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SOCIOPHONETICS AND RHOTICS

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Introduction

Rhotics display a large amount of phonetic variation, and for this reason readily lend themselves to becoming sociolinguistic variables, in many language varieties. Rhotic variability has been shown to play a role in sociolinguistic variation within and between speech communities, from Labov's (2006[1966]) landmark department store study onwards. Labov's study was on a relatively coarse-grained level, involving the presence versus absence of post-vocalic *r*. Several other famous rhotic variation studies have been on a similarly coarse-grained, discrete level, such as the variation between alveolar and uvular *r*. More recently, a growing number of rhotic variation studies demonstrate that even fine phonetic detail has the potential to be picked up by speakers/listeners and utilized in socially relevant ways. Apart from the high propensity for rhotics to be synchronically variable, they are also involved in many historical and ongoing sound changes (and indeed these two types of variation are not independent of each other). Sound changes where rhotics play a role involve both those that target the rhotic itself and those where the immediate context (often, the preceding vowel) is the target. Outside of sociophonetics proper, rhotics are studied by phonologists, acquisitionists, and typologists, among others, illustrating the many relevant links between these and related fields with sociophonetics.

"All sounds are variable, but some are more variable than others," as Scobbie (2006:337) put it. The large amount of variability among the group of sounds classed as "rhotics" has been remarked upon by many linguists over the years, both in terms of trying to define or delimit the class—the question being: What is a rhotic?—and in terms of describing the synchronic patterns of variation displayed by the category, or phoneme, /r/ in various languages. These two questions of rhotic variability are rarely considered in conjunction, the former being largely a language typological concern (though not an unimportant debate for theoretical phonologists either), and the latter one for those with a more descriptive focus, from phonologists analyzing a particular pattern of allophony to sociolinguists investigating patterns of variation and change. That said, studying the phonetic and phonological particulars of rhotics runs into a problem that is likely unique to this class of sounds—that is, determining which sounds are, and which are not, included in it.

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Even in this volume, a chapter on rhotics sits somewhat uneasily among others on phonological categories that relate directly to manners of articulation with phonetic definitions such as stops (Chodroff & Foulkes) and fricatives (Chappell, Garcia & Davidson) (although they each have a few complicated cases at the margins, of course). Even their closest cousins, the laterals (Turton), have nowhere near the definitional problems of the rhotic class.

Definitions of rhotics have been sought in the articulatory and acoustic domains, but a phonetic feature that is present in all sounds that have been given the rhotic label has so far not been found (Lindau 1985; Ladefoged & Maddieson 1996). Taps, trills, fricatives, and approximants have all been labeled rhotics in languages around the world, and there are languages where all these manners of articulation coexist as variants of a single /r/ phoneme—sometimes even produced by a single speaker (Sebregts 2015; Rennicke 2015). The lack of a phonetic property underpinning all rhotics has led phoneticians to propose that they are linked by a looser network of similarities (the Wittgensteinian "family resemblance" model of Lindau 1985), by diachronic connections (Barry 1997; Sebregts 2015), or indeed by orthographic convention (Ladefoged & Maddieson 1996). Phonologists, meanwhile, have proposed that rhotics need not be phonetically stable as long as they are phonologically so, either in terms of their abstract representation (Walsh Dickey 1997) or their outward phonological behavior, especially their role in phonotactics (Wiese 2001; Chabot 2019). It is important to note that these discussions are not only relevant for typologists and phonological theorists, but have a direct bearing on those working on processes of variation and, particularly, change, and they once again demonstrate the uniqueness of rhotics. Diachronically, of course, stops may change into fricatives, fricatives into approximants, nasals into stops; synchronically, these categories may display alternations with each other. However, if a particular speech sound in a particular language displays the articulatory and acoustic characteristics of an [s], it is rarely called into question whether that speech sound should indeed be analyzed as a fricative. Rhotics are trickier. An alveolar tap [ɾ] may be an allophone of /t/ in one language and consequently classed as a stop, and of /r/ in another, and classed as a rhotic; a [χ] may be a rhotic in one language and a fricative in another, and so on. Similarly, if a rhotic that was historically a trill or tap changes into a fricative or approximant, that change in manner of articulation does not usually lead to reassigning it to a different class.

While the above examples all concern manner of articulation, rhotics are also extremely variable in place of articulation. There are sounds classed as rhotics from labio-dental to pharyngeal, and everywhere in between. It shows that the category has fuzzy boundaries on all sides, and occasional debates come up surrounding particular members of the class. More than for other classes of sounds, rhotic classhood depends on arguments from outside the phonetic characteristics proper. As described above, these may be based on phonological behavior, historical connections, or orthography.

The large amount of rhotic variability is undoubtedly behind its potential as a sociolinguistic variable. Unlike most other consonants (and even more so than vowels) rhotics allow for a relatively large amount of intracategory modification without the danger of being misperceived. In fact, unlike the situation with vowels, relatively radical changes to *r* are possible without triggering changes to the entire consonant system. This relative realizational freedom gives ample opportunity for *r* variation to acquire indexical properties, and indeed it often does. As described below, in a number of languages particular *r* variants are associated with changes in progress. In a subset of these, it is not only the case that innovative variants are more frequently employed by a younger generation, but that several innovative variants coexist, serving to highlight diverging paths of change among social groups.

Literature review: *r*-processes and sociophonetic variation

This section highlights three processes involving *r* sounds that have recently featured prominently in the literature, and that demonstrate how important it is to study the social and the phonetic together: 1) the variation in place of articulation between apico-alveolar and uvular *r* variants, and in particular the substitution of the former by the latter; 2) the articulatory variation among approximant variants between retroflex (or "tip up") articulations and those involving a bunched tongue dorsum ("tip down"); 3) the emergence of new variants. A number of classic and recent studies on each of these processes are discussed below.

Trading places

Alveolar variants of *r* being replaced diachronically by uvular ones is a well-known historical process in a number of European languages. The questions of why and how alveolar variants of *r* come to be replaced by uvular ones have been taken up on a number of occasions by dialectologists, phoneticians, and phonologists. There is no lack of speech communities where alveolar *r* is the standard and where uvular realizations are regarded as speech defects (at least, by the wider public, if not by linguists), and indeed, children are sent to speech therapists to learn to produce an alveolar trill, or at least a tap. However, where uvular trills and fricatives have established themselves as acceptable variants, they are often seen to gradually take over as the more popular variant. This is particularly visible in Northwest Europe. In Danish, for instance, uvular and/or pharyngeal *r* variants are currently standard and dominant across dialects (Grønnum 1998). In European French and many varieties of German, including Standard German, uvular *r* is the dominant and/or standard, though alveolar realizations are still common in Swiss German (Ulbrich & Ulbrich 2007) and survives in some French dialects (Fougeron & Smith 1993). The process is ongoing in Belgian Dutch; alveolar *r* dominates and is largely considered standard, but uvular *r* is on the rise, both socially (after having previously been classed as a speech deficit) and geographically (Rogier 1994; Van de Velde 1996; Verhoeven 2005; Tops 2009; Van de Velde, Tops & van Hout 2013). In the Netherlands, meanwhile, uvular and alveolar *r* are both considered standard, the former increasingly dominant, though the situation is more complex due to the rapid rise of the coda approximant (see below). Uvular *r* is also either gaining ground in its perception as standard or has become dominant in coastal varieties of Norwegian and Southern Swedish (Muminovic & Engstrand 2001; Torp 2001). Outside of Northwest Europe, uvular *r* has established itself in Portuguese (including Brazilian Portuguese) (Mateus & d'Andrade 2000; Rennicke 2015), Puerto Rico Spanish (Lipski 1994), and Canadian (Quebec) French, which we discuss in a little more detail below. The ongoing shift from apical to dorsal variants in Quebec is well described and exemplifies a phase in the process of sound change that is well within the realm of traditional sociolinguistic study: the spreading of a sound change once it has been established as a competing variant, including an association with prestige (of particular urban centers or of particular social groups in which the change takes hold first) as a plausible explanation for its increasing adoption. At first blush it may in fact seem there is not much of particularly sociophonetic interest, although the wider sociolinguistic interest is obvious, but we will see that this first impression is mistaken.

While apical and dorsal *r* variants may have coexisted in Quebec for as long as three centuries, dorsal variants were largely confined to Eastern Quebec. In Montreal, the shift from alveolar to uvular variants being the norm (both in terms of dominance and in terms of being considered standard) took place over the course of the first three decades after the Second World War (Santerre 1978; Clermont & Cedergren 1979, as cited in Sankoff & Blondeau 2007). A number of studies have charted the ongoing change. Sankoff & Blondeau (2007) show that there is both

a community-wide shift, with the incidence of uvular *r* increasing for every younger cohort, and, among a minority of individual speakers, change across the lifespan. While around two-thirds of the speakers in their panel study remained stable (most being either categorical or near-categorical alveolar or uvular *r* speakers), nine speakers, or just under a third of the sample, increased the proportion of uvular tokens among their *r* realizations between 1971 and 1984. Most of the speakers who increased their uvular *r* usage became near-categorical users of the innovative variant over this period of time. Their results for the most variable speakers suggest that there is at least some linguistic conditioning present, with prevocalic contexts favoring apical variants and uvular variants appearing alongside lenited/vocalic ones in codas. This is also the pattern found by Côté & Saint-Amant Lamy (2012) for their most variable speaker. Theirs is a study of a similar ongoing shift in Trois-Rivières, a city located between Montreal and Quebec City, indicated as the border between the apical and dorsal *r* areas in studies from the mid twentieth century (Sankoff, Blondeau & Charite 2001). The onset-coda allophony exhibited by variable speakers, in combination with the appearance of other, more lenited variants of *r* in codas, leads Sankoff & Blondeau to wonder to what extent the change conforms to established sociolinguistic patterns. Since the change from apical to dorsal *r* is in principle an abrupt change phonetically, it would not be unexpected for the phonological conditioning to be minimal—that is, for speakers to treat [r] and [ʁ] as discrete stylistic variants mainly related to levels of formality or standardness. In addition, the change is towards a high-prestige variant from the outside—a typical change from above. So if there is allophony, the more salient onset position might be expected to be the context that favors uvular *r*. Instead, the variant seems to "[creep] in through the back door" (Sankoff & Blondeau 2007:579). Here is where the specifically sociophonetic angle we identified above comes in: apart from the more generally sociolinguistic questions of prestige, and change via community versus individual shift, the question of why uvular *r* appears where it appears is of interest.

The phenomenon that precedes the gradual spread of uvular *r*— that of its spontaneous innovation by speakers of languages with a dominant alveolar *r* variant—has occasionally received attention from linguists, although it has mostly been from phoneticians, rather than sociolinguists. Here, the question is how uvular *r* variants are linked to alveolar ones to the extent that they (and not other potential substitutions) survive in the first place. A number of authors have highlighted the perceptual link between alveolar and uvular trills. For both, of course, the most obvious perceptual cue is the pattern of openings and closings, and indeed the trill frequencies of alveolar and uvular trills are relatively similar (Ladefoged, Cochran & Disner 1977; Lindau 1985; Verhoeven 1994; Tops 2009). The similarities do not stop there: as shown by Engstrand, Frid & Lindblom (2007) for alveolar and velar approximants, and Van de Velde & Demolin (2021) for alveolar and uvular trills, there are similarities in the formant transitions of alveolar and dorsal articulations (specifically, their high F3/low F4) that may increase the perceptual overlap. This suggests that a uvular trill is a good substitute for an alveolar one in cases where the latter is the norm and an individual speaker cannot produce it. Coupled with the articulatory complexity and aerodynamic precarity of alveolar trills (see, e.g., Solé 1998, 2002), the argument can be made that children simply hit upon uvular trills during the acquisition process as a substitution that works well enough (see, e.g., Sebregts 2015, although the argument goes back as far as Von Kempelen 1791 [cited in Wollock 1982]). On the other hand, there is evidence that alveolar and uvular articulations are not only linked perceptually and acoustically. Morin (2013) suggests that even articulatorily, moving from alveolar to uvular *r* does not constitute an abrupt sound change. He claims that uvular articulations (specifically, uvular approximant or fricative articulations) may arise as lenition variants of apico-alveolar trills. The argument goes back to Jespersen (1889), who states that alveolar trills have a double constriction: both the tongue tip and the tongue dorsum are

raised. That many rhotic variants involve two or even three articulatory gestures is now well established, via articulatory research such as that by Delattre & Freeman (1968) on American English *r* and Proctor (2011) on Spanish and Russian *r* (though for a dissenting view see Recasens 2016). Morin's re-examination of data from Charbonneau (1971) and Santerre (1982) on Montreal French *r* leads to the same conclusion. Demolin & Van de Velde (submitted) combine the articulatory and acoustic evidence and, based on an articulatory model simulation, argue that the [r] > [ʁ] substitution is a "quantal change," in that a small displacement of the front constriction for [r] can lead to a perceptual reinterpretation as dorsal. That said, as noted above, the two trills are apparently perceptually different enough for uvulars to be recognized as "defective" in some strongly normative communities, and social factors remain crucial in explaining why and how uvular *r* has become socially acceptable or even desirable in a number of speech communities but not others. What these findings illustrate above all is how a detailed investigation that brings together sociolinguistic data and phonetic experimentation can shed new light on a phenomenon that was thought to be well-understood.

Going up or down?

A fertile strand of research into rhotic variation over the past 20 years has been driven by the development of instrumental methodologies, especially that of articulatory imaging techniques. The variation among speakers of rhotic American English was first described by Delattre & Freeman (1968) using motion X-ray. Since then, ultrasound tongue imaging in particular has shed light on the articulatory configurations involved in approximant *r* types. In addition to being much less invasive, dangerous, and costly than X-ray, ultrasound also makes it easier to analyze the dynamic dimension, currently using frame rates of 60–200 fps (Wrench & Scobbie 2011).

Explorations into the particulars of the retroflex/bunched distinction have not only been driven by methodological gains (i.e., researchers used articulatory imaging because they could), but also by theoretical interests shared by phoneticians and phonologists. One of these is the mapping between articulation and acoustics.

Delattre & Freeman (1968) describe how American English *r* had, in the years leading up to their study, been described as having two articulatory variants, a retroflex and a bunched one, the latter also known as "molar" (the dorsum is bunched up against or toward the palate with considerable bracing against the molars). Sources from the 1940s and 1950s tended to describe the retroflex variant as the dominant one. Delattre & Freeman's X-ray study dispelled both notions. They distinguish between eight different articulatory variants, rather than two, and of their 46 subjects the majority in fact had a bunched *r.* Later ultrasound studies confirmed the plethora of gestural shapes and the dominance of bunched ones. The various tongue shapes tend to remain classifiable as retroflex or bunched, or more accurately, though more broadly, as tip-up and tip-down.

Acoustically, American English *r* is characterized by a rapid dip in F3, as Delattre & Freeman's measurements confirm (they cite sources going back to 1947 for this finding). Their study enables the comparison of images of the maximal articulatory constriction with the acoustic output of this constriction. It shows that the F3 dip (and a resulting closeness of F2 and F3) are correlated with the strength of both the palato-velar and pharyngeal constrictions involved, as well as with the level of contraction in the bunched dorsum and the dorsum lowering behind it. Most crucially, no correlation is found between tongue shape (retroflex or bunched) and formant frequencies; the combined effects of the constrictions involved in both types lead to the same acoustic output. Interspeaker variation, in other words, was present at the articulatory level, but not at the acoustic (or auditory level).

That the acoustic target for American English *r* is a low F3, or possibly a close approximation or confluence of F2 and F3 has now been shown in many acoustic studies (Hagiwara 1995; Stevens 1998). In recent years, ultrasound studies have confirmed that this acoustic target can be reached in articulatorily clearly distinct ways, that speakers vary greatly individually, and that the various gestures they employ actually increase acoustic stability (Guenther et al. 1999; Zhang et al. 2003). In other words, there seems to be a two-to-one (or many-to-one) mapping of tongue shapes to formant shapes. Articulatory variation similar to that in American English has since been found for Dutch approximant *r* (Scobbie & Sebregts 2010). A reasonable assumption following from these facts may be that retroflex and bunched articulations are simply different strategies employed by individual speakers to arrive at the same acoustic result and that the articulatory variation is in itself irrelevant—both phonologically and socially. It is a reasonable assumption because it is hard to see how speakers could make social-indexical use of different articulations if the acoustic result is the same. This would both be difficult to learn (listeners have limited access to speakers' individual gestural patterns) and have low ecological power (socially relevant distinctions that are not recoverable from the acoustic output).

As far back as Delattre & Freeman's (1968) study, however, gestural configurations have displayed group differences. Dividing their speakers up by region, they find more tip-up articulations in the South and New York City, and more bunched *r* on the Pacific Coast and New England. In their case, much of the variation among their participants may relate to levels of rhoticity (the South and New York are two areas characterized by non-rhoticity), although this fails to explain the strong position of bunched *r* types in New England (also an area with non-rhotic dialects). That said, the assumption that the interspeaker variation related to gestural types is irrelevant socially, has found support from other studies that show speakers do not perceive the difference between different articulatory strategies, and that speakers mainly show idiosyncratic differences (Mielke, Baker & Archangeli 2010, 2016).

Meanwhile, studies on *r* production in Scottish English have in fact shown social factors to be relevant predictors of bunched versus retroflex articulations. Lawson, Scobbie & Stuart-Smith (2011) found that middle-class speakers in Glasgow were more likely to use bunched articulations compared to working-class speakers, whose productions were more often "tip up" (given the small number of actual retroflex articulations, this term is a more accurate characterization of the other end of the spectrum from the bunched ones). They also show an effect of gender: the male speakers among their (mostly young) participants use more tip-up variants than the female speakers. In other words, they discovered a classic sociolinguistic distribution corresponding to gender and class, with female middle-class speakers on one end and male working-class speakers at the other. They note that the bunched and retroflex variants are in fact auditorily distinct from each other, in contrast with those in American English.

Given the discussion above, this result may at first glance appear mysterious, but, as Lawson, Scobbie & Stuart-Smith (2011) point out, the different articulations are linked to different levels of *r*-reduction. A pattern of strong versus weak *r* realizations being associated with class differences had been established before (Romaine 1978). Even without going into its articulatory dimension, the variation was of particular interest because it goes against the assumption in earlier literature that middle-class speakers would tend towards the nonrhotic standard south of the border. In fact, it is working-class speakers who are becoming less rhotic. In addition, as a sound change in progress, it seems to be developing in both directions: the middle-class speakers are also becoming more "*r*-ful"—that is, using perceptually ever stronger *r* variants.

In a series of follow-up studies, the authors examine the phenomenon of derhoticization, the progressive loss of a perceptually salient *r* in coda positions, in the context of articulatory variation

in a wider sense. They show the crucial role of gestural timing in the differences between the tip-up and tip-down speakers. Apart from the different tongue shapes, the gestures involved for the tip-up speakers reach their maximal articulatory targets later, often after the offset of voicing, leading to a reduced percept (or even one of deletion) (Lawson, Stuart-Smith & Scobbie 2018). Meanwhile, the middle-class, bunched-*r* speakers' relative stability of the bunched dorsum configuration leads to a stronger cue to rhoticity and a co-articulatory effect on pre-*r* vowels (merging /ɪ/, /ɛ/, and /ʌ/), which are kept apart more often by working-class speakers (Lawson, Scobbie & Stuart-Smith 2013; Stuart-Smith, Lawson & Scobbie 2014; Lawson & Stuart-Smith 2021). In other words, there are two concurrent sound changes taking place, both phonetically and sociolinguistically. In the sense of Labov (e.g., 1994), there is both a change from above and a change from below affecting Scottish English *r*. The former is led by female middle-class speakers towards stronger approximant *r* variants in all positions, the latter by working-class speakers who, in the words of Stuart-Smith, Lawson & Scobbie (2014), "are participating in long-term vernacular change from below," possibly on their way to a situation of non-rhoticity. Stuart-Smith, Lawson & Scobbie point out the potential relation between Scottish derhoticization and other sound changes (such as TH-fronting) that may be influenced by Anglo-English.

The studies on Scottish English articulatory *r* variation and derhoticization provide a wealth of detailed phonetic data to sociolinguists interested in the interplay between linguistic and social factors in sound change. Questions regarding the standard (or socially more attractive non-standard) varieties south of the border and their influence on changes in Scottish English can now be explored with direct reference to the phonetic detail involved. In fact, tracking closely how derhoticization develops (e.g., which vowel and consonantal contexts are targeted first) may provide a window on the past as well, allowing us to infer how varieties that are currently fully nonrhotic may have evolved.

Derhoticization, or at least a gradual weakening of coda-*r* can also be observed in other currently rhotic varieties of English, such as West Country English (Blaxter et al. 2019; Malarski 2021), as well as in other languages. In varieties of German, for instance, coda-*r* can vary between a uvular fricative [ʁ] and an open vowel [ɐ], with the latter considered more standard (Wiese 2000). Similarly, in varieties of Brazilian Portuguese word-final *r* may reduce to [h] or be deleted (Rennicke 2015), and in Dutch as well as Quebec French, approximant and vocalic variants occur in addition to more constricted alveolar and uvular ones (Sebregts 2015; Sankoff & Blondeau 2007). Whether the latter examples are in fact stages of progressive *r*-loss leading to non-rhoticity remains to be seen, but the tools to trace any further developments are now at hand.

Read my lips

Another recent focal point for studies of rhotics has been the emergence of new variants and their consequent spread throughout speech communities. By "new variants" we here mean speech sounds that were previously regarded as speech defects or developmental variants, and possibly not as rhotics at all. Children learning language varieties with an alveolar trill as one of the major allophones have been found to use a number of substitutions, including lateral, uvular, and pharyngeal consonants (see Sebregts 2015 for references; examples come from Czech, Estonian, Spanish, and Slovenian, among others). Some of these substitutions persist into adulthood; speakers from various languages have been reported to use lenited *r* variants as opposed to the prestige or standard forms (often apical trills or taps). While uvular trills tend to be regarded as rhotics, even if not target-like for a specific language or variety, other speech sounds may fall outside the category for native listeners; these may ultimately be rejected by the speech community and remain as idiosyncratic realizations, or they may become serviceable rhotics,

thereby expanding the class. Examples of the latter are uvular fricatives, now the dominant *r* in French, and vocalic offglides such as [ə] or [ɐ], functioning as coda-*r* in German and Danish. The remainder of this section will examine another such variant: the labiodental approximant [ʋ], currently spreading in UK English.

Foulkes & Docherty (2000) trace the history of discourse around [ʋ] in academic and nonacademic works, to find that it has a long tradition of being regarded as defective speech, as well as a feature of upper-class affectation, going back as far as Dickens's *The Pickwick Papers*. It has since been used a source of ridicule in books, films, and commercials. They subsequently note an increasing number of linguistic sources from the 1970s, 1980s, and 1990s reporting [ʋ] as either newly emerging or already widespread and common variant of *r*, primarily a feature of young urban speakers, and spreading from the southeast of England. This means that in a relatively short space of time, labiodental variants have become accepted realizations of /r/ in at least some varieties of British English, and in fact have considerable social currency helping them spread to new varieties. Foulkes & Docherty's data come from Newcastle and Derby (urban centers in the northeast and East Midland areas of the UK, respectively). They show that use of [ʋ] is an incipient phenomenon in Newcastle, while it is already more established in Derby, especially among the working-class speakers in their sample. In discussing possible explanations for the rise of labiodental variants of /r/, Foulkes & Docherty consider them as part of a larger group of consonantal changes (including t-glottaling and TH-fronting) that emanate from southeastern accents and simultaneously move away from the traditional standard accent and from strongly local varieties (in other words, dialect leveling towards a prestigious, though nonstandard, reference accent).

Foulkes & Docherty (2000) used a relatively classical sociolinguistic approach. Apart from the independent variables being class, age, and location, their dependent variable is framed in terms of discrete phonetic categories in competition with each other. On the other hand, they acknowledge that their acoustic data display gradient variation, which they encode by having categories in between lingual [ɹ] and labiodental [ʋ] ("more [ʋ]-like than [ɹ]-like," and vice versa). That said, when examining the acoustic detail in their Newcastle and Derby data, they conclude that there is a qualitative difference between the [ɹ]-like and [ʋ]-like variants: the most typical acoustic correlate of post-alveolar (bunched or retroflex) realizations of /r/, a low third formant, was absent from the auditorily most labial-sounding tokens. This is despite lip-rounding itself also having a slight lowering effect on F3 (as part of a general lowering of formants, but especially F2, due to an increased front cavity). The phonetic pathway from lingual to labial *r* in these varieties of English is most likely not a purely acoustic one, but has an important articulatory component: what we have been calling "lingual" *r* here is usually described as having considerable secondary labialization, with [ɹʷ] a more apt transcription (e.g., Collins & Mees 1996). What remains underexplored, then, is the relative contribution of labialization of the lingual variants to their acoustic makeup, and the link between the labial component in them and the subsequent development of the labiodental variants. It is this kind of production–perception link that could provide another piece of the puzzle explaining the rapid uptake of the change. In recent years, more detailed phonetic studies, including those analyzing articulatory data, have indeed shed light on the interplay between the lingual and labial gestures in *r* variants. The work of King & Ferragne (2020a, 2020b) and King & Chitoran (2022) has shown that the labial gesture plays a crucial role in the acoustics of variants that retain the lingual gesture, too, and that the visual aspect is another factor that deserves highlighting.

The widely held assumption discussed above that Anglo-English (non-rhotic) *r* is generally a tip-up approximant variant is challenged by the work of King & Ferragne (2020a). They show that, in fact, non-rhotic Anglo-English speakers display gestural variation similar to that of

rhotic American English speakers, including bunched variants, although the proportion of tip-up speakers is higher (similar results for New Zealand English, also nonrhotic, are reported in Heyne et al. 2020). King & Ferragne additionally note the relative absence of studies into the labial gesture which is, nonetheless, often noted as a feature of Anglo-English *r.* Their study shows that bunched realizations tend to be accompanied by more lip protrusion, and suggest that this may be a compensatory gesture in order to achieve an acoustic output sufficiently similar to that of retroflex speakers. The specifics of the labial gesture are at the same time sufficiently different from those of /w/, so that a perceptual contrast is maintained. Intriguingly, they suggest that the *r*-specific lip configuration comes from exposure to labiodental *r* speakers (an idea first put forward by Dalcher, Knight & Jones 2008, based on perception data); since labiodental *r* lacks the characteristic low F3 (acoustically present with both bunched and retroflex *r* speakers), Anglo-English listeners have come to rely more on the second formant. While this is low for [ɹʷ], it is lower still for [w], so the /r/~/w/ contrast is maintained—even if somewhat precariously.

In a separate study, King & Ferragne (2020b) show that an artificial neural network trained on images of the labial gestures in /r/ versus /w/ is able to classify these with an accuracy of over 90 percent, confirming that they are indeed significantly different. While the authors are careful not to extrapolate these results to human perceivers, their study certainly suggests that for face-to-face interactions, visual cues may be more important (and perhaps even sufficient) for the contrast. King & Chitoran (2022) take up this question using a cleverly designed study with matching and mismatching audio/visual [ɹʷ]~[w] pairs. They find that native Anglo-English speakers are indeed also near-perfect in identifying the contrast relying on visual information only. Auditory information alone, on the other hand, leads to considerable ambiguity. King & Chitoran conclude that the robustness of the visual contrast may contribute to an ongoing shift towards nonlingual variants in the future.

While King & Ferragne (2020a, 2020b) and King & Chitoran (2022) are not sociophonetic studies as such, as they are not focused on socially based variation, the suggested pathway of lingual to labial variants is an important contribution to the study of sound change. These studies shed light on mechanisms that have heretofore been inaccessible, but that are central in answering the basic sociolinguistic questions of how sound changes come to be (actuation) and spread (propagation) (Weinreich, Labov & Herzog 1968).

CASE STUDY Dutch *r* variation

Dutch *r* variation is particularly complex, both socially and phonetically, due to the wealth of realizations possible not only across regional varieties of Dutch (Weijnen 1991; De Schutter & Taeldeman 1993, 1994; van Reenen 1994) but even within the relatively codified standard variety. For instance, all three processes described in the previous section are relevant. There is variation between alveolar and uvular *r* variants, particularly at the geographical level, both at a large scale (Netherlandic vs. Belgian Dutch) and at smaller ones (e.g., Bruges vs. Ghent Dutch). There is a relatively recent variant now rapidly spreading in the form of an approximant acoustically similar to those in varieties of English; articulatory studies have shown similar patterns to those in American and Scottish English, both in terms of gestural variation and gestural weakening. However, this only scratches the surface of the issues involved. This section first provides a brief overview of recent findings, and then turns its focus on the following questions: 1) How are the Dutch *r* variants linked, that is, what are the phonetic pathways

that may have led particular variants to arise from other types of *r*? 2) How do social factors (age, gender) and geography interact with the linguistic ones, specifically the phonetic ones identified under 1)? We aim to demonstrate again how examining the phonetic detail and its social context maximizes our insight into processes of variation and change.

Methods

That Standard Dutch has a large amount of *r* variation was increasingly observed in studies from the 1990s, when Voortman (1994), Booij (1995), and Van de Velde (1996) identified five, six, and ten variants respectively. This century saw even more detailed studies into Dutch *r* expand the number of variants to 24 (Smakman 2006), though here we will discuss the data and classification used in Sebregts (2015), which recognizes an only slightly more manageable 20. Unlike the other studies mentioned above, Sebregts (2015) focused solely on the realizational variation of *r* in ten urban varieties of Dutch most accurately described as colloquial Standard Dutch—that is, morphosyntactically

Figure 9.1 Location of the cities in the HEMA urban accent corpus within the Dutch language area

and lexically standard while allowing for variation in the sound system. Data were collected in Amsterdam, Rotterdam, The Hague, Utrecht, Nijmegen (the first four being the largest cities in the Netherlands), and Bruges, Ghent, Antwerp, and Hasselt (the largest cities in four of the five Flemish provinces in Belgium). Locations are mapped in Figure 9.1.

In each of the cities, 40 speakers, stratified by age and gender, were recorded as they participated in a picture-naming and word list reading task eliciting /r/ in a number of segmental and syllabic contexts. Recruitment was done "in the field" (i.e., by approaching patrons of cafes/restaurants in their local HEMA department store). Tokens of /r/ in the recordings were coded and transcribed by the author and Evie Tops (see Tops 2009) based on auditory and visual (spectrographic) analysis. Table 9.1 shows the twenty variants.

Results

As shown in Table 9.1, the variation concerns place of articulation (Dutch *r* can be alveolar, retroflex, palatal, or uvular) and manner (trills, taps, fricatives, approximants, and vowels coexist, as well as "zero" variants, i.e., *r*-deletion). Not all speakers use all variants. Some variants are not found in some of the urban accents at all; the number of variants per accent varies between 14 (Hasselt, The Hague) and 20 (Utrecht). Variation is also strongly constrained by the syllable context, with the number of variants found in onsets between seven and ten, while in codas it varies between 13 and 20.

Sebregts (2015) contains detailed descriptions of how the variation plays out in each city in the corpus. Figure 9.2 shows the distribution of the main six *r* categories in each Dutch (NL) and Belgian (FL) city. Place of articulation varies strongly from city to city. In Antwerp and Bruges, for instance, speakers largely use alveolar *r*, while speakers in Ghent and Nijmegen use mostly uvular variants. The token frequency of alveolar and uvular variants is most balanced in Rotterdam, Leiden, and Hasselt. However, zooming in on individual speakers reveals how this balance can have different sources; while in Hasselt, speakers tend to be either alveolar or uvular *r* speakers, a much larger number of Leiden speakers vary between the two. Manner of articulation reveals similar patterns of variation at city and individual levels, although here the major divide is the Dutch/Belgian border: while in the Belgian Dutch varieties *r* is largely consonantal (trills, taps, fricatives) in all syllable contexts, the Netherlandic ones show an allophonic pattern of consonantal variants in the onset and approximants and vowels in the coda.

Apart from larger geographical patterns and how these are shaped by individual speakers of each accent, the data also show effects of gender and age on the use of particular variants, suggesting changes in progress. For instance, in Hasselt there is an effect of age on the use of alveolar versus uvular variants, with young speakers using more uvular variants. In other words, uvular *r* seems to be gradually replacing alveolar *r.* The specific sociolinguistic situation is conducive in two ways. While the alveolar trill is the traditional prestige variant, that prestige is waning. At the same time, Hasselt is located in an area where uvular *r* has been a local vernacular form for a long time.

The more spectacular change in progress visible in the Dutch urban accent data concerns the rapid spread of what is identified as a retroflex/bunched approximant in Table 9.1. This variant marks the most salient split between the Netherlands and Flanders in the data. While virtually absent from Belgian Dutch, the retroflex/bunched approximant makes up almost 20 percent of coda tokens in Nijmegen, the

Table 9.1 *r* variants in the HEMA urban accent corpus

IPA	*Descriptive label*
r	voiced alveolar trill
r̥͡ɹ̝̊	partially devoiced alveolar trill
r̥	voiceless alveolar trill
r͡ɹ̝	alveolar trill/tap followed by homorganic frication
ɹ̝	voiced (post)alveolar fricative
ɹ̝̊	voiceless (post)alveolar fricative
ɾ	voiced alveolar tap
ɾ̥	voiceless alveolar tap
ɹ	alveolar approximant
ʀ	uvular trill
ʀ̝	uvular fricative trill
ʁ	uvular fricative
ʁ̞	uvular approximant
ɻ	retroflex/bunched approximant
j̇	palatal approximant
ɛ	low-mid front vowel
ə	central vowel (schwa)
ɐ	low vowel
ØC̱	elision of /r/ with retraction of the following C
Ø	elision of /r/

Source: Sebregts 2015

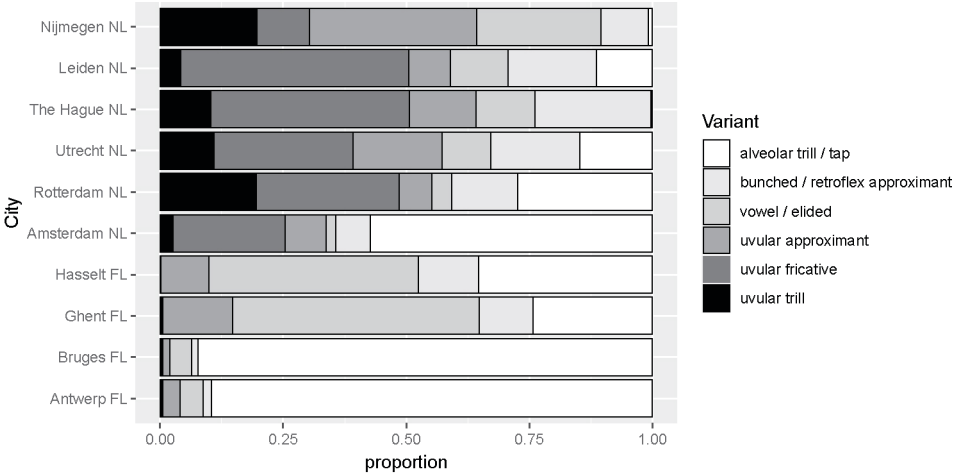

Figure 9.2 Frequency distribution of the six main *r* categories in six Dutch (NL) and four Flemish (FL) cities

Dutch city with the lowest frequency for this variant. In Leiden, on the other end of the frequency scale, this goes up to as much as 84 percent of coda-*r*. As a change in progress, it shows effects of age and gender, with young female speakers leading the way. The variant is also linguistically constrained, as it is confined to coda position. As Scobbie & Sebregts (2010) demonstrate in an articulatory study using ultrasound, this leads to complex allophonic patterns. Individual speakers combine either alveolar or uvular *r* variants in onsets with either bunched or retroflex *r* in codas, without there being an obvious articulatory connection between the two.

Discussion

The theoretical focus of Sebregts (2015) is on how the *r* variants are related to each other, a concern shared by many working on rhotics, as outlined in our introductory section. Taking off from Lindau's (1985) famous model of family resemblances among rhotics, a model of family relationships is built around the phonetic pathways that may lead certain rhotics to develop from others, through processes that are common in casual speech such as reduction/lenition, as can be seen in Figure 9.3.

The model in Figure 9.3 works through "inspecting very closely the phonetic detail of *r* sounds in connection with their linguistic distribution in a large corpus such as the urban accent data that enable the establishment of the origin of particular variants in others" (Sebregts 2015:280). An example of where this works particularly well is the development of fricative variants from trills. Based on detailed phonetic explorations such as Solé (2002), fricative *r* variants are predicted to occur due to trill failure. Trill failure itself is predicted on the basis of the articulatory complexity and aerodynamic precarity of trills, and it is even possible to predict where it is more likely to happen. For alveolar trills, specifically, the syllable coda and the segmental environment of high vowels are the most likely loci for the occurrence of fricative variants. Sebregts (2015) shows that these are indeed the contexts in which alveolar fricative variants occur most in the Dutch data, establishing the relationship between trills and fricative rhotics as one based on co-articulation and reduction. It also becomes clear, however, that these processes are not automatic and variety-independent but instead partially under control of the speaker. The relative frequencies of voiced, partially devoiced, and fully devoiced/fricated alveolar trills differ from city to city, and coda-*r* in Antwerp appears to have a more strongly devoiced/fricated target than that in Bruges, for instance, despite strong similarities in *r* patterns at a more superficial level.

There are also cases in the Dutch *r* data where the model seems to work less well—that is, where close examination of the phonetic detail of variants in conjunction with their distributional patterns leads to counterintuitive or paradoxical results. A clear example of this is the rapid rise of retroflex/bunched *r* in coda positions in the Netherlandic Dutch data. Here, the ultrasound study by Scobbie & Sebregts (2010) had confirmed the articulatory complexity of both the retroflex and the bunched variants subsumed under the label, each involving at least two constrictions. This makes them less clear candidates for a reduction analysis; though strictly coda variants, they are likely to be more complex than many of the onset variants used by the same speakers. This is exactly where the combination of phonetic and sociolinguistic arguments becomes crucial again: to explain the adoption and rapid spread of a gesturally complex variant, disrupting the phonetic model, we need recourse to its social status. As shown in a series of studies by Van Bezooijen and colleagues, the retroflex/bunched

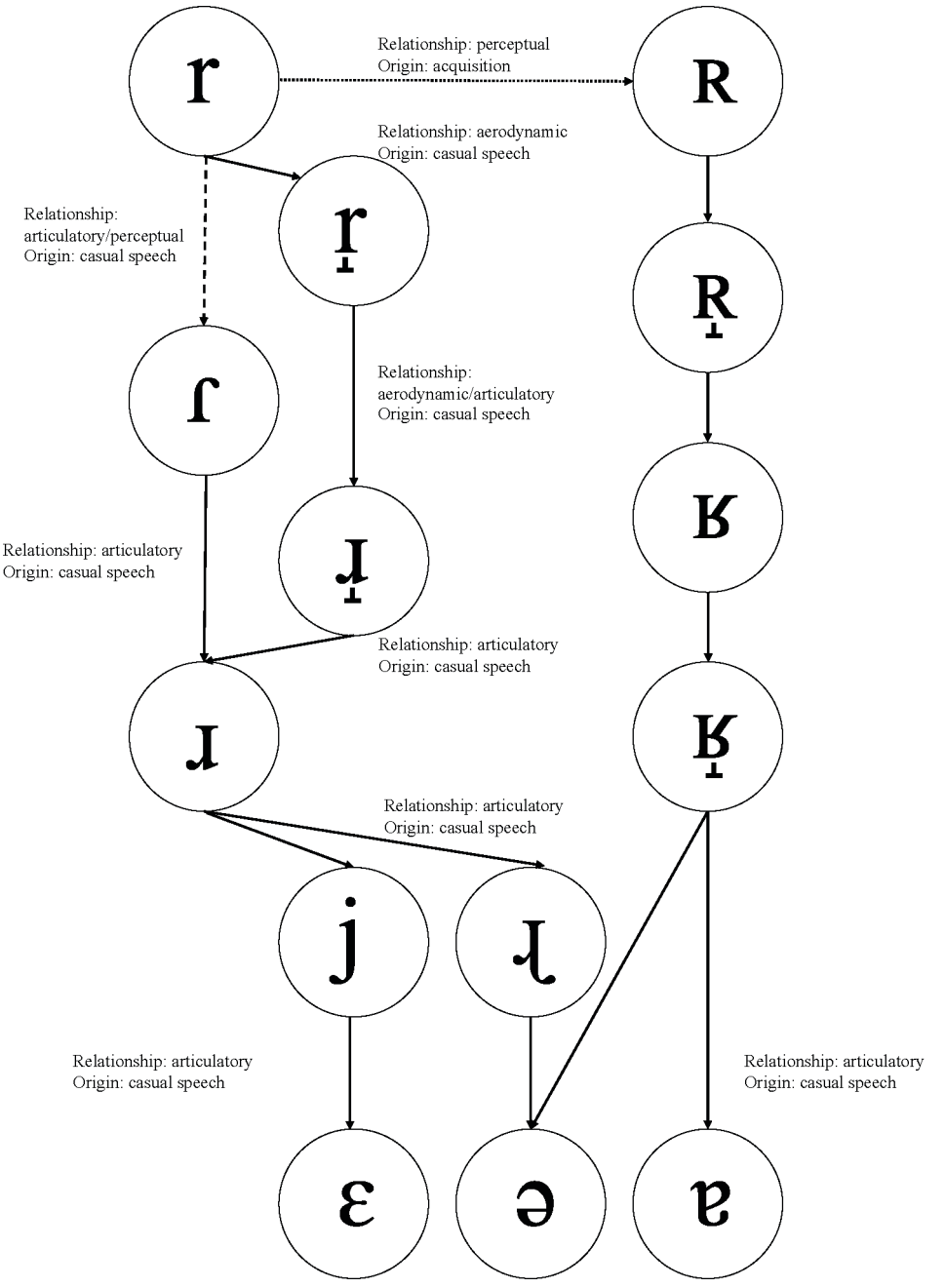

Figure 9.3 Family relationships between Dutch *r* variants, with place of articulation on the horizontal axis and manner of articulation on the vertical axis

Source: Sebregts 2015

approximant (known popularly as "Gooise r") is a high-prestige variant in the Netherlands (Bezooijen, Kroezen & van de Berg 2002; Bezooijen & van den Berg 2004; Bezooijen 2005). All in all, the situation surrounding Dutch *r* variation offers a rich testing ground for sociophonetic methodologies and, conversely, only by combining the social and the phonetic can we achieve new levels of insight in the phenomena under investigation.

The future of rhotic studies

Given the complexity of rhotics and their common and deep embedding in social and historical processes of variation and change, their study is a playground for methodological innovations and theoretical developments. The great variability and fuzzy character of rhotics indicate the necessity to improve their description in language typological databases. The present sociophonetic insights in rhotic variation are strongly based on West-Germanic (Dutch, English, and German) and Romance languages (Italian, French, Spanish, and Portuguese). These studies strongly suggest that alveolar variants and trills are over-reported and that the actual amount of variation is consistently underestimated (Anselme, Pellegrino & Dediu 2023). A structured template to describe rhotics is required, in addition to guidelines for the construction and analysis of large speech corpus data. Even for trained phoneticians it is notoriously difficult to distinguish the wide range of *r* variants, and there is a need to study *r* in large speech corpora in a wide range of languages. Hence, tools for the automatic classification of *r* variants, as well as tools for the detection of (possible) new variants in speech corpora should be developed with the help of machine learning techniques.

Another line of research should test specific hypotheses of the articulatory, aerodynamic, and acoustic characteristics of the variants and their relationship to obtain more insight in the class of rhotics. Ultrasound research has proven to be crucial in detecting more detailed articulatory gestures, but other techniques, like fMRI, articulography, or dynamic digital radiography could be explored. Measuring the acoustic and aerodynamic characteristics and visualizing in increasing detail the articulatory movements in the production of variants may uncover the contrastive spectral values and link these to articulatory gestures.

In addition to variationist quantitative studies of speech corpora, we want to argue for a more experimental approach, as proposed in laboratory sociolinguistics (Van de Velde et al. 2021). Important research tracks are the link between (variability in) production and (variability in) perception, the processing of variation in speech production and speech perception, and the acquisition of rhotic variation by both L1 and L2 speakers. Interestingly, various psycholinguistic experimental designs offer pathways for research. A promising perspective is lexically guided perceptual learning where the boundaries between two phonemes are being manipulated, for instance the boundaries between the liquids /l/ and /r/ (Scharenborg, Mitterer & McQueen 2011). Acoustic manipulations could be applied to various *r* variants, or to sounds like [χ] in Dutch that may classify as either a rhotic or a fricative.

Priming effects present another promising experimental approach. Priming research has been carried out on (ing), another classic sociolinguistic variable (White, Tamminga & Embick submitted). The alveolar and velar variants have different effects on priming words. Extending this observation to *r*, it would be relevant to know how priming processes are activated by, for example, word-final absence or presence of /r/. It would provide information on the processing of competing variants and on the way sociolinguistic variants are being stored in memory. An important research question might be whether (all) reduced variants have the same priming effect as full variants,

or whether new variants differ in priming from the old ones. Priming research can be combined with eye-tracking, a very attractive way to measure processes below the level of consciousness. Techniques from social psychology like the Implicit Association Task might be instrumental in uncovering the indexical properties of the observed *r* variants (Hilton et al. 2016), but a relatively direct approach with a systematic set of words with pronunciation variants and pictures with social meanings and/or associations might work as well (see Staum Casasanto, Grondelaers & van Hout 2015).

A fascinating observation is that the observed patterns of change are mainly of a reductive nature, especially in large speech communities, resulting in a simplification of the articulatory complexity of *r* in a language variety. It is tempting to link processes of reduction to linguistic complexity and population size (Fenk-Oczlon & Pilz 2021), but at this point it is again important to realize that our insights into rhotics are mainly based on Germanic and Romance languages, and that a wider scope of languages and speech communities is needed.

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