceived sex?



Height and age judgments as a function of sex recognition accuracy. Circles indicate mean judged age (male speakers in blue, females in red). Vertical bars indicate highest density intervals.

- Older females are consistently underestimated in age, and to a lesser extent height, even when their sex is judged correctly.
- Disparities between estimated and true age/height are greater when sex is incorrect for post-pubescent females.
- When sex is judged correctly, age underestimation may be explained by acoustic patterns in Figure 2: F0 and GMFF do not continue to decline in older females. Similarly, when sex is incorrect, female talkers are heard as pre-pubescent males, and responses are consistent with the high degree of acoustic overlap between the older girls and younger boys.

Sex recognition



- Sex recognition approaches 100% in boys 14 years or older, but ranges between 40-75% for the older girls.
- For the younger children, sex recognition is around 50%, with both boys and girls slightly more likely to be reported as female.
- However, a strong asymmetry appears for the older talkers, where girls are often misidentified as male, while boys are almost never reported as female.

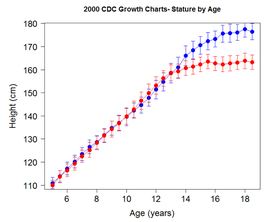
Mean absolute error	Sex correct		Sex incorrect	
	Boys	Girls	Boys	Girls
Height (feet)	0.35	0.35	0.39	0.47
Age (years)	1.97	2.33	2.49	2.82

Mean absolute difference between actual and estimated height and age.

- For both age and height, estimation error is larger when sex is misidentified, particularly for girls.

Discussion

- The 2000 CDC Growth Charts[3] show a plateau in growth rate around 15 years in girls, several years earlier than boys.



- Acoustic characteristics also stop changing for the girls in our sample around this age. As a result there is substantial overlap in acoustic measures of older females and younger males at most age groups.

Summary and Conclusions

- Height and age judgments are closely related, reflecting the fact that physical height and age follow a similar trajectory in childhood.
- Barreda and Assmann (2018) showed that knowledge of the sex of the talker plays an important role in the perception of age for children's voices. The present results indicate that a similar relationship exists for the perception of height.
- Acoustic properties (mean F0 and GMFF) appear to provide a plausible explanation for these patterns.

References

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Acknowledgments

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