Sex, gender, and variability of the vocal tract

Module type: Lecture material

Class: Phonetics

Purpose: Complements existing material on acoustic phonetics

Goal(s):

- Highlights the distinction between sex and gender
- Challenges the default value for the average vocal tract length
- Discuss how hormone (and hormone therapy) influence fundamental frequency

Sex is a collection of biological characteristics (such as reproductive anatomy, chromosomes, gene expression, etc.), that are usually divided up into two categories for humans: male and female. However, sexes are more complex than this simple binary division, since males and females do not always neatly separate in the space of biological properties. For example, not all members of a sex share all their biological characteristics, and in fact, can have a mixture of characteristics from different sexes, to varying degrees (someone whose sex characteristics are sufficiently mixed may be called intersex).

A related concept is gender, which is how people perceive themselves in relation to various socially constructed roles and traits often linked to sex. Gender is often assigned at birth based on sex, but the relationship between sex and gender is not universal of consistent. Someone whose gender corresponds to their assigned gender is called cisgender; for example, a woman who was assigned female at birth would be a cisgender woman. Someone whose gender does not correspond to their assigned gender is called transgender; for example, a woman who was assigned male at birth would be a transgender woman. Someone whose gender falls outside the traditional man/woman binary is often called non-binary. Note that there is some variation in terminology, and the social and political underpinnings and connotations of these terms and concepts are quite complex and often controversial, so there is necessary simplification here.

The reason sex and gender matter for our current purposes is that we have taken 17.5 cm to be a reasonable value for the human vocal track length. Though this is framed as a way to make resonant frequencies easier to calculate, it is somewhat problematic (both historically and empirically) to use this value, so extra thought and discussion is warranted. To begin with, male physiology is often treated as the default in scientific study, so using a "male" vocal tract length of L = 17.5 cm as our default perpetuates the implication that males are default (and thus "normal") and that everything else is a deviation from the default (and thus, "abnormal").

Furthermore, identifying L = 17.5 cm as a typical "male" vocal tract length (and shorter lengths as "female") treats male and female as homogenous categories and implicitly assumes that these categories are representative of men and women in general. However, not only does this collapse and ignore a significant amount of human sexual variation within these categories, but it also excludes bodies and identities that fall outside of these categories. Males and females are much more diverse than their averages, and sex and gender are much more diverse than binary distinctions.

Much of the human sexual variation at issue in determining averages relates to overgeneralizations about physiology and biology. Because formant frequencies are different for different vocal tract lengths, with lower formants in longer vocal tracts, many linguists have proposed that individuals with larger bodies, generally assumed to be men, will consequently have lower vowel formants. However, body size does not correlate perfectly with sex or gender, and formants can differ as much within these groups as between them.

Sex and gender not only have a complex relationship with vocal tract length and formant values, but also the fundamental frequency of vocal cord vibration. The rate of vibration partly depends on the mass of the vocal folds: larger vocal folds produce slower vibration, resulting in a lower F0 (and thus, a deeper voice), while smaller vocal folds produce a faster vibration, resulting in a higher F0.

Cross-sex differences in male and female F0 typically arise during puberty, when the greatly increased testosterone production that characterizes male puberty causes a lowering and lengthening of the larynx and a thickening of the vocal folds, increasing the overall mass and thus lowering F0. Hormones are therefore an important contributing factor in delimiting a speaker's F0 range. While cisgender men typically experience this lowering during puberty, transgender individuals who take testosteronebased hormone replacement therapy (HRT) will undergo a similar thickening of the vocal folds regardless of their life stage. However, while testosterone HRT thickens the vocal folds, it does not lead to any other changes to the vocal tract; an individual on testosterone will therefore experience a lowering of their F0, their resonant frequencies will not be affected. Estrogen-based HRT, on the other hand, does not lead to any physiological changes to the vocal tract. For this reason, many transgender individuals who take estrogen pursue speech therapy to train their voices to more closely align with their gender identities. They may also work to re-learn their intonation patterns, volume, speech rate, and articulation, all qualities that have their own gendered associations. Speech therapy is also an option for individuals on testosterone, due to the characteristic thickening of the vocal folds from the hormone, many such speakers choose not to pursue it.

Of increasing importance in (socio)phonetic research is the recognition of gender diversity that has not historically been acknowledged in the field until more recently. Recent accounts of the relationship between sex, gender, and the vocal tract have shown that speakers' alignment with certain gendered phonetic styles can vary across time, culture, language, and social group, which is strong evidence for the influence of sociocultural norms even where biology and physiology are clearly also at play. This may be especially true for transgender speakers. Importantly, because what is considered to be a "feminine" or a "masculine" voice varies depending on cultural norms, and it is crucial that acoustic studies also include support for the socially-grounded explanations for sex and gender differentiations in the voice.

In short, determining phonetic correlates based on averages of human physiology and sex or gender presents some challenges and does not account for substantial sexual and gender diversity. While biological factors may present some limits on the frequencies a speaker is able to produce, it is by no means fixed and may be subject to change across the lifespan.

Consult the following for more information on gender diversity and the vocal tract:[1]

Cler, Gabriel J., Victoria S. McKenna, Kimberly L. Dahl, and Cara E. Stepp. 2019 (in press). Longitudinal case study of transgender voice changes under testosterone hormone therapy. *Journal of Voice*.

Davies, Shelagh, Viktória G. Papp, and Christella Antoni. 2015. Voice and communication change for gender nonconforming individuals: Giving voice to the person inside. *International Journal of Transgenderism* 16(3). 117–159.

Murray, Katherine. 2016. "I grew up knowing how to talk female:" Transgender men's reported communicative changes in their post-transition lives. *Texas Linguistics Forum* 59. 79–89.

Zimman, Lal. 2018. Transgender voices: Insights on identity, embodiment, and the gender of the voice. *Language and Linguistics Compass* 12(8). e12284.

[1] Note that transgender speakers on estrogen and transgender speakers who do not pursue any hormone therapy at all are underrepresented in the linguistic literature. One exception is in the speech language pathology literature, where transgender women on estrogen are overrepresented.