Chapter 4
An Inclusive Approach to Phonetics and Phonology

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Abstract. In this chapter, we provide detailed discussions of three specific content areas in which phonetics and phonology can be taught in more inclusive ways: (i) a broader introduction to transcription beyond the language of instruction, (ii) considerations of body diversity for acoustics, and (iii) diversity of modality. To support instructors in adapting these ideas to their own courses, we also provide sample course materials on these topics that can easily be adapted by other instructors for their own courses.

1 Introduction

A common refrain in linguistics is that "all languages and dialects are equally valid" (Anderson et al. 2022: Chapter 1.2). To truly model this principle for our students in a concrete way, this should be more than just a statement about what language varieties are valid objects for linguistic inquiry. It should also inform and shape our teaching practices, so that we bring a more inclusive approach to the linguistics classroom and avoid replicating and reinforcing the very biases that we claim to denounce (see related discussion in Charity Hudley et al. 2024a, 2024b and throughout this volume).

The subfields of phonetics and phonology have inherent connections to the physical world, so they face distinct challenges to inclusive teaching, but these challenges also provide interesting insights and pedagogical opportunities that can also be valuable in other fields. Previous work on inclusive teaching in phonetics and phonology include Wells-Jensen 2005, Lillehaugen et al. 2014, Zuraw 2022, Garellek et al. 2023, Aonuki and Hall 2024, McGarrity and Yip 2024, and Sanders et al. 2024, all of which include ideas that are also applicable more broadly in linguistics. In this chapter, we discuss three specific content areas in which phonetics and phonology can be taught in more inclusive ways. We support this discussion by providing sample course materials that can be easily integrated into relevant courses, allowing instructors to make their teaching more inclusive without having to do a significant amount of additional background research and course development of their own. This is an important equity issue for many faculty, who are early career and/or in precarious (non-tenurable or non-renewable) positions, and thus, may be more likely to have less choice in what courses they teach, to have to teach content they are less familiar with, and to have less experience in course design.

In Section 2, we discuss transcription in the context of beginning discussions of phonetics and phonology, where there is often a primary or even exclusive focus on the language of instruction. In Section 3, we discuss body diversity in the context of acoustic phonetics, where physical values for cisgender men are often used as unquestioned defaults. In Section 4, we discuss diversity of modality in the context of both phonetics and phonology, where the vocal-auditory modality of spoken languages is often the only modality given any significant discussion. We conclude in Section 5 with a summary of the chapter and brief discussion of other issues to consider for creating a more inclusive learning environment in phonetics and phonology courses.

2 Introductory transcription and the language of instruction

Many linguistics textbooks and instructors ground early discussions of language patterns, formal notation, and analytical tools in properties of the language of instruction (LOI). For example, if the LOI is a standardized variety of English, the first discussions of phonetic transcription of spoken languages often begin by teaching a subset of symbols from the International Phonetic Alphabet (IPA) to allow students to transcribe the most notable allophones for the phonemes of one major English dialect, or maybe a few, before there is any significant discussion of speech sounds from other languages (see, for example, popular textbooks like Rogers 2000, Odden 2013, Ladefoged and Johnson 2015, Fromkin et al. 2018, O'Grady and Archibald 2019, and Dawson and Hernandez 2022, which all begin their respective units on transcription with significant discussion focused on English; some, like Zsiga 2024, explicitly caution against viewing unfamiliar phones as "exotic").

In this section, we explore some of the benefits (§2.1) and drawbacks (§2.2) of beginning with the LOI as the object of study when teaching linguistics, with a focus on transcription. Then we describe an alternative approach that is more inclusive of languages beyond the LOI from the beginning (§2.3). Finally, we explore the benefits of this more inclusive approach (§2.4).

2.1 Benefits of an initial focus on the LOI

To satisfy ordinary university admissions requirements, undergraduate students are typically expected to be sufficiently fluent in some variety of the LOI, so instructors can reasonably use linguistic patterns from the LOI as concrete entry points to topics in linguistics. This may help students better understand more advanced and abstract concepts later in the course, since they can relate them back to more familiar properties and analyses of the LOI they learned about earlier. This concept was noted in phonetics more than century ago by Soames (1891: 2), who justifies beginning with English before moving on to French and German "because we ought to proceed from the known to the unknown […] and when the principles of

phonetics have once been taught and illustrated in our own language, this need not be repeated" (see also Chou and Shu 2015 and Biggs et al. 2022 for general pedagogical discussion of building upon and analogizing from the familiar to support student learning of the unfamiliar).

In addition, much of our linguistic knowledge is implicit and beyond our conscious awareness (Bialystok 1978, Krashen 1981, Ellis 2006), so it is a valuable pedagogical exercise for introductory linguistics students to analyze their own language and discover first-hand how much of their linguistic knowledge is unconscious. This can be an effective way to demonstrate why linguistics is worth studying, by highlighting the need for specialized training and methods to help reveal implicit linguistic knowledge. This is beneficial for student learning, since having a better understanding of the practical benefits of the course content can be an important motivating factor for increasing student engagement and success in the course (Johansen et al. 2023).

2.2 Drawbacks to an initial focus on the LOI

By the very nature of university education, the LOI is often a standardized variety of a socially powerful spoken language. Giving further priority to the LOI as the primary or sole object of study has the effect of reinforcing its existing social power, as well as the various ideologies that come along with that power. Students in general already tend to struggle if the LOI is not one of their first languages (Jain 2017, Bernhofer and Tonin 2022) or if they use a stigmatized variety of the LOI (Eades 2013, Dunstan and Jaeger 2015). This effect may be further pronounced for Indigenous students in a classroom where the languages, cultures, and knowledge systems of their colonizers are given prominence (Cummins 1989, Ogbu 1992, Wright and Taylor 1995). Positioning the LOI as the primary object of study, and not just using the LOI as the metalanguage used for classroom discussion, may exacerbate these effects.

Prioritizing the LOI also runs the risk of inadvertently implying that it is representative of crosslinguistic defaults or generalizations, more worthy of scientific attention than other languages, or special in some other way (easier, simpler, more logical, etc.) (see related concerns about disproportionate focus on culturally dominant languages and social groups in research in linguistics and in other fields: Cutler 1985, Henrich et al. 2010, Medin et al. 2017, Rad et al. 2018, Blasi et al. 2022, Bjorndahl et al. 2024, Berghoff and Bylund 2025, *inter alia*). A delay in teaching non-LOI speech sounds could thus give students a distorted view of linguistic typology (e.g. a belief that those speech sounds are inherently unusual, difficult, or less interesting in a broader crosslinguistic sense), building upon and reinforcing the language ideologies and linguistic prejudices they might carry over from society at large. For example, it is common for English speakers to perceive German and certain other languages that have the voiceless velar fricative [x] or

3

other dorsal obstruents as "harsh" (Kaplan 2016), and this could accidentally be reinforced in a linguistics classroom with English as the LOI if [x], [ɣ], [χ], etc. are not discussed until after the speech sounds of English have been covered.

2.3 Including more than the LOI at the beginning

A more inclusive approach would be to continue covering the speech sounds of the LOI in the beginning (to retain the pedagogical benefits of early grounding in familiar linguistic patterns), but to do so by blending the LOI with a selection of other common speech sounds from the outset, so that different speech sounds are treated with equal status regardless of whether they exist in the LOI or not. So, in an English-speaking classroom, an inclusive approach would include the symbols needed for broad transcription of many dialects of English (not just the standardized variety used as the LOI) as well as for some of the more common non-English speech sounds, such as those with relatively high frequencies in PHOIBLE (Moran and McCloy 2019): [ɲ], [x], [ɣ], [ɨ], etc.

This will increase the amount of early material that must be learned in comparison to looking only at the LOI, so it must be done strategically, such as including symbols for speech sounds that fill out natural classes with those in the LOI. For example, for English, including [x] would be more effective than including [ħ], since [x] helps fill out the natural class of velars with [k], [g], and [ŋ], while there are no other pharyngeals in English for [ħ] to be grouped with. If the resulting set of speech sounds is too large to cover all at once, it should be split up by phonetic considerations (such as obstruents before sonorants) rather than by social considerations (such as LOI before non-LOI).

The IPA charts in Figures 4.1 and 4.2 represent sample sets of vowels and consonants that could be reasonably used as introductory starting points in phonetics and phonology in contexts where English is the LOI.
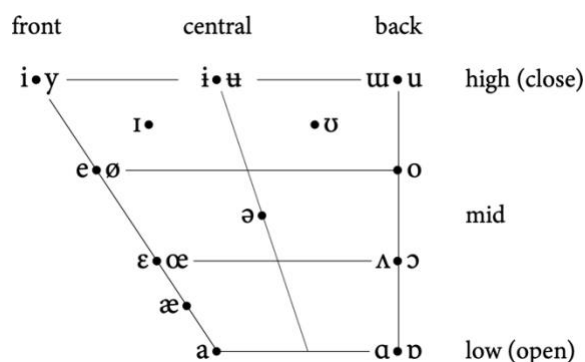

Figure 4.1. Sample inclusive set of introductory IPA symbols for vowels, with English as the LOI.

		places of articulation									
		bilabial	labiodental	(inter)dental	alveolar	postalveolar	retroflex	palatal	velar	labial-velar	glottal
manners of articulation	plosive	p b			t d				k ɡ		ʔ
	nasal stop	m			n			ɲ	ŋ		
	fricative		f v	θ ð	s z	ʃ ʒ			x ɣ		h
	affricate				t͡s d͡z	t͡ʃ d͡ʒ					
	flap (tap)				ɾ		ɽ				
	trill				r						
	lateral approximant				l						
	central approximant				ɹ		ɻ	j		w	

Figure 4.2. Sample inclusive set of introductory IPA symbols for consonants, with English as the LOI.

These charts include a sufficient number of IPA symbols to transcribe many varieties of English, as well as a few additional symbols with high frequencies in PHOIBLE that fill out existing natural classes in English, while still being feasible for students to learn in a short period of time. In each set, there are only a few additional non-English symbols that students would need to learn, but more could be added, depending on the instructor's goals and the pace of the course. To further help shift focus away from the LOI, these kinds of charts could be presented to the students as charts of "some common and useful IPA symbols", without explicitly naming the LOI (i.e. do not use "IPA symbols for English and other languages").

Of course, any such inclusive set would need to be adapted to the specific classroom context. For a dedicated phonetics or phonology course, larger sets could be used than for a general introductory linguistics course, where transcription may only be relevant for a few weeks. For some LOIs, certain symbols used in Figures 4.1 and 4.2 could be removed to create a set that is more appropriate for the LOI. For example, the variation in pronunciation of the rhotic across English dialects would not normally need to be covered in the early stages of a non-English classroom, so many of the symbols for rhotics in Figure 4.2 could be removed if the LOI is not English. Alternatively, for some LOIs, certain symbols not used in Figures 4.1 and 4.2 could be added. For example, the voiceless alveolar lateral fricative [ɬ] is not found in standardized Mandarin or Cantonese, but it is found in some other Chinese varieties and is perceived as "harsh" (Leung 2010). So, in the

same way that [x] and [ɣ] are used in Figure 4.2 to help combat this kind of phonesthetic-based language ideology for dorsal obstruents, it would make sense for a similar inclusive set of consonant symbols to use [ɬ] when Mandarin or Cantonese is the LOI.

Crucially, for all of the speech sounds in whatever introductory set of symbols is used, examples should be given both from the LOI (when possible) and from other languages, in parallel, without exoticization. For example, when discussing affricates in a context where English is the LOI, the alveolar affricates in Chamorro *lachi* [ˈlat͡si] 'wrong' and *guaiya* [ˈgwaj͡d͡za] 'love' (Chung 2020) and the postalveolar affricates in English *latch* [læt͡ʃ] and *gauge* [ge͡d͡ʒ] could be discussed together and compared to each other, rather than waiting to discuss the alveolar affricates weeks after the postalveolar affricates.

2.4 Benefits of including more than the LOI at the beginning

This method of using a more inclusive introductory set of symbols for transcription provides multiple additional benefits beyond just helping to combat harmful language ideologies and heading off unintended implications about crosslinguistic defaults. First, having a larger introductory set of symbols to draw from also gives the instructor access to a wider variety of speech sounds beyond the LOI to use in early assignments and activities, which allows for more flexibility in assessing students' skills in transcription, natural class identification, articulatory description, and other relevant skills.

Requiring all students to learn symbols for different varieties of the LOI and for some non-LOI languages also addresses an equity issue. Students who are highly fluent in a standardized form of the LOI will naturally have an advantage over other students in certain tasks related to identifying speech sounds from the LOI, especially those that are contrastive in the LOI but not in some other languages or in some varieties of the LOI. For example, a common task in phonetics and phonology courses is to transcribe words or pseudo-words as pronounced by the instructor or sometimes as written in orthography, along the lines of "transcribe the made-up word [kɛf]" or "transcribe the English word *bet*". Since [e] and [ɛ] are contrastive in English but not in Spanish (or many other languages), students whose first language is Spanish may have more difficulty recognizing when to use [e] versus [ɛ] in comparison to students whose first language is English. This means there could be a gap in student performance that is based in part on their incoming degree of fluency in the LOI rather than on what they have actually learned in the course. This gap can be minimized by going beyond the standardized form of the LOI, so that all students have to develop the skills to recognize at least some less familiar speech sounds and contrasts.

Early access to non-LOI speech sounds also provides an opportunity to increase student engagement by asking for pronunciations and sample words from

non-LOI languages that they are fluent in when non-LOI symbols are discussed. Increased engagement leads to greater success (Appleton et al. 2008), and this particular method empowers them as experts (cf. Denham 2020), which can lead to increased self-confidence and many other positive benefits for students (González et al. 2005, Bucholtz et al. 2014, D'warte 2016). It also reinforces a central tenet of linguistics that language users, not linguists, are the ones who truly hold crucial knowledge about a language (Samarin 1967).

Furthermore, even if students are not asked (or willing) to act as language experts during class time, students still often report being excited about having their languages spotlighted in the classroom and on assignments. By capturing their enthusiasm right from the beginning of the course, this can increase their engagement throughout the course. Spotlighting non-LOI languages can be especially meaningful for students who use minoritized or stigmatized language varieties, since these students are often also socially marginalized in other ways and face linguistic discrimination as a more institutionally authorized proxy for racism and other forms of discrimination (Lippi-Green 2012, Flores and Rosa 2015, Baugh 2018, Baker-Bell 2020, Craft et al. 2020, Drożdżowicza and Peled 2024). Positively spotlighting such languages very early in a course can be validating for a student's linguistic background, which can provide many psychological and academic benefits.

3 Body diversity and the acoustics of the vocal tract

In this section, we describe how male bodies are often used as a default in phonetics, especially with respect to the vocal tract (§3.1). We then explore the drawbacks of using male bodies as defaults in phonetics and in science more generally (§3.2) and how any sex and/or gender default is problematic in its erasure of body diversity, especially with respect to transgender people (§3.3). Finally, we describe an alternative approach to teaching about the vocal tract that is more inclusive of broader diversity in human bodies (§3.4).

Terminological notes: In this discussion, we use *sex* to refer to a physiological classification usually connected to chromosomes, reproductive anatomy, and other biological attributes. Sex is typically assigned at birth based on external physical characteristics, with female and male being the two most commonly assigned sex categories. We use *gender* to refer to a sociocultural identity based on a person's relationship (or lack thereof) to the conventionalized social roles and behaviours culturally associated with sex, with woman and man being the two adult gender categories that are normatively aligned with the sex categories female and male, respectively. We use *cis(gender)* to refer to people whose gender is normatively aligned with their assigned sex at birth, and *trans(gender)* to refer to people who are not cisgender. This includes many non-binary people, whose gender falls outside the woman/man binary. Sex and gender

7

are very complex, so there is understandable variation in how the terms used here are defined by different people, especially for individuals (Gray 2023), so some necessary simplification has been used here for expository purposes, and our definitions are not intended to be taken as a complete and definitive account of sex and gender.

3.1 A male default for vocal tract length

Phonetics is often taught using simplified tube models of the vocal tract to estimate certain acoustic properties of speech sounds (as in Ladefoged 1996, Johnson 2012, and Ladefoged and Johnson 2015). The resonant frequencies of these tube models are particularly useful for estimating the expected centre frequencies of vowel formants, because resonant frequencies are easy to calculate with relatively simple formulas that typically rely only on a tube's length and general shape. More complicated models are possible (as in Fant 1960), but in a typical phonetics course, especially at the introductory level, crude approximations are sufficient, so certain aspects of tube shape can be ignored, such as bends, minor variations in cross-sectional area, and the relatively small glottal opening.

For example, a uniform cylindrical tube with an overall tube length of L, a full opening at the lips, and a full closure at the glottis (as in the bottom left of Figure 4.3) is often used to model the configuration of the vocal tract during the articulation of a mid central unrounded vowel [ə] (as depicted by the midsagittal diagram on the right in Figure 4.3).
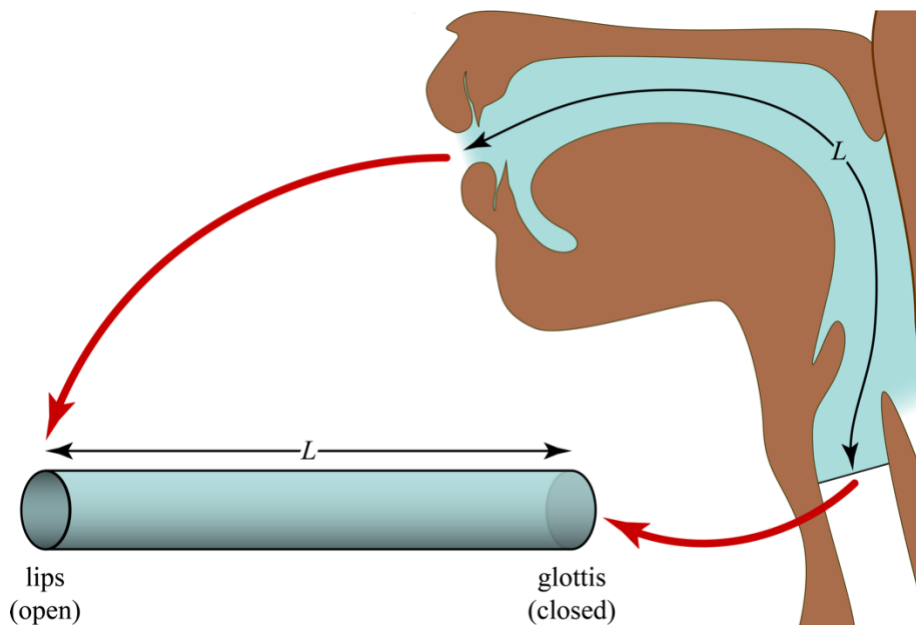

Figure 4.3. Tube model of the vocal tract for the articulation of [ə].

8

A tube with this shape has resonant frequencies R_n given by the formula in (1), in which n is the rank order of the resonant frequency ($n = 1$ for the lowest resonant frequency, $n = 2$ for the next lowest, etc.), s is the speed of sound through the air inside the tube, and L is the length of the tube.

(1) $R_n = \frac{(2n-1)s}{4L}$ ($n = 1, 2, 3, \ldots$)

The speed of sound through the warm humid air inside the mouth is approximately 35,000 cm/s, and a commonly used value for L is 17.5 cm, which is a possible length for an adult human vocal tract (and is more typical of male bodies than female bodies) that also conveniently divides evenly into 35, making the arithmetic for (1) easy for students to do without a calculator. Substituting these values of s and L into (1) yields $R_1 = 500$ Hz, $R_2 = 1500$ Hz, and $R_3 = 2500$ Hz as the first three resonant frequencies for the tube model for [ə] in Figure 4.3, and these are in fact reasonable values for the centre frequencies of the formants for [ə] for speakers with vocal tracts about 17.5 cm long. Analogous results can be obtained for different tube models for many other speech sounds, so the overall simplicity of these models and their corresponding calculations can help students understand the relationship between articulation and acoustics.

However, a vocal tract length of 17.5 cm is often treated by textbooks and instructors as a general default rather than just a mathematical convenience. For example, Howard and Angus 2017 and Behrman 2023 both use 17.5 cm as a default value for L, but with $s = 34{,}400$ cm/s and $s = 34{,}000$ cm/s, respectively, so there is no gain in arithmetic simplicity. The default status of 17.5 cm for vocal tract length may only be implied, but 17.5 cm is often explicitly claimed to be a "typical" (Gobl and Ní Chasaide 2010: 380) or "average" (Behrman 2023: 231) adult male vocal tract length, if gender, sex, or age are even mentioned. However, the true average is a bit shorter (Ladefoged 1996), around 16–17 cm (Fitch and Giedd 1999, Groll et al. 2020). Aside from its inaccuracy, the use of 17.5 cm as a default is problematic in other ways.

3.2 Problems with men and male bodies as the default

Even if 17.5 cm were the actual average vocal tract length for male bodies, we should avoid using a male default as the primary default. There is already widespread sex and gender bias in scientific research on humans (and a similar bias with sex in other animals), with cis men and male bodies overwhelmingly being the primary or sole objects of study, partly reflecting a larger bias among the scientific community itself in terms of representation, funding, institutional practices, citation, retention, etc. (Ceci et al. 2023). The bias of cis men and male bodies being the default objects of study is found in fields as diverse as human-computer interaction (Cassell 2002), radiation safety (Makhijani 2009), medicine

9

(Nowogrodzki 2017), facial recognition technology (Buolamwini and Gebru 2018), and sport and exercise science (Cowley et al. 2021), among many others. This bias essentially ignores many sex- and gender-based differences (genetics, epigenetics, metabolism, body proportions, musculoskeletal structure, mechanisms of pain transmission, hormones, symptom presentation, medication response, socialization and its effects on behaviour, etc.) that can affect the research outcomes and have serious practical consequences.

For example, anthropomorphic test devices (ATDs, a.k.a. crash test dummies) have been used since the 1950s to help study various kinds of crash-based damage to the body, especially for helping improve automobile design and safety interventions. Since their creation, ATDs have been based only on male bodies, to the point that even ATDs intended to represent female bodies are actually just scaled-down versions of male ATD models. However, real female bodies are not just smaller copies of male bodies: they differ in shape, mass distribution, neck strength, spine alignment, and various other factors relevant to crash safety (Linder and Svedberg 2019). This bias means that the knowledge gained about automobile safety disproportionately represents male bodies, and thus, cis men disproportionately benefit from this research. This effect is borne out empirically: in crashes with comparable conditions, women tend to suffer more severe injuries than men do, especially whiplash (Bose et al. 2011).

3.3 Problems with any default: Body diversity and trans people

In addition, relying too strictly on any defaults for sex or gender categories oversimplifies the true diversity of the human body within those categories. Consider the simplified graph in Figure 4.4 showing female and male vocal tract diversity as calculated for adults over 25 from their vowel formants, based on data and analysis from Fruehwald 2013.
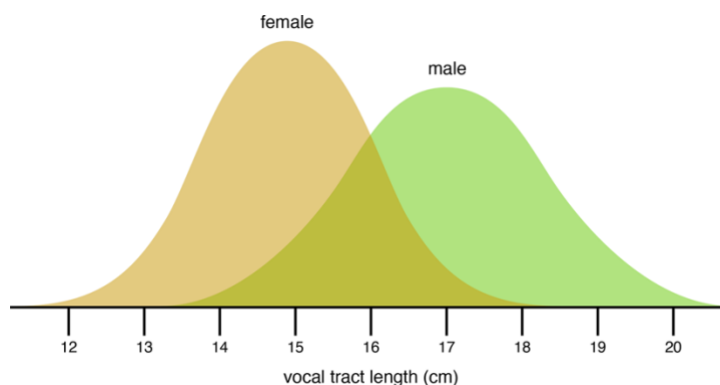

Figure 4.4. Distributions of adult female and male vocal tract lengths (adapted from Fruehwald 2013).

There is wide variation in these effective vocal tract lengths within the two sex categories (standard deviations of 1.1 cm for female and 1.4 cm for male), as well as large overlap between them. Note that a corresponding graph for gender that includes trans people would be expected to have even more variation and overlap.

There are many other ways that inclusion of trans people has interesting implications for phonetics, though they are often excluded from linguistics research (Murray 2016, Zimman 2018). For example, many trans people use hormone replacement therapy (HRT, sometimes referred to as *gender-affirming hormone therapy* in this context), with trans men using testosterone-based HRT and trans women using estrogen-based HRT (other hormones may also be involved in either therapy). HRT can have many effects on the body, but most relevant to phonetics is the effect of testosterone on the vocal folds: testosterone causes the vocal folds to thicken, which causes them to vibrate more slowly, lowering their fundamental frequency and the pitch of the voice (Evans et al. 2008, Azul et al. 2017, Cler et al. 2019). Note that thickened vocal folds are still fully capable of producing higher pitches (as needed for high tones, for example), but since vocal fold thickening does change the baseline pitch, it would be relevant for any analysis of intonation or tone.

In contrast, estrogen has little effect on the vocal tract, so many trans women instead use gender-affirming speech therapy to help feminize their voice. Some trans men may also use speech therapy, but the masculinizing effects of testosterone are usually satisfactory, so they are less likely to seek out gender-affirming speech therapy (consequently, research on gender-affirming speech therapy is heavily biased towards trans women; Davies et al. 2015). In addition to helping control pitch (Mészáros et al. 2005), speech therapy can also help with training in how to adjust overall articulation to alter the resonant frequencies of the vocal tract (Carew et al. 2007, Zimman 2012, Gelfer and Tice 2013, Leyns et al. 2023). Thus, the effects of both HRT and speech therapy, in combination or separately, can be relevant across a broad range of phonetics research. Importantly, it is not sufficient to rely on biological classifications alone, since some apparent sex-based differences may in fact be socially constructed as part of performing gender (Zimman 2018).

3.4 Inclusive solutions to address gender diversity

A more inclusive approach to teaching acoustics could begin by replacing the overused default vocal tract length of 17.5 cm with one or more other values within a reasonable range (approximately 8–20 cm for humans generally and 13–20 cm for adults; Lammert and Narayanan 2015). If only a single value is needed, an intermediate value for adult humans of about 15–16 cm could be used (cf. the region of overlap in Figure 4.4).

11

This small change could be further paired with explicit discussion about the common use of 17.5 cm as a default, body diversity in acoustics, and the importance of representing more humans than just cis men in science. This discussion might be particularly effective early on, to help lay the groundwork for a better understanding of variation in the acoustic properties of speech. To facilitate this discussion, instructors can use the lecture notes titled "Sex, gender, and variability of the vocal tract" on the Linguistics Equity, Diversity, and Inclusion Repository (LEDIR; Sanders et al. 2021–2025) at https://ledir.ling.utoronto.ca/. These lecture notes were originally written specifically for LEDIR but have been updated based on research done for this chapter. The LEDIR lecture notes present much of the same material in this section in a way that is approachable for undergraduate students and could be straightforwardly adapted for most phonetics courses that cover tube models, as supplemental reading for students and/or as background reading for instructors. In addition to updating the LEDIR lecture notes, we have also included a few sample questions (with sample solutions) in Appendix A that instructors could use on tests and assignments to assess student learning of the topics covered by this material.

An inclusive approach to sex, gender, and body diversity based on the ideas in this section is more scientifically comprehensive and accurate, which broadens the scope of the course material and provides more opportunities for diverse and innovative assessment. In addition, many students interested in speech-language pathology take phonetics, and learning about relevant issues for trans people can help prepare them for future trans clients. More importantly, increasing representation of trans people, trans issues, and trans researchers in the classroom can have a validating impact on trans students and their identities. This is especially true in the context of a phonetics course, since issues of language and biology are central to both phonetics and trans experiences.

4 Modality

In this section, we discuss the modality bias in linguistics, especially in phonetics and phonology, in which spoken languages are often the only languages described and analyzed (§4.1). Then we explore the drawbacks to this bias, both social and scientific (§4.2). Finally, we offer more inclusive ways to teach about modality in phonetics and phonology (§4.3).

4.1 The modality bias

Language has multiple possible modalities, and modality is central to the fields of phonetics and phonology. However, textbooks and courses on phonetics and phonology overwhelmingly focus only on the vocal-auditory modality of spoken languages. Many popular textbooks (such as Rogers 2000, Hayes 2009, Odden 2013, Ladefoged and Johnson 2015, Kennedy 2017, Fromkin et al. 2018, and O'Grady and Archibald 2019) even explicitly define phonetics and/or phonology

solely in terms of spoken languages and sounds, though there a few recent notable exceptions (e.g. Anderson et al. 2022 and Dawson and Hernandez 2022). This is partly due to the focus on spoken languages throughout most of the history of linguistics as a whole. It was not until the 1960s that linguists began to recognize that signed languages had fundamentally the same kinds of units, patterns, and expressive capability as spoken languages, due especially to foundational work by Stokoe (1960). However, despite more than 60 years of research into signed language linguistics since Stokoe's work, linguistics is still taught with this historical bias, and signed languages are often marginalized or ignored across the field, but especially in phonetics and phonology. Even when signed languages are discussed, other modalities (such as the manual-tactile modality of tactile signing) are generally not discussed at all.

4.2 Drawbacks of the modality bias

The bias in the field against signed languages is not just an historical artifact of linguistics itself. It reflects broader societal audism against deaf and hard-of-hearing (HOH) people in every level of society. Throughout the world, deaf/HOH people are confronted with constant barriers to accessibility in legal systems (Vernon and Miller 2005), education (Schick et al. 2006), healthcare (Kuenburg et al. 2016), employment (Smith 2020), transportation (Orczyk and Młodystach 2022), and many other aspects of their daily lives. Deaf/HOH children are particularly vulnerable, since their parents and pediatricians are often not knowledgeable about the importance of early access to signed languages for promoting their linguistic, cognitive, psychological, and social development (Humphries et al. 2014). Language access for the deaf/HOH is a fundamental human rights issue, and as experts in the nature of language, linguists are well-positioned to play an import advocacy role by demystifying signed languages in the classroom. When we ignore the diversity of modality in our teaching, we are helping perpetuate these social biases.

In addition, a primary focus in linguistics on spoken languages misses out on knowledge crucial to a full understanding of how language really works. Language is multimodal, both across languages and within a single language, and our linguistic models and analyses are fundamentally incomplete if we do not take into account a broader range of modalities (Perniss 2018, Holler and Levinson 2019, Henner and Robinson 2023). Unfortunately, a traditional linguistics education includes very little (if anything) about signed languages, let alone other modalities or multimodality, and most linguists do not end up correcting their knowledge gap. In the classroom, they go on to teach what they do know, and avoid teaching what they do not, which passes along the very same knowledge gap to their students, who in turn become the next generation of linguists, perpetuating a cycle of ignorance about a fundamental aspect of language (Zuraw 2022). However,

it is our scientific responsibility to engage with the full breadth of our object of study, not just one convenient subset. Linguists should, at the very minimum, learn what is needed to expand the scope of their teaching to include all modalities and break the cycle.

Currently, it is common for undergraduates to graduate with a degree in linguistics without having ever analyzed any data from a signed language. At best, they may have gotten a brief discussion of modality diversity in a general introductory course, but it is rare for students to analyze phonological or syntactic phenomena in signed languages in the same way they do for spoken languages. The opposite scenario, where a student studies linguistics without analyzing any data from spoken languages, seems inconceivable to most linguists, and the field should evolve so that it is just as inconceivable to ignore signed language data. This evolution takes a willingness to learn something new about language, which should excite us as linguists. After all, we regularly teach about interesting patterns and structures in spoken languages that we do not speak. However, it is natural for instructors to be apprehensive about teaching about signed languages, given how different the modality is and especially how marginalized signed languages and their signers are (cf. Zuraw 2022). This is why we have provided concrete resources for instructors to use as a starting point, discussed in Section 4.3.

4.3 Expanding modality in phonetics and phonology

A truly inclusive approach to teaching about modality would give all modalities equal time, but this is often not practical. There is not enough time in a single term to cover all modalities, and there is limited research beyond spoken and signed languages to teach from. However, some general discussion of the broader diversity of modality, and the multimodality of language, could be included. The LEDIR lecture notes titled "Introductory background on signed languages" include such discussion, as well as serving as an entry point to deeper discussion of signed languages. These lecture notes can be used in nearly any course that discusses phonetics and/or phonology, including an introductory course on general linguistics.

Moving further into the linguistics of signed languages, instructors could also make use of the LEDIR lecture notes titled "Signed language articulation", which give more specifics about the articulators and biomechanics of linguistic articulation. There is also a set of follow-up lecture notes on LEDIR titled "Signed language description and notation", which introduces detailed discussion of how to describe the articulation of signs. It also covers issues with transcription, such as the lack of a single accepted universal standard (see Hochgesang 2014 for an overview of transcription systems for signed languages). The issues raised by these lecture notes also provide a good opportunity for discussions of equity in the field: research on the phonetics and phonology of signed languages is impeded in part by

the lack of a single accepted transcription system, as well as the difficulty in working with the systems that do exist (for example, the lack of Unicode support). This is in contrast to syntax or semantics, where the relevant linguistic properties (constituents, scope, etc.) can mostly be notated in essentially the same way for both spoken and signed languages.

For phonetics courses that cover perception, instructors could make use of the more advanced LEDIR lecture notes titled "Signed language perception", which discuss some aspects of the visual perceptual system and how they might play a role in shaping signed languages (cf. Sanders 2018). For phonology courses, instructors could make use of the more advanced LEDIR lecture notes titled "Signed language phonology", which discuss phonological representations of signs, with an emphasis on static holds versus dynamic movements (Liddell 1984, Liddell and Johnson 1986, 1989, Sandler 1986, 1989, van der Hulst 1993, Johnson and Liddell 2010), especially how the notions of sonority and syllables might play a role in the analysis of the phonology of signed languages (Brentari 1990, Corina 1990, Perlmutter 1992, Sandler 1993). These lecture notes also touch on other topics relevant to theoretical phonology, such as autosegmental phonology, markedness constraints, and phonological rules.

To further support inclusion of signed languages into phonetics and phonology courses, we provide a few sample questions (and answers) in Appendix B. Many of these questions can serve as the basis for a range of variant questions (as specifically exemplified by Question 5).

5 Conclusion

In this chapter, we have discussed three content areas in which phonetics and phonology can be taught in more inclusive ways: (i) going beyond the language of instruction in introductory transcription, (ii) going beyond male body defaults in acoustic phonetics, and (iii) going beyond the vocal-auditory modality in phonetics and phonology. A common obstacle to pedagogical improvement is overcoming the inertia of relying on recycled methods and materials from year to year, so we also have tried to help lower the barrier to entry for instructors who want to do this work by providing concrete course materials that can be easily adapted to their courses, such as the sample starting IPA symbol sets in Figures 4.1–4.2; the updated LEDIR lecture notes; and the sample questions in Appendices A and B.

There are many other ways to make phonetics and phonology more inclusive beyond the discussion in this chapter so far. For space limitations, we only address a few of these briefly. One important issue is that there may be students with disabilities and accessibility needs that interact with phonetics and phonology in particular ways that require more than simply adjusting the course content. For example, students with visual impairment may need alternative tools to access phonetic notation, along the lines of Lillehaugen and colleagues' (2014) tactile IPA

system or Medina González and Hardison's (2022) Assistive Design for English Phonetic Tools (see also Wells-Jensen 2005, Ed-dali 2024, and Chapter 10, this volume, for related discussion). Students who are deaf, hard-of-hearing, or have an auditory processing disorder may need different assessment tasks for traditional perception and transcription tasks, which can go hand-in-hand with a general reduction of focus on spoken languages. See McGarrity and Yip 2024 for further discussion and ideas on these issues.

In a phonetics course that covers perception, issues of social bias and their effects on perception could be discussed. This topic is covered by the LEDIR lecture notes titled "The complexity of language perception: Social information and biases", which we briefly summarize here. The linguistic signal conveys many aspects about identity, such gender, age, ethnicity, etc. (Foulkes 2010), and our expectations about this social information can affect how we perceive the linguistics signal. For example, because women and men (for some languages) tend to pronounce sibilants slightly different, when we hear an intermediate sound between [s] and [ʃ], we are more likely to hear it as [s] if we believe a man is speaking and as [ʃ] if we believe a woman is speaking (Munson et al. 2006). Unfortunately, our expectations about the relationship between language and social information (especially race) can have a variety of negative effects (Lippi-Green 2012): willful misunderstanding (Kang and Rubin 2009); judgements about accentedness (Babel and Russel 2015) and credibility (Rockford and King 2016); and discrimination in housing (Purnell et al. 1999), employment (Jackson and Denis 2025), and other aspects of life.

We urge phonetics and phonology instructors to try out some of the resources and methods we have offered and to make connections with other linguists who specialize on these topics to help make their teaching more inclusive, even in little ways.

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Appendix A: Sample questions on body diversity in acoustic phonetics

The following are some sample questions based on the LEDIR lecture notes on body diversity in acoustic phonetics that could be used on tests and homework assignments. Sample answers and explanations are provided in red.

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1. Which of the following vowel properties would be most changed for a transgender man after a few years on testosterone-based hormone replacement therapy? Assume he does not also undergo any speech therapy.
a) duration
b) centre frequencies of formants
c) bandwidth of formants
d) fundamental frequency (pitch)
The correct answer is (d), because testosterone causes the vocal folds to thicken and vibrate slower, which lowers their fundamental frequency, and thus, pitch.

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2. For each blank in the following sentence, circle the choice that best completes the sentence: Testosterone *lowers / raises / has no effect* on pitch, and estrogen *lowers / raises / has no effect* on pitch.
The correct answer is testosterone lowers pitch (because it causes the vocal folds to thicken and vibrate slower, which lowers their fundamental frequency, and thus, pitch), while estrogen has no effect on the vocal folds, and thus, on pitch.

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3. For each blank in the following sentences, circle the choice that best completes the sentences: A common value cited as the average adult male vocal tract length is 17.5 cm, but the true average is a bit shorter, maybe around 16 cm. Assuming the vocal tract for [ə] is approximately a uniform half-open tube, we expect that F1 for [ə] in the shorter vocal tract to be *higher than / lower than / the same as* F1 for the longer vocal tract, and we expect that that F2 for [ə] in the shorter vocal tract to be *higher than / lower than / the same as* F2 for the longer vocal tract.
The correct answer is higher than for both, because shorter tubes of this shape have higher resonant frequencies than longer tubes, since all of the resonant frequencies for this tube shape are inversely proportional to tube length.

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4. The common use of male defaults for body measurements in phonetics is part of a larger bias in the sciences generally, in which men and male bodies are treated as the default objects of study. Find another example of this bias in some other field besides phonetics and describe how the bias manifests. Cite any sources you use for this question.
Various answers are possible, such as those discussed in the chapter: human-computer interaction, radiation safety, medicine, facial recognition technology, sport and exercise science, and automobile safety.

5. Suppose a phonetic study is designed to estimate vocal tracts for all participants, and the study includes many transgender people. All participants are categorized and analyzed first by sex assigned at birth (assume just two groups: female and male) and then by gender (again, assume just two groups: woman and man). Which of the following is most likely to describe the difference in amount of group overlap between the two analyses?

a) There should be more overlap for sex than for gender.

b) There should be less overlap for sex than for gender.

c) There should be about the same amount of overlap for sex as for gender.

d) There should be no overlap for either sex or gender.

The correct answer is (b), because both sex and gender have enough variation that their categories overlap, and vocal tract length is somewhat more consistent within sex categories than within gender categories.

Appendix B: Sample questions on signed languages

The following are some sample questions based on the LEDIR lecture notes on signed languages that could be used on tests and homework assignments. Sample answers and explanations are provided in red.

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1. Which of the following joints normally can only flex and/or extend? Circle all the apply.

    base knuckles   elbow   interphalangeals   radioulnar   shoulder   wrist

The correct answers are elbow and interphalangeals, because these joints can flex and extend. They cannot rotate or abduct/adduct.

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2. Which manual parameter in signed languages is determined only by the configuration of the base knuckles and the interphalangeal joints?

a. handshape
b. orientation
c. location
d. movement

The correct answer is (a) handshape. Orientation is determined by the configuration of the other four joints, while location and movement are determined by all joints.

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3. Which manual parameter in signed languages has neutral signing space as a default?

a. handshape
b. orientation
c. location
d. movement

The correct answer is (c) location, because neutral signing space is a location.

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4. Which joints that are used for local movement in a sign cannot be used to alter handshape? Select all that apply.

    base knuckles   elbow   interphalangeals   radioulnar   shoulder   wrist

The correct answer is radioulnar and wrist. The elbow and shoulder are used for path movement not local movement, and the base knuckles and the interphalangeals are used for both local movement and handshape.

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5. Watch the two videos linked below from the website Spreadthesign, showing two signs with the same meaning (BLACK) from two different languages: Croatian Sign Language (Hrvatski znakovni jezik, HZJ) and Polish Sign Language (Polski język migowy, PJM). The two signs have nearly the same manual articulation, except for one parameter. Which one manual parameter do these signs most differ in? (Other manual parameters may also differ slightly. Choose the manual parameter that

differs the most.)

      HZJ: https://media.spreadthesign.com/video/mp4/42/402723.mp4

      PJM: https://media.spreadthesign.com/video/mp4/19/58964.mp4

a. handshape

b. orientation

c. location

d. movement

The correct answer is (b) orientation, because in HZJ, the palm faces to the signer's left, while in PJM, the palm faces the signer's face. The handshape, location, and movement are all roughly the same (an open hand moving back and forth in front of the face).

Variants of this question are possible using similar pairs from Spreadthesign (European Sign Language Centre 2018), including:

year	Romanian	Bulgarian	handshape
key	Estonian	Icelandic	handshape
coffee	Polish	Croatian	handshape
deaf	Polish	Spanish	handshape
think	Spanish	British	handshape
look	Urdu	Turkish	handshape
black	Croatian	Polish	orientation
tired	Chilean	Austrian	orientation
dead	Icelandic	Bulgarian	orientation
give	Spanish	Austrian	orientation
sentence	Lithuanian	German	orientation
thin	British	Russian	orientation
black	Greek	Cypriot	location
doctor	Greek 1	Greek 2	location
Spain	German	Spanish	location
Spain	Bulgarian	Ukrainian	location
thank	British	Estonian	location
water	Ukrainian	Belarusian	location
black	British	New Zealand	movement
black	Icelandic	Polish	movement
year	Japanese	Swedish	movement
black	French	Latvian	movement
orange	Bulgarian	Russian	movement
school	Icelandic	Hindi	movement