

Variability in /s/ among transgender speakers: Evidence for a socially-grounded account of gender and sibilants

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Abstract

Sibilant consonants are well-established as resources for the negotiation of gender and sexuality, but the origin of these links is less clearly agreed upon. Some researchers have pointed to sex differentiation in the vocal anatomy as a cause for gender differences in /s/, though a review of the literature indicates that learned articulatory patterns play a critical role. This article focuses on the spectral qualities of /s/ among 15 English-speaking transgender individuals. Because their early socialization and physiological development is not normatively aligned with their self-defined gender identities, trans people are well-positioned to illuminate the relative contribution of physiology and identity on the gendered voice. Two analyses are presented, one of which focuses on inter-speaker variation among all 15 participants, and the other of which compares one bilingual speaker's productions of /s/ in English and Spanish. Together, these analyses demonstrate that sex category does not determine the gender-linked acoustic characteristics of /s/. Instead, a more complex, multidimensional framework for gender that distinguishes between gender assignment, role, identity, and presentation is necessary to account for the full range of gendered phonetic styles that speakers can employ and hence to understand the process through which gendered voices arise.

Keywords:

transgender, sociophonetics, gender, sex, identity

1. Introduction

As part of the explosion of interest in sociophonetics over the last decade or two, sibilant consonants have come to occupy an important place in the field. Numerous studies have identified /s/ as resources for the negotiation of identity along axes such as gender, sexuality, class, region, and ethnicity (e.g. Campbell-Kibler 2007 and 2011; Levon 2007; Munson 2007; Pharao et al. 2014; Stuart-Smith 2007). Although sibilants are well-established as indices of gender and gender normativity, the originating cause of this difference is less clearly agreed upon. In much of the phonetically-oriented literature on gender and /s/, physiological differences in female and male vocal anatomy are held up as likely sources of gender differentiation in this sound (e.g. Flipsen et al. 1999; Fuchs and Toda 2010). On the other hand, sociolinguistic research on variation in /s/ associated with identity point to the conclusion that articulatory habits mediate, if not trump, any sex-linked anatomical correlates that might exist. Often, these studies take language socialization as a likely source of socially-learned gender differences in the voice. However, the mutual reinforcements that exist between biology, child socialization, and the intersubjectively forged identities that adults typically express make it difficult to tease apart the contributions of each.

However, some speaker populations provide a unique perspective on these relationships because their physiology, socialization experiences, and current identity do not align in normative ways. In this study, I center one such group: transgender

speakers. The analysis presented here compares the acoustic properties of /s/ as produced by a group of 15 English-speaking transgender men and others on the transmasculine identity spectrum. *Transmasculine* is an umbrella label – i.e. a spectrum of identities – that can be said to include anyone who is assigned female at birth but who does not self-identify with that gender. This includes those who identify as men as well as those who position themselves outside of the female/male binary system all together with labels like *genderqueer* or *non-binary* (see Bershtling 2014 for more on language and genderqueer identity).

Transgender speakers can inform sociophonetic inquiry into gender in a number of ways; one particularly important contribution is toward our understanding of how biology and social practice exert influence over the gendered voice. The transmasculine individuals in this study could be categorized as members of the same sex: all were assigned female at birth, all went through their adolescent puberty in a female gender role and developed secondary sex characteristics normatively identified as female, and all began a regimen of testosterone as hormone replacement therapy upon or shortly before beginning participation in this study. Testosterone brings about marked masculinization on a number of fronts, including increased body and facial hair, changes in musculature and fat distribution, and, notably, a significant drop in vocal pitch. The fieldwork from which these data are drawn consisted of two years of ethnographic participant-observation and recording in trans communities in the San Francisco Bay Area (2010-2012). The goal of this project was to track changes in the voices of transmasculine people in the first 1-2 years of testosterone in order to capture how pitch changed during this time and how these changes relate to other elements of the gendered voice, including vowel formant frequencies and the acoustic characteristics of /s/. Despite physiological similarities, there are significant differences in how these individuals experienced their transmasculine identities. I have already pointed to one of these differences, between those who strongly identify as men and those who do not understand themselves as either female or male. Section 2 of this article provides an in-depth discussion of the framework for conceptualizing gender within many trans communities. This framework, I argue, provides a useful vocabulary for linguists to conceptualize gender as a complex, multi-dimensional aspect of social subjectivity.

A biologically deterministic account of gender differences in /s/ would predict a great deal of similarity across these transmasculine speakers based on their shared sex at birth and similar hormone-induced development in their vocal anatomy at the time of recording. A strictly socialization-based account of gender differentiation, on the other hand, might predict similarity based on the shared childhood and adolescent experiences of those assigned female at birth. However, the most striking aspect of these speakers' productions of /s/ is the tremendous variability in the acoustic output, which spans the entire range typically reported for English-speaking women and the entire range typically reported for English-speaking men. This finding undermines any attempt to identify physiology or socialization as a direct cause of gender differentiation in sibilants. Explaining the differences among these speakers depends instead on recourse to subtle distinctions in gender and sexual identity that nevertheless carry great significance to members of this community. Ultimately, speakers whose early life experiences and physiology is not normatively aligned with their self-defined gender identities help reveal

how biological predispositions and socialization experiences are always mediated by individuals' understanding and practice of their own gender identities.

The next section provides a literature review that focuses on evidence for either a social or biological basis for gender differences in /s/ based on previous research in this area. Although sex differentiation in the vocal anatomy continues to prove an enticing explanation for gender-based patterns, the body of research on gender and /s/ as a whole points to the critical importance of socially-learned articulatory habits. Section 3 contains more information about the study from which the data under discussion are drawn, the vocabulary used by members of this community to talk about gender, and a description of methods used in the acoustic analysis. This is followed by a discussion of the findings from this study, which includes two separate analyses. First, an inter-speaker comparison of the 15 participants in this study illustrates the usefulness of distinguishing between different facets of gender – including gender assignment, role, identity, and presentation – along with other aspects of identity closely linked to gender, like sexuality. Second, an intra-speaker analysis of one bilingual speaker considers the capacity of individuals to employ different articulatory strategies for sibilants. The different frequency ranges evident in this speaker's productions of /s/ in Spanish and English undermine the possibility that oral anatomy is the direct cause for gender-based differences in /s/. The conclusion of this article includes a brief discussion of the implications of this study for our theorization of embodiment and identity in sociophonetics.

2. Lit review

The phonetic characteristics of the voice include some of the most salient sociolinguistic indices of gender. Some of these are intuitively obvious to many non-linguists, such as differences in the pitch ranges used by women and men. But phoneticians have long documented less obviously gendered aspects of the voice, such as the spectral characteristics of /s/. Gender differences in this sound among English speakers have been studied at least as far back at least as far as Schwartz (1968), who tested listeners' ability to distinguish speaker gender based on isolated voiceless fricatives produced in laboratory conditions. Listeners in this study showed good accuracy on the sibilants /s/ and /ʃ/ but were not consistently successful at identifying speaker gender based on /f/ or /θ/. Their perceptions were reflected in the acoustic analysis as well, with women's productions showing greater acoustic energy in the high frequencies range of /s/. Since then, numerous studies have reached similar findings in investigations using a variety of analytic methods. One of these is the identification of acoustic peaks in the spectrum, which identifies the frequency with highest amplitude in the sample. Peak frequencies for English-speaking women have been reported in the range of approximately 5,500-9,000 Hz, while English-speaking men have been placed in the range of approximately 4,700-8,000 Hz (by Fuchs and Toda 2010; Schwartz 1968; Stuart-Smith 2007; Yeni-Komshian and Soli 1981). Another method involves calculating a weighted mean in the form of a center of gravity or centroid. Using this method, women's means appear to range from 6,400-8,500 Hz, while men's range from 4,000-7,000 Hz (Avery and Liss 1996; Fuchs and Toda 2010; Flipsen et al. 1999; Nittrouer 1995; Nittrouer et al. 1989; Stuart-Smith 2007; Tjaden and Turner 1997).

In much of the phonetically-oriented literature on gender, sexual dimorphism in the vocal tract is a first-line explanation for significant gender differences in acoustic

output, even if the same findings could be used to support a socially-grounded explanation. As many others writing about /s/ have noted, sex differences in the vocal tract are thought to exist mainly in the posterior region (particularly the pharynx), whereas the frequency profile of /s/ is determined primarily by the size of the “front cavity,” or space between the tongue constriction and the teeth (Shadle 1985, cited in 1991). Some researchers have proposed that previously undocumented sex differences may exist in the front cavity, which would provide a physiological basis for the observed gender differences in /s/. For example, Flipsen et al. (1999) report that young women and girls as young as nine tend to have a higher center of gravity compared to boys of the same age. Rather than concluding that children may learn to produce /s/ in gendered ways prior to puberty, however, the authors suggest that anatomical differences in the mouth arise earlier than previously thought, which is what causes 9 year olds to show these kinds of gender differences.

Fuchs and Toda (2010) investigate the hypothesis that sex-based anatomical traits determine the articulation of /s/ directly through an analysis of both anatomical and acoustic measurements taken from small numbers of English- and German-speaking women and men (6 in each cell). The anatomical measures ended up being less conclusive than might be hypothesized. There was no clear difference in palate length between the women and men, though the authors emphasize a non-significant trend for English-speaking men to have longer palates than their female counterparts. Despite the lack of a consistent gender difference, Fuchs and Toda do report a significant difference between the English- and German-speaking subjects. The fact that the difference between English and Germany speakers was greater than any sex or gender difference found this study calls into question the idea that biological sex, as a binary trait, is the primary driving force behind variation in /s/. Despite the lack of significant differences anatomically, there were significant differences in the acoustics of /s/ for speakers of both languages. One significant anatomical connection that did occur was between palate length and the size of the front cavity, the latter of which is known to be the primary determinant of the acoustic properties of /s/; however, in the absence of data confirming that there is a sex-based difference in palate size, it seems unwise to jump to the conclusion that this correlation is connected to gender or sex in some way. Fuchs and Toda conclude that physiology and socially learned behaviors each contribute toward the production of gender differences in /s/, though their findings could just as easily be interpreted as a lack of evidence for anatomical effects.

Of course, even if correlations do exist between anatomy and acoustics within a given population, this does not necessarily mean that the productions of any one individual is caused directly by their own anatomically constrained ability to produce a higher or lower frequency /s/. In fact, there are at least four sources of evidence that point to the conclusion that articulation can largely override anatomy with it comes to sibilants. First, we know from modeling work done by Shadle (1990) that even very small shifts in articulation can have significant effects on the acoustics of /s/ (p. 193, cited in Stuart-Smith 2007), suggesting that any individual can produce /s/ in a variety of ways that will result in different acoustic output. Second, although gender differences in /s/ are observable in multiple languages, as the other issues of this special issue demonstrate, they do not appear to be as close to universal as are differences in fundamental frequency or formant frequencies. Gordon, Barthmaier and Sands (2002), for instance, compare /s/

productions by speakers of seven disparate languages, mostly indigenous (Aleut, Apache, Chickasaw, Scottish Gaelic, Hupa, Montana Salish, and Toda) and found gender differences only among the speakers of Chickasaw. Similarly, Heffernan (2004) suggests that sibilants provide a more robust gender marker for Canadian English speakers than for speakers of Japanese. This is especially striking given reports that Japanese has more dramatic gender differentiation in pitch than does American English (e.g. Loveday 1981; Ohara 2001; Yuasa 2008), indicating that it isn't lack of attention to the gender binary that is keeping Japanese speakers from utilizing /s/ to index gender. Lest one suspect that such differences are driven by biological variation across American and Japanese speaker populations, Ohara (2001) shows that English-Japanese bilinguals treat pitch as a resource for managing their gendered identities as they shift between the languages. I will return to the issue of cross-linguistic differences among bilingual speakers when I present results from my own bilingual participant and his variable production of /s/ in Spanish and English.

Third, there is evidence like that from Flipsen et al. (1999) that children begin displaying gender differences in /s/ at a young age, despite the findings of studies like Fitch and Giedd (1999), whose imaging of children's vocal tracts indicates that significant sex differences do not appear to develop until puberty, even though gendered phonetic patterns appear before then. Finally, there is considerable variation in the gendered properties of /s/ among speakers of the "same" language or dialect. Stuart-Smith's (2007) study of Glaswegian English reveals that although adult women in Glasgow tended to produce /s/ at a higher frequency than their male counterparts, a different pattern appeared among young adolescents. Middle-class teenage girls patterned with the adult women in terms of the most prominent frequencies in /s/, but the /s/ of working-class teen girls was closer to the adult men's than to the adult women's or middle-class girls'. Given that working-class and middle-class adolescent girls are more similar to one another physiologically than to adult men, one must turn to articulatory practices to explain these findings. On the other side of the Atlantic, several studies have identified /s/ as one of the most consistent and most salient cues for the perception of sexual orientation among North American English-speaking men (Campbell-Kibler 2011; Levon 2007; Munson 2007; Munson et al. 2006; Zimman 2013, *inter alia*), which demonstrates that adult men are entirely capable of producing /s/ with a range of frequency profiles. This usually comes in the form of a more negative skew, i.e. a skew toward more amplitude in the higher frequencies even given the same center of gravity. We are reminded by this research that "women" and "men" are far from homogenous groups, and that the intersections of identities based on gender, sexuality, class, etc. produce different constellations of gender-linked linguistic features.

The matter of teasing apart biological and social influences on speech is always challenging at best. Should we heed the words of poststructuralist queer theorists like Butler (1990 and 1993), we might conclude that drawing a clear line between nature and nurture is ultimately a hopeless effort because of the ways these domains mutually reinforce one another, acting in a constant feedback loop. Though I am more than sympathetic to this view, I also submit that studying the voices of transgender people can provide special insight on the degree to which physiology constrains articulatory production. For normatively gendered cisgender (i.e. non-transgender) women and men, there is a confluence of sex, self-identified gender, and gender socialization throughout

the lifetime, which makes it particularly difficult to separate these strands of influence. For transgender people, however, the divergence between early biological development and socialization on the one hand, and identities claimed later in life in the other, can help to clarify the extent to which nuanced aspects of gender identities might override the effects of sexual development or gender assignment at birth. It is with this perspective in mind that we can now turn to some background on the study and community as well as the methods used in the acoustic analysis to follow.

3. Background and methods

3.1 Background on the study and community

This article derives from a 2 year ethnographic sociophonetic study of English-speaking transmasculine people in the San Francisco Bay Area during their first or second year on testosterone. Between 2010 and 2012, I recorded 15 trans individuals on a regular basis, leading to a body of data consisting of interviews, read speech, and more mundane interactions. Most of the speakers were in the earliest months of hormone replacement therapy when we began working together, though two were in their second year of testosterone, and all experienced a significant drop in vocal pitch as a result (documented in Zimman 2012). I was able to record 10 of these 15 participants for a full year, but five left the Bay Area before completing the full longitudinal study. At each recording session with these participants, we recorded a reading of Fairbanks' (1960) "Rainbow Passage" in order to have a simple means of tracking change in fundamental frequency and other measures without the effect of broad differences in topic, context, or affect that are typical across interactional contexts. However, each recording session also included spontaneous speech of some sort, whether in the form of an interview or semi-structured conversation (Alim 2004) with the researcher or in interaction with participants' friends, family, co-workers, etc. In addition to these recording sessions, I engaged in participant-observation within a number of speakers' varied communities of practice. This involved following participants through their daily activities, attending trans community events that often brought my participants together, and seeing the ways interpersonal relationships and institutional forces inform their negotiations of gender.

One of the most important products of ethnographic fieldwork conducted for this study was a sense of how sex, gender, and sexuality are understood by speakers and others in their communities. In the discussion below, I invoke a distinction between several dimensions of gender that are worth introducing now. Because these dimensions all align in the expected ways for normatively gendered people, gender often appears to be a unitary aspect of identity. However, an understanding of not only transgender identity but a great number of non-normative gendered identities depends on a distinction between gender assignment, gender role, gender identity, and gender presentation. These terms are in use in many transgender communities as well as gender-focused scholarship and activism, and one important conclusion to be drawn from the present study is the usefulness of this multi-dimensional system. *Gender assignment* refers to the gender category an individual is placed into at birth. Those outside of transgender communities often talk about someone's "biological sex" or describe someone as having been "born (fe)male" to reference this aspect of their identity. The notion of gender assignment, however, captures the fact that individuals are not simply born into a gender, but rather receive that gender socially through a process of assignment. It also allows us to

recognize that assignment does not arise directly from sex (e.g. an intersex person, whose body is not normatively female or male at birth, will still typically be assigned to one of those two gender roles). Conflating gender assignment with sex also suggests that sex is an unchangeable characteristic determined at birth, whereas the changes in trans people's embodiment through hormone therapy, for instance, can be quite significant. This complicates any assumption that trans men can be treated as biologically female or that trans women as biologically male.¹ When we say that someone was "born (fe)male," we naturalize their gender assignment at birth and treat trans identity not as inborn but as something one develops later in life by deviating from one's original identity.

Gender assignment is designed to determine *gender role*, a relatively nebulous concept meant to unify the social positionalities a person occupies in everyday interactions, both personal and institutional. For instance, someone who lives in a male gender role would prototypically be perceived and referred to by others as a man, access men's spaces (e.g. gendered restrooms), and have governmental, employment, educational, health-related and/or identity documents that indicate maleness. Of course, not everyone has a prototypical gender role, which can complicate any attempt to definitively name the gender role to which an individual belongs. Outside of trans communities, the transition from male to female or vice versa is frequently framed in terms of a change to biological sex, as references to someone "having a sex change operation" suggest. Yet it is the social transition from one gender role to another that my participants, and many other trans people, emphasize as having the most profound affect on their lives. Corporeal changes are important at least in part because they facilitate a social transition in a society where biological sex and social gender are expected to "match" in particular ways.

In transgender communities and the academic fields engaged with them, the phrase *gender identity* generally refers to the gender categories that people claim for themselves. If someone self-identifies as female, their gender identity is female, regardless of their biology, their social role, or their current gender expression. In addition to reflecting someone's identification as a woman or a man, there are finer shades of gender identity that are especially important in trans communities. One important category is *non-binary* gender identities, which includes people who do not identify as either strictly female or strictly male. Some who identify outside of the binary use labels like *genderqueer*, which is itself an umbrella label suggesting either an incorporation of feminine and masculine qualities, a fluidity between genders, or a rejection of both mainstream categories. Some other non-binary identities include *agender*, which refers to those who do not feel that they fit into any gender category at all; *bigender*, which is used by people who occupy both gender roles, either simultaneously or in rotation; and *gender-fluid*, which emphasizes movement between gender positionalities across time. Sticking with this degree of nuance, we can also see more complexity in the gender identities of binary-identified trans women and men. Among participants in this study, one important division was between the trans men who saw themselves as "just men," no different from cisgender men, and those who felt that "trans man" is a distinctive gender category with important differences from the

¹ See Zimman 2014 for an in-depth critique of the naturalization of biological sex.

unmarked cis male category.² A final distinction in the gender identities expressed by participants in this study can be made between the “trans men” and the “trans boys.” This distinction does not mean precisely the same thing to all who use these two terms, but the label “trans boy” was adopted by some of my participants who have a masculine gender identity but who feel uncomfortable affiliating themselves with the word “man.” For some this discomfort comes from the feeling that “man” is too oppressive a category because of the limitations it places on gender expression, while others felt that manhood is associated with the most privileged gender group and did not capture their experience with gendered power.

A final critical distinction is between gender identity and gender presentation. *Gender presentation* (also referred to as *gender expression*) highlights the semiotic manifestations of gender and the various ways that an identity like “man” can be enacted. Gender expression consists in part of visual elements like clothing choices, hairstyle, and the presence of facial hair, makeup, or other forms of gendered body modification. Bodily hexis, including gesture, gait, posture, and so on, are also semiotic resources for gender presentation. Even the body itself can be read as a part of gender expression – for instance, the display or concealment of skin, muscle mass, or fat in certain parts of the body. And, of course, one of the crucial ways that masculinity and femininity are enacted semiotically is through the voice and linguistic practice more broadly. Cultural norms lead us to expect people who look male-bodied to identify as men, and we expect people who identify as men to have or desire a masculine gender presentation. But gender identity and presentation are not necessarily aligned in normative ways. One might identify as a man but simultaneously have a feminine mode of self-presentation. Likewise, one might identify as non-binary but have a very normatively masculine style of gender presentation. Zimman (forthcoming a) discusses these categories in greater detail.

While self-identification as transmasculine suggests some affiliation with masculinity, the nature of that affiliation varies wildly among the participants in this study. In Table 1, I have roughly summarized my 15 participants’ gender identities, gender presentations, and sexual orientations, using their own words taken from interviews and other interactions. As the table indicates, several of my participants saw themselves as having quite normative enactments of masculinity – an assessment with which I and members of their immediate communities seem to agree. Adam, for instance, reports having a very masculine gender presentation his entire life. From the time he came out as a lesbian at age 19 until he started his transition at 38, he lived as a butch lesbian who also used the word “transgender” as an identifier for several years prior to the start of his transition. Adam is from suburbs north of New York City, where he grew up in an Irish and Italian family with strong ties to their local Catholic community. After years of being visibly queer, Adam told me he was somewhat disappointed that his

² This is an instance of what Bucholtz and Hall (2004) term *adequation and distinction*, and illustrate how the “same” identity is understood from different perspectives. Some trans men engage of *adequation*, or the construction of “sufficient similarity” of trans and cis men, which involves emphasizing similarities and downplaying differences; other trans men engage in *distinction*, or the construction of salient difference, of trans and cis men, which involves emphasizing differences and downplaying similarities.

masculinity is “pretty conventional,” given his classic dress style and affective reservation – a disappointment that drives Adam to maintain an strong identity as a trans man rather than simply a man. On the other hand, my participants also included individuals who had quite feminine gender presentations before their transitions, and who in some cases maintained that outward expression of femininity through their transitions. The best example here is Dave, a white, middle-class trans man originally from the San Francisco Bay Area in his early twenties whose gender identity is strictly and simply male. At the same time, Dave strongly identifies as a queer man and describes his gender presentation as “fem.” He indexes this femininity in part through his preference for tight, form-fitting clothing, often in bright colors or flamboyant prints. Dave is small in frame and stands just over five feet, but is usually perceived as male due in large part to his facial hair and low-pitched voice. Although it is low-pitched, Dave’s voice is also extremely “queeny,” as he puts it. He makes ample use of falsetto voice quality, large excursions in his pitch range that contribute to his engaging and expressive interactional style, and, as the analysis below reveals, he also has among the highest frequency productions of /s/ among the speakers in my study. Among those that fall somewhere between Adam and Dave are participants like James, who blends masculine and feminine stylistic elements as part of his genderqueer identity and expression. James is a 26 year old white, upper class, genderqueer trans boy from Massachusetts who embodies a scruffy, punk aesthetic with simple clothes adorned with hand-modifications like patches, pins and other slogans of anti-authoritarianism. But he blends this rather masculine baseline style, which is enhanced by his unshaven facial hair, with much less normatively masculine accessories like the bright green bandana he had tied around his neck when we first met, the glittery jewelry he habitually wears in his facial and ear piercings, and the variety of toenail polish colors I saw him in.

A final note about sexuality is useful for interpreting the information in Table 1. I have included information both about the identities that these speakers claim for themselves, which in this case includes *straight* and *queer*, as well as the to which gender(s) they are attracted.³ This is because gendered attractions do not necessarily determine sexuality in a predictable way in trans communities. As Table 1 shows, only normatively masculine men described themselves as straight, but the word *queer* was used to cover a wide range of attractions. While Ethan, Joe, and Mack see their attractions to women as heterosexual, Carl, Adam and Tony (as well as many who are attracted to other genders in addition to women) see their interest in women as queer either because they form relationships with queer-identified women, because of their history living as queer women, or because they disidentify with the notion of heterosexuality. Carl embodies this tension by simultaneously identifying himself as straight and queer. The remainder of these participants generally describe themselves as queer on the basis of their preference for men and/or genders outside of the binary.

Table 1: Participants’ self-described gender identities, presentations, and sexualities

Speaker	Gender identity	Gender	Sexual identity	Attracted to...
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³ Of course, these are not the full range of potential sexualities inhabited by trans people, who may also identify as gay, lesbian, bisexual, pansexual (attracted to all genders), asexual (attracted to no genders), etc.

		presentation		
Ethan	Man	Typical guy	Straight	Women
Joe	Man	Regular guy	Straight	Women
Mack	Man, trans man	Regular guy	Straight	Women
Carl	Trans man	Nerdy kid	Straight AND queer	Women
Jeff	Trans man	Sensitive, spiritual trans guy	Queer	Primarily men
Adam	Trans man	Conventionally masculine	Queer	Women
Tony	Trans man	Typical guy	Queer	Women & trans men
Kyle	Trans man	Blend of queer, outdoorsy & feminist masculinities	Queer	Primarily women, but since transition men as well
Jordan	Trans man	Masculine, androgynous, later fem	Queer	All genders
Elvis	Genderqueer, transgender, but prefers not to use gender labels	Masculine, sensitive guy	Queer	Women & men
Kam	Genderqueer, trans boy	Fem	Queer	Masculine people
James	Genderqueer, trans boy	Mixture of masculine and feminine	Queer	All genders
Pol	Genderqueer, trans boy	Dandy	Queer	A variety of genders
Dave	Man, trans man	Fem	Queer	All genders, but especially masculine people
Devin	Genderqueer, transgender, but prefers not to use gender labels	Mixture of masculine and feminine, androgynous	Queer	Primarily men

There are a few important points to take away from this section before turning to the acoustic analysis. First, people who describe themselves as transmasculine lay claim on an array of gender identities and gender expressions. Second, the layers of identity, presentation, assignment, and embodiment that transmasculine people invoke in talk about gender provide a vocabulary for understanding the multi-dimensional nature of gender, which in turn illuminates the linguistic variation described in the next section. Importantly, none these aspects of gender – assignment, role, identity, or presentation – necessarily aligns with the others in predictable ways. But this division is not unique to transmasculine people: even as trans identities bring the dislocations of gender into sharper focus, gender assignment, expression, and identity are elements of gender normative cis women’s and men’s experience as well.

A final aspect of this study worth mentioning is my decision to focus on the production of /s/ in read speech – a data source common in phonetics but less often the focus of sociolinguists. Importantly, I do not treat read speech as representative of how these speakers use their voices in other contexts. In some studies, the differences between

read speech and casual, spontaneous talk-in-interaction can be a methodological limitation, but in this case it provides a special set of insights precisely *because* of the way read speech calls attention to the act of speaking. In this way, read speech is a kind of performance in the anthropological sense, which is to say it is a genre that opens a space for reflection on social and linguistic norms both for performers and audiences (see, e.g., Bauman and Briggs 1990). For transmasculine individuals in transition, who are already acutely tuned in to the ways their bodies and voices are changing, self-conscious speech creates an opportunity for a distinctly self-conscious performance of gender. That is not to suggest that the voices my speakers use while reading is somehow more artificial than other speaking styles they (or others) might employ. Rather, what I want to emphasize is that the linguistic analysis of performance can bring its own set of insights on the ways sociolinguistic norms and practices are negotiated, resisted, valorized, or otherwise oriented to. Analysis of everyday vernacular speech can show unguarded moments in which unwanted styles or features come through, for instance, but analyzing read speech can shed light on the gendered personae my participants *want* to enact, revealing much about their linguistic goals and desires as well as their linguistic abilities.

3.2 Methods

The acoustic analysis presented below has two parts. The first is an inter-speaker comparison based on a set of 14 word-initial tokens of /s/ occurring in the Rainbow Passage. Each speaker recorded the Rainbow Passage anywhere from 2 to 13 times over the course of their participation in this study; see Table 2 for the total number of recordings and tokens analyzed for each individual.

Table 2: Number of recordings and /s/ tokens per speaker (inter-speaker analysis)

Speaker	Total no. of recordings	Total no. of tokens
Ethan	4	56
Joe	5	70
Mack	11	154
Carl	9	126
Adam	12	168
Tony	10	140
Jeff	3	42
Kyle	13	182
Jordan	2	28
Elvis	9	126
James	8	112
Pol	8	112
Kam	4	56
Dave	11	154
Devin	13	182

The second dataset, which informs an intra-speaker analysis, includes word-initial tokens of /s/ from a Spanish translation of part of the Rainbow Passage produced by a

participant I call Pol, who is a native speaker of Castilian Spanish and British English. Data from the Spanish Rainbow Passage which will be compared to his production of /s/ in the English Rainbow Passage. Because the Spanish translation's word-initial /s/ tokens all preceded either /u/ (5 tokens) or /o/ (1 token), I only included tokens of /s/ from the English passage that were also followed by back, non-low monophthongs, namely /ʌ/ (5 tokens) and [u] (1 token). Table 3 contains the total number of tokens analyzed in the English and Spanish data for the intra-speaker analysis.

Table 3: Number of recordings and tokens of /s/ in pre-back non-low vowels (intra-speaker analysis)

Language	Total no. of recordings	Total # of tokens
English	8	40 (5 per recording)
Spanish	8	48 (6 per recording)

Recordings were made on a Fostex FR-2LE Field Recorder with an Audio-Technica BP892 headset microphone, at a sampling rate of 44,000 Hz. Prior to analysis, audio files were put through a Hann pass filter to remove sound below 1,000 Hz and above 13,000 Hz, which helped eliminate background noise in some recordings while preserving the range of approximately 4,000-10,000 Hz in which the bulk of acoustic energy for /s/ occurs (Shadle 1990). A long-term average spectrum was constructed for each token of /s/, including the entire segment save any portion that contained signs of periodicity. Praat's moments analysis function was then used to calculate the four "moments" of center of gravity, standard deviation, skew, and kurtosis. Variation in center of gravity and skew have both been consistently linked to gender and sexuality, though the status of standard deviation and kurtosis is less well established. While center of gravity provides a weighted mean frequency, skew represents whether the distribution skews toward lower or higher values. A more negative skew indicates more prominence in the high frequency ranges of /s/, relative to the mean, while a positive skew indicates more prominence in the low frequency ranges. The focus of the inter-speaker analysis below is center of gravity, which provides enough complexity on its own for a full exploration of sex, gender, and sexuality as practiced within these communities. In my intra-speaker analysis I present results from all four acoustic measures.

For statistical analysis of the inter-speaker data, I relied on Praat's box plotting function, which uses procedures from Chambers (1983) to calculate which boxes have significantly different medians from one another at the 0.05 level. This is represented graphically with notches on the sides of each box, as displayed in Figure 1; boxes with overlapping notches are not significantly different. For the comparative analysis of the Pol's /s/ in Spanish and English, linear mixed effects regressions were conducted, treating each of the acoustic measures (center of gravity, standard deviation, skew, and kurtosis) as the dependent variable in a separate analysis. The repeated measures (one per acoustic variables) require a Bonferroni correction, providing a new alpha level of 0.0125. The independent fixed effects variable in these regressions was language, while the random effects variables included the segment that followed the /s/ token, the recording from which the token was extracted, and the word in which it occurred.

4. Results and discussion

4.1 Inter-speaker analysis

Taken as a whole, the most remarkable aspects of this dataset of transgender speakers is the enormous variation in their center of gravity for /s/. In Figure 1, center of gravity (or COG) is plotted for all 15 speakers, who are ordered from lowest to highest mean. As the methods section notes, the notches in this boxplot indicate which speakers' values for /s/ are significantly different from the others. If the notches of two speakers' boxes overlap (as they do for Joe and Mack, for instance), the difference is not statistically significant, but if they do not overlap (as with Joe and Ethan), there is a significant difference between them. Table 4 provides numeric means for each of these speakers' centers of gravity.

Figure 1: Center of gravity for /s/ for all speakers

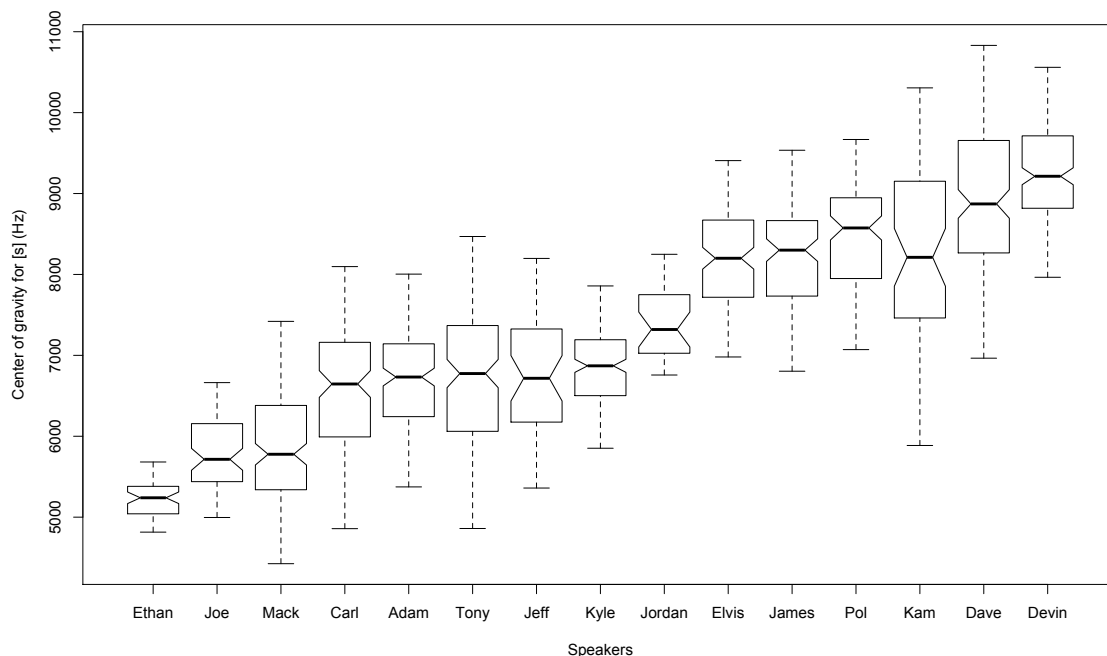


Table 4: Mean centers of gravity for /s/ for all speakers

Speaker	Total no. of tokens	Mean COG for all tokens
Ethan	56	5226 Hz
Joe	70	5788 Hz
Mack	154	5921 Hz
Carl	126	6579 Hz
Adam	168	6705 Hz
Tony	140	6727 Hz
Jeff	42	6728 Hz

Kyle	182	6819 Hz
Jordan	28	7338 Hz
Elvis	126	8128 Hz
James	112	8196 Hz
Pol	112	8264 Hz
Kam	56	8267 Hz
Dave	154	8905 Hz
Devin	182	9188 Hz
Total range	1,708	5,226 – 9,188 Hz

One potential interpretation of these data is that some speakers have been more successful than others in achieving a masculine voice. Yet this argument depends on the assumption that transmasculine people share the same stylistic target, and that this target is a strictly normative masculinity. When we consider the complicated relationships these speakers have with gender, a more compelling explanation emerges, which brings together each of the facets of gender I identified above: assignment, role, identity, and presentation.

Based on what we know about the acquisition of gendered phonetic traits during childhood, it is important to consider gender assignment here because of the time these speakers spent being seen and treated as girls and women. Assignment is a useful notion because it allows us to refrain from assuming that biological sex is responsible for any aspect of these speakers' voices that distinguishes them from cis men. While the role of biology is of some contention when it comes to /s/, it is clear that language socialization early in life does play some kind of role in producing gender differences in this sound, as the literature review above discusses. Socialization, however, is not a homogenous, unidirectional force. As researchers in socialization have emphasized (Garrett and Baquedano-López 2002; Kulick and Schieffelin 2006), socialization is a dynamic process between interactants. In other words, children play a crucial role in their own socialization process. This is particularly important to keep in mind because trans people describe very different kinds of relationships to their gender socialization early in life. Some of the transmasculine people in this study saw themselves as girls and women prior to transitioning, but others indicated that they never saw themselves as female. The latter group often describe themselves as actively resisting the femininity imposed on them in childhood, even as other trans men may talk about accepting or welcoming femininity. One interesting account of how my speakers see their gender assignment and socialization as impacting their voices came from Devin, a 24 year old white middle-class non-binary-identified queer person from the Bay Area who prefers not to use identity labels to describe his gender. Devin told me during one of our early meetings that he remembers thinking, as a child, that his voice was not feminine enough and that he should work harder sound like other girls. Devin made reference to this aspect of his socialization while he was giving an account of his own voice. Despite having the most dramatic drop in pitch of any of my speakers (from an average of 169 Hz to 113 Hz over the course of a year), Devin told me that a friend had described him as sounding "like a woman with a deep voice." This was an evaluation that wasn't a problem for Devin, though it would have been for many of the male-identified speakers in this study. This kind of commentary makes it clear that socialization does not end in childhood. To the

contrary, the evaluation and sanction of gender presentation continues throughout the lifetime and is often delivered in a particularly blunt manner for trans people in transition. Trans people do not simply receive socialization in childhood and then act out that socialization throughout the rest of their lives; instead, ongoing socialization experiences continue to shape and reshape speakers' relationships with their voices and other aspects of gender expression. Childhood language socialization, then, can help to explain why many – but not all – of the speakers in this study have centers of gravity within the ranges typically reported for English-speaking women. However, the force of socialization cannot explain all of the variation represented in Figure 1. Indeed, if socialization always “worked” the way it is supposed to, we would not see the kind of gender diversity we find among individuals who have had similar socialization experiences. However, we can turn to the other dimensions of gender, along with sexuality, to fill in the gaps.

For speakers like Ethan, Joe, and Mack – who have the three lowest means for center of gravity – the fact that they are the only participants to identify as straight men is undoubtedly significant. These three men – who are all white, between age 40 and 56, and come from working class families – enact fairly conventional forms of masculinity and are very comfortable being identified as men. With mean centers of gravity below 6,000 Hz, they are within the norms for men's center of gravity based on the range I cited above (approximately 4,000-7,000 Hz).

The next group of speakers, whose centers of gravity fall into the range where men's and women's productions have been reported to overlap (6,400-7,000 Hz), can be distinguished in terms of gender identity and sexuality as well. While Ethan, Joe, and Mack self-identify as straight men, the speakers in the middle group – Carl, Adam, Tony, Jeff, Kyle, and, separately, Jordan⁴ – identify as queer and prefer to be classified as specifically trans men. For Jeff, the label *queer* refers to his primary attraction to men, but for the others it is a label that they apply to their relationships with women. Most of these queer trans men have relatively conventional gender presentations, as well, compared to some of the speakers I will discuss momentarily. Kyle, however, enjoys blending markers of queer masculinity (e.g. he says likes to “get cute” with his female partner before they go to a club, referencing his makeup and dancing gear) with his outdoorsy and increasingly athletic lifestyle. In fact, trans men like Kyle who prize their affiliation with queer and distinctively transmasculine identities often expressed concern that they would be mistaken for straight non-trans men, and /s/ can be seen as a potential resource for distinguishing these speakers from straight men like Mack, Joe, and Ethan.

The speakers who do not identify as men and instead use labels like *boy* and *genderqueer* – or avoid labels all together – all have significantly higher centers of gravity than the other two groups I have just described. This includes Elvis, James, Pol, Kam, and Devin. In fact, several of these speakers' mean center of gravity is beyond even the upper end of the range generally reported for English-speaking women (8,500 Hz). All of these individuals distance themselves from hegemonic masculinity in a variety of ways, linguistic and otherwise. This is evident in their non-normative gender expressions

⁴ Interestingly, Jordan's productions of /s/ put him between the group of queer trans men and the group of non-binary-identified individuals that includes Elvis, James, Pol, Kam, and Devin. This neatly reflects the fact that I was only able to record Jordan twice, at the very start of his transition, during a time that he said he was gradually shifting away from a genderqueer identity and toward identification as a trans man.

which they describe with words like *dandy*, *queer*, and *androgynous*, and which involve the incorporation of markedly feminine signs like Elvis' turquoise rings, James' sparkly body piercing jewelry, or Kam's lack of interest in binding (i.e. flattening) his chest.

This leaves Dave, who again provides the clearest demonstration that gender identity and gender presentation are distinct for members of this community. Dave does not identify as genderqueer but instead refers to himself as a man, full stop, who happens to be queer and have a fem gender presentation. His voice is among the most salient means that he uses to constitute his flamboyantly non-normative take on masculinity, for which he mentions Oscar Wilde as a role-model. In this case, Dave's status as having the second highest mean center of gravity among these speakers reflects his gender presentation rather than his gender identity.

4.2 Intra-speaker analysis

The intra-speaker comparison that fleshes out this discussion was motivated by the observation that one speaker, Pol, produces /s/ very differently in his two native languages: Castilian Spanish as spoken in his Barcelona and the British English of his Cornwall, England-born mother. As of the beginning of his participation in this study, Pol was a 23 year old college student from a working-class family who identifies as queer and genderqueer. Despite a fairly prototypical history with gender for a transmasculine person, which includes a life-long history of masculine gender expression, Pol rejects that narrative and instead situates himself outside of the gender binary and describes himself as a trans boy rather than a trans man. His primary goal in pursuing hormone replacement therapy and chest surgery was to move his embodiment to a more ambiguous place rather than to occupy an unambiguously male body. Though clearly masculine in presentation, Pol is also soft-spoken, gentle, kind, and on occasion describes himself as a *tenderqueer* – a semi-tongue in cheek term used in some genderqueer communities to indicate a sensitive disposition. His dapper sense of style and English accent also set him apart from hegemonic gender norms for American men.

In Spanish, Pol employs a distinctively Iberian low frequency /s/ that has been characterized by phoneticians as apical rather than laminal (Martínez-Celdrán et al. 2003) and/or retracted (Ladefoged and Maddieson 1996). In English, as the inter-speaker analysis above indicates, Pol has a relatively high frequency /s/, with a mean center of gravity of 8,264 Hz across his dataset. Although the cross-linguistic analysis includes only tokens of /s/ that precede back vowels, Pol's mean COG in this subset of data is only slightly lower than the full dataset at 8,112 Hz. In Spanish, however, Pol's center of gravity was much lower, with a mean of 4,846 Hz. Figures 2 and 3 show spectra from a token from each language, selected to be as similar as possible in phonemic environment. These spectral slices plot frequency against amplitude such that the most prominent frequencies are represented as peaks. Figure 2 comes from word-initial /s/ in *superimposition* from the English passage. This token has a center of gravity of 6,191 Hz – lower than Pol's average no doubt because of coarticulation with the following high back vowel. The peak frequency, taken at the highest amplitude peak, is 4,593 Hz. Figure 3 represents the first segment in the phonologically similar word *suspendidas* ('suspended'), which has a center of gravity of 4,697 Hz and a peak frequency of 3,411 Hz. Peak frequency is indicated with an arrow in each spectrum. The Spanish token is

also more positively skewed than the English one because of its relatively lower amplitude in the range of 6,000-7,000 Hz (1.255 for Spanish vs. 0.903 for English).

Figure 2: Spectrum for English /s/ in the word superimposition

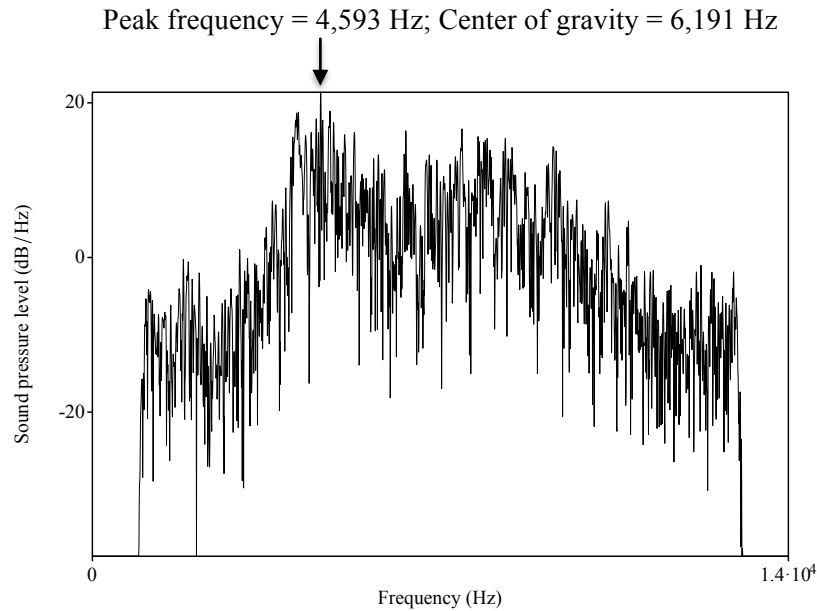
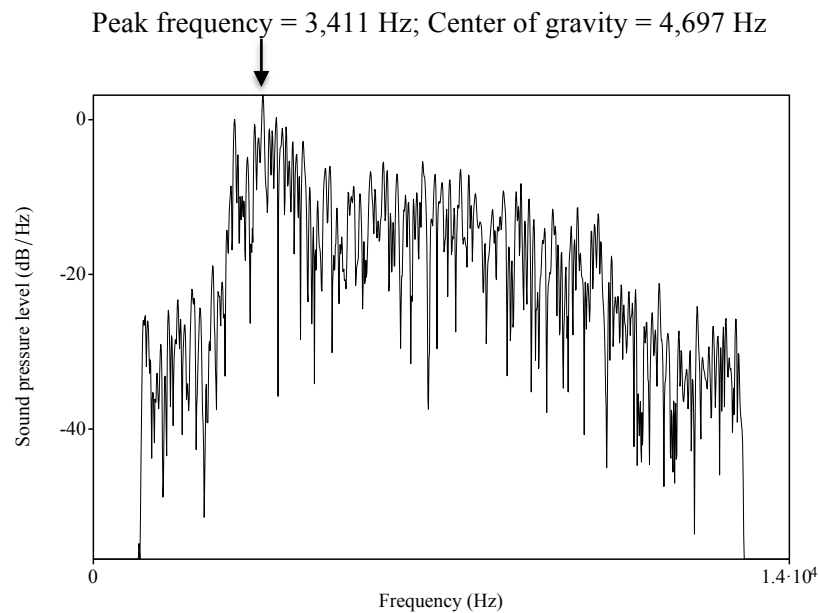


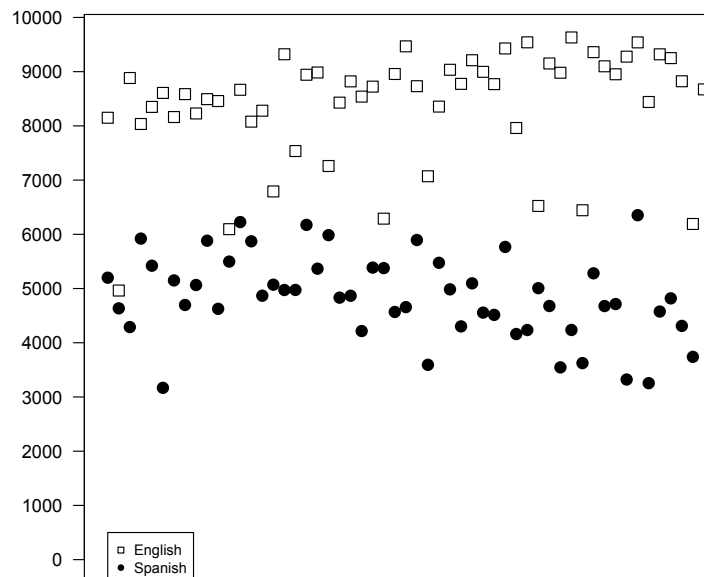
Figure 3: Spectrum for Spanish /s/ in the word suspendidas



The difference exemplified in Figures 2 and 3 are also reflected in the linear mixed effects regressions conducted on these data. Four regressions were carried out, one for each of the acoustic measures (center of gravity, standard deviation, skew, and

kurtosis). However, only center of gravity proved to have a statistically significant difference across the two languages. Pol produced /s/ with a significantly lower center of gravity when speaking Spanish ($B = -1556, p < 0.000$); there was also a trend toward more positively skewed distributions of energy in /s/ in Spanish, but it did not reach significance ($B = 0.6353, p = 0.099$), even without the adjusted alpha of 0.0125. Figure 4 provides a scatterplot for these data, in which English is represented by empty squares and Spanish by filled circles. Clearly, there is very little overlap in center of gravity between these sets of measurements.

Figure 4: Scatterplot of English and Spanish tokens of /s/



The difference in center of gravity across Pol's read speech in Spanish and English could be explained in a few different ways. It could be that the difference is essentially language-based, and that any speaker of Castilian and English would display comparable differences in their articulation of /s/. Perhaps it is the case that, Pol produces a high-frequency /s/ relative to other English speakers when he is speaking English and a high-frequency /s/ relative to other Castilian Spanish speakers when he is speaking English. Another possibility is that Pol's high frequency /s/ in English reflects his particular history of acquisition, in which his mother was a primary interlocutor for many of his English-based interactions during childhood. While Pol had access to a full range of Spanish sociolinguistic variation in his childhood, adolescence, and early adulthood in Spain, his options for face-to-face interactions with native English-speaking models were more narrow in gender until he moved to San Francisco in his early 20's. In this case, it may be that Pol occupies a more typically masculine frequency range for /s/ when speaking Spanish, which would reflect his long history of masculine gender presentation and affiliation with trans and gender non-conforming communities in Spain. Of course, to

test either of these hypotheses, we would need to compare Pol's productions of /s/ with those of other Castilian Spanish speakers.

Whatever the precise cause(s) for the difference between Pol's /s/ in Spanish and in English, he is clearly physiologically capable of producing this sound with a much lower center of gravity than he typically does while reading in English. It is also clear that this difference is articulatory in nature, and cannot reflect a biophysically pre-determined frequency range for sibilants. Far from being limited to Castilian Spanish, a low frequency or retracted /s/ has also been documented in certain varieties of English, often with some kind of link to masculinity and/or working-classness (Campbell-Kibler 2011; Stuart-Smith 2007). Given that COG for many of the Spanish tokens in Figure 4 are in the range of 4,000-6,000 Hz, this kind of /s/ may not even be perceived as retracted, particularly when paired with a low-pitched voice (Strand 1999). There is nothing about Pol's vocal anatomy that prevents him from using a lower frequency /s/ in English. Instead, this divergence of /s/ across his languages is a matter of learned articulatory habit informed by both early socialization experiences as well as subsequent developments in identity throughout the lifespan.

5. Conclusions

Thanks to the most basic academic contributions of feminist scholarship, many linguists are by now well practiced at distinguishing between sex, as a biological quality, and gender, as a set of social practices. This division, however, has the effect of naturalizing gendered embodiment as an unchanging product of naturally asocial forces while reducing gender's numerous facets to a single dimension of femininity versus masculinity. By focusing on the voices of transgender people, this analysis illustrates the importance of taking a more complex, multi-dimensional approach to gender. The language we use to talk about this aspect of sociality must be complicated to recognize distinctions between gender assignment, role, identity, and presentation, in addition to sex and sexuality. The variety of gendered phonetic styles employed by the trans people in this study underscore the myriad of ways these aspects of gender can align with one another, each one with its own importance for explaining gendered linguistic practice.

Although sex has an unavoidable role to play in the production of gender differences in the voice, we need a more sophisticated way to approach the relationship between embodiment and speech. Even if there are broad correlations between anatomical measures and the production of /s/ within a large population of women and men, we must be careful not to assume that these anatomical characteristics are the direct cause of gender differences that we observe in individual voices. The variability in one bilingual speaker's productions of /s/ provides simple yet compelling evidence that oral anatomy does not directly determine how high- or low-frequency a speaker's center of gravity for /s/ will be. The same speaker has the physical capacity to articulate a sound like /s/ in a great many ways, and these articulatory differences appear to have significant acoustic results. While second-wave feminist thought might prompt us to turn to gender socialization as an alternative cause for the patterns we find in more normatively gendered populations, socialization always works in concert with (or against) the individual's developing social subjectivity. This dynamic interplay between self and other demands a consideration not just of biology, gender assignment, or gender role, but

also the gender identities that individuals' claim for themselves and the semiotic expression of those identities in everyday life.

This degree of complexity in these distinctions may seem unnecessary for those of us who work with cisgender speakers – or, more often than not, speakers who we *assume* to be cisgender. Undoubtedly, transgender speakers provide a perfect opportunity for teasing apart social and biological influences on the gendered voice; however, there are clear applications of this model of gender that can enrich our understanding of cisgender voices as well. For example, Zimman (2013) discusses the importance of considering gender presentation, and not just sexual orientation, in sociophonetic theorizations of perceived sexuality among men. Gender expression is a concept that can help us understand the everyday production of gender through both linguistic and extra-linguistic means. Whatever our community of study, if we hope to account for the full range of voices that speakers produce we need to recognize the limitations of a unitary gender binary and move instead toward a multi-dimensional approach.

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