Hormonal Organizing Effects and Sound Change from Below

Míša Hejná
(misa.hejna@cc.au.dk)
Claire Cochrane
Lauren Ackerman
Joel Wallenberg

Research Question

If gender is not binary and is influenced by biological factors, could "gender effects" be (in part) biological effects?

Change from below the level of consciousness:

- Young women lead language change, e.g., [1,2,3]
- What are the underlying mechanisms?
  - Social cohesion for men? [e.g, 1]
  - Social capital for women? [e.g., 2]
- ***Is change from below involved in social signals?***

Why biological influence?

- Change from below sex effects carry little information about speaker sex [4]
- Prenatal hormone exposure affects gender ID [5,6,7]
  - And social behaviors [8,9], including learning [10]
  - See also Yu (2010) on AQ and speech perception [11]
- Prenatal hormone exposure and gender correlate with the ratio of index finger length to ring finger length (2D:4D ratio) [12,13]

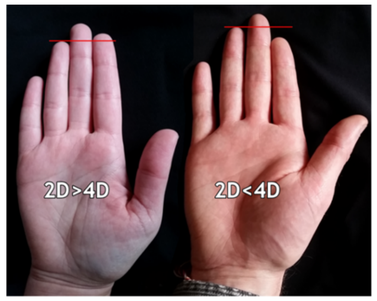
Background

Preaspiration:

- [h] between sonorants and voiceless obstruents
- Normalised as a proportion of the overall word duration
- Reported to be undergoing change in Tyneside English; alongside creak, breathiness [14]

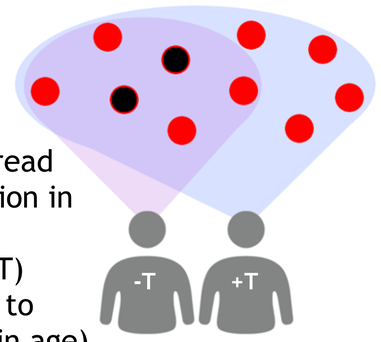
2D:4D Ratio:

- Proxy for early-life androgen exposure, validated for rats and humans [15,16]
- Right hand; measured digit length with precision calipers
- Base of digit (crease) to tip



A Biosocial Model

Is social learning affected by prenatal exposure to androgen maybe mediated by gender ID?



1. Variant appears, begins to spread
2. Acquired by sampling population in speech community
3. Less testosterone exposure (-T) leads to greater sensitivity to social models (peers close in age)
4. Differences in sampling affects target mean for variation
5. Speakers with higher testosterone exposure (+T) sample population more broadly, lag behind others

Hypothesis: Differences should show up between and *within* sex cohorts (genetic, genital, assigned-at-birth), according to gradient or continuous T exposure and gender

Experiment:

- 22 informants, aged 20–45 (AFAB; female-identified)
- Recorded interviews (one hour of speech per informant)
- Annotations done in Praat; FAVE-aligned to transcripts
- Preaspiration duration normalised to overall word duration
- Data was coded for:
  - vowel context
  - consonant context
  - foot and foot stress
  - interviewer
  - speaker age, ethnicity
  - following segment

References

[1] Labov, W. 2001. Principles of Linguistic Change. Volume 2: Social Factors. Oxford: Blackwell; [2] Eckert, P. 2011. Language and power in the preadolescent heterosexual market. American Speech 86:85-97; [3] Blaxter, T. 2015. Gender and language change in Old Norse sentential negatives. Language Variation and Change, 27:349-375; [4] Fruehwald, J. 2015. Social meaning and information theory. Presented at: The 10th UK Language Variation and Change (UKLVC), University of York; [5] Auyeung, B., S. Baron-Cohen, E. Ashwin, R. Knickmeyer, K. Taylor, G. Hackett, M. Hines. 2009. Fetal testosterone predicts sexually differentiated childhood behavior in girls and in boys. Psychological Science, 20(2):144-148; [6] Hines, M., C. Brook, G. S. Conway. 2004. Androgen and psychosexual development: Core gender identity, sexual orientation, and recalled childhood gender role behavior in women and men with congenital adrenal hyperplasia (CAH). Journal of Sex Research, 41(1):75-81; [7] Pasterski, V. L., Geffner, M. E., Brain, C., Hindmarsh, P., Brook, C., Hines, M., 2005. Prenatal hormones and postnatal socialization by parents as determinants of male-typical toy play in girls with congenital adrenal hyperplasia. Child Development 76 (1):264-278; [8] Knickmeyer, R., S. Baron-Cohen, P. Raggatt, and K. Taylor. 2005. Foetal testosterone, social relationships, and restricted interests in children. Journal of Child Psychology and Psychiatry, 46:198-210; [9] Lutchmaya, S., S. Baron-Cohen, and P. Raggatt. 2002. Foetal testosterone and eye contact in 12-month-old human infants. Infant Behavior and Development, 25:327-335; [10] Hines, M., V. Pasterski, D. Spencer, S. Neufeld, P. Patalay, P. C. Hindmarsh, I. A. Hughes, C. L. Acerini. 2016. Prenatal androgen exposure alters girls' responses to information indicating gender-appropriate behaviour. Philosophical Transactions of the Royal Society B: Biological Sciences, 371(1688):20150125; [11] Yu, A. 2010. Perceptual compensation is correlated with individuals' "autistic" traits: Implications for models of sound change. PLoS One, 5(8):e11950; [12] Berenbaum, S. A., J. M. Bailey, 2003. Effects on gender identity of prenatal androgens and genital appearance: evidence from girls with congenital adrenal hyperplasia. The Journal of Clinical Endocrinology & Metabolism, 88 (3):1102-1106; [13] Atkinson, B., T. Smulders, and J. Wallenberg. 2017. An endocrine basis for tomboy identity: The second-to-fourth digit ratio (2D:4D) in "tomboys". Psychoneuroendocrinology. 79:9-12; [14] Watt, D., and W. Allen. 2003. Tyneside English. Journal of the International Phonetic Association, 33:267-271; [15] Lutchmaya, S., S. Baron-Cohen, P. Raggatt, R. Knickmeyer, J. T. Manning. 2004. 2nd to 4th digit ratios, fetal testosterone and estradiol. Early human development, 77(1):23-28; [16] Talarovičová, A., Krsková,L., Blažeková, J., 2009. Testosterone enhancement during pregnancy influences the 2d: 4d ratio and open field motor activity of rat siblings in adulthood. Hormones and Behavior, 55(1):235-239.

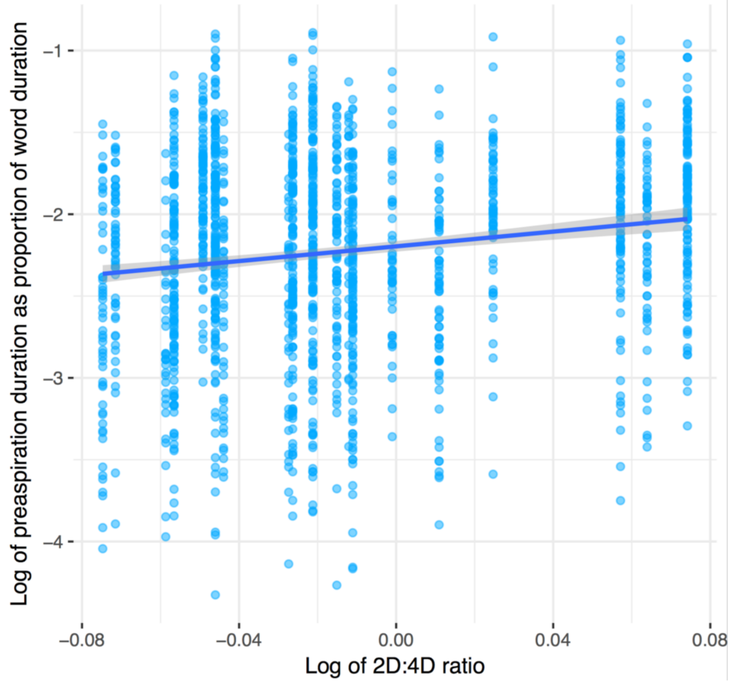
Experiment Results

Statistical analysis:

Significant main effect of normalized ln(2D:4D)
(β=16.8, SE=7.6, $\chi^2(2)$=7.5, p=0.023)

No significant effect of age
(β=-0.004, SE=0.01, $\chi^2(1)$=0.62, p>0.1)

Significant correlation between log 2D:4D ratio and log normalised preaspiration duration
(r=0.16, t=6.2, df=1543, CI 95%=0.11—0.20, p<0.0001)



Discussion:

- Preaspiration duration is correlated with 2D:4D ratio
- Main effect of 2D:4D suggests that gradient hormone exposure within a sex cohort affects production of variant
- Could no age effect indicate change is near completion?
- Is this effect from attending to younger social models more narrowly? Or is it due to the way social groups are differentially formed, mediated by biological factors?