



# Sociophonetics

## Document Version

Submitted manuscript

[Link to publication record in Manchester Research Explorer](#)

## Citation for published version (APA):

Baranowski, M. (2013). Sociophonetics. In R. Bayley, R. Cameron, & C. Lucas (Eds.), *The Oxford Handbook of Sociolinguistics* (pp. 403-424). Oxford University Press.  
<https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199744084.001.0001/oxfordhb-9780199744084-e-20>

## Published in:

The Oxford Handbook of Sociolinguistics

## Citing this paper

Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

## General rights

Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

## Takedown policy

If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [<http://man.ac.uk/04Y6Bo>] or contact [uml.scholarlycommunications@manchester.ac.uk](mailto:uml.scholarlycommunications@manchester.ac.uk) providing relevant details, so we can investigate your claim.



Baranowski, M. 2013. Sociophonetics. In Bayley, R., Cameron, R., & Lucas, C. (eds.) *The Oxford Handbook of Sociolinguistics*. Oxford: Oxford University Press. 403-424

## **Sociophonetics**

Maciej Baranowski

The term *sociophonetics* refers to the interface of sociolinguistics and phonetics, and specifically to the use of modern phonetic methods in the quantitative analysis of language variation and change. Although its definition can be quite broad, including any sociolinguistic study involving sounds analysed impressionistically, it usually implies the use of instrumental techniques. It remains to be seen whether sociophonetics develops into a separate discipline, with its own questions and standards of proof, or whether it continues to mark a methodological approach within variationist sociolinguistics. This chapter takes the more modest view of sociophonetics as a tool contributing to our understanding of the nature of language variation and change. Assuming a basic knowledge of acoustic phonetics, it focuses on sociophonetic methodology, with particular attention paid to the practice of acoustic vowel analysis.

The foundations of what is referred to as sociophonetics today were laid by Labov, Yeager and Steiner [LYS] (1972) in their seminal study of variation and change in American English vowels; the term *sociophonetics* has until recently been largely associated with acoustic vowel analysis. Although it is now broader and includes the instrumental analysis of other types of speech sounds, the acoustic analysis of vowel variation and change remains its central focus. For the first few decades following LYS, acoustic studies of vowel variation were conducted almost exclusively in the United States, first at the University of Pennsylvania, e.g. Hindle (1980), Labov (1991, 1994), Ash (1996), Fought (1999), and then elsewhere, e.g., Fridland (2001), Thomas (2001). The last decade has seen a rapid growth of acoustic vowel studies, both of North American English, e.g. Baranowski 2007, Boberg 2008, Yaeger-Dror and Thomas

(2010), and of other varieties of English, e.g. Australian English (Cox 1999), Singapore English (Deterding 2003), English English (Kerswill, Torgersen, and Fox 2008), Brunei English (Sharbawi 2006), and New Zealand English (Maclagan & Hay 2007). The *Atlas of North American English* [ANAE] by Labov, Ash, and Boberg (2006) deserves special mention as the most comprehensive and arguably most important sociophonetic study of vowel variation and change since LYS.

Most sociophonetic studies of vowels have investigated variation and changes in the position of vowels in phonetic space, measured in terms of differences in F1 and F2 (and occasionally F3, e.g., Bowie 2008), over time and across different dialects or social groups. These include studies of vowel shifts mentioned above, and studies of vowel mergers (e.g. Baranowski 2013; Johnson 2010, Eberhardt 2008) and near mergers (e.g., Di Paolo & Faber 1990, Labov, Karen, and Miller 1991). Vowel duration has been studied as a factor in chain shifts (e.g. Jacewicz, Fox, & Salmons 2006; Labov & Baranowski 2006, Langstrof 2009) and mergers (Di Paolo 1992), in regional variation in American English (Jacewicz, Fox, & Salmons 2007, Tauberer & Evanini 2009) and in studies of the Scottish Vowel Length Rule (e.g. Scobbie, Hewlett, & Turk 1999).

### **Selection of Tokens for Analysis**

The minimum number of tokens required depends on the research questions of the study and on the number of speakers involved. In studies investigating vowels, the first question to consider is whether the complete vowel systems of the informants are to be studied or whether the focus is on one or two vowels. The latter includes studies of the movement of a particular vowel in phonetic space, e.g. Fabricius' (2002) study of the tensing of word-final /i/, as in *city*, *happy*, or investigations of the phonemic status of two vowels, such as studies of the *cot-caught* merger in

North American English (e.g., Johnson 2010; Nycz 2011). Such studies often involve the measurement of a large number of tokens per speaker of just one or two vowel phonemes. Large numbers of tokens of a phoneme are particularly desirable when there are lexical effects at play. When there is some indication that the same phoneme may behave differently in different words depending on their frequency (Bybee 2002), for instance, then the vowel should be measured in as many different words as are available in the recording.

Many other studies, however, investigate the complete vowel systems of the informants, e.g., LYS, ANAE, Baranowski 2007; Dinkin 2009; Thomas 2001; they include the measurement of all vowel phonemes in all phonological environments relevant in a given dialect. One major advantage of this approach is that changes to a particular phoneme are often part of a larger change involving other vowels in the same sub-system. In other words, the vowel we are interested in may be affected by changes to other vowels and it itself may affect other vowels as well; looking at the whole vowel system may allow us to gain a better understanding of the mechanisms of these changes. This is seen most clearly in chain shifts, such as the Northern Cities Shift (ANAE; Gordon 2001) or the Southern Shift (ANAE, Fridland 2001; Labov 1994), where one cannot fully understand a change in one vowel without looking at changes in the rest of the system.

Another case in point is the *cot-caught* merger mentioned above. It is often part of a larger change, co-occurring with a shift in the position of other vowels, i.e., the backing of /æ/ and the backing and lowering of /ɛ/ and /ɪ/. It is a feature of Canadian English known as the Canadian Shift (see Boberg 2005), but similar developments have recently been found in sociophonetic studies of California (Eckert 2004), Charleston, South Carolina (Baranowski 2013), and Illinois (Bigham 2009). This insight would have been lost if the focus had been

exclusively on the two low back vowels.

An intermediate approach is, while focusing on a particular phoneme, to include the formant measurements of a few other vowels occupying the most peripheral positions in acoustic space which are known to be stable in the speech community, i.e., are not undergoing change. These vowels, e.g., the highest and frontest and the lowest or most retracted, are treated as anchor points which can be used to study the relative position of other vowels and their change in apparent time. This approach was successfully adopted by Fought (1999) in her study of /uw/-fronting in Chicano English, where the vowel of *seat* and the vowel of *cot* and *father* (merged in the dialect) were used as anchor points. Fought took the ratio of the speakers' mean F2 of /uw/ to the mean F2 of the two anchor vowels as the measure of the extent of the fronting.

The difficulty here is knowing whether the vowels used as anchor points are actually stable in the community. Therefore it is best to obtain measurements of the complete vowel system for at least a selection of speakers, those representing the oldest and the youngest generations, even if the focus of the study is on one or two phonemes. Naturally, for a study of a speech community whose vowel system has not been studied systematically before, looking at the complete vowel system is the best option.

In order to measure the complete vowel systems of our informants, we first need to identify all the vowel phonemes, i.e. all the relevant word classes. For British English dialects, the word classes identified by Wells (1982) can be used. Chapter 2 of the ANAE provides a list of word classes relevant to the study of American English dialects. Each of them should be assigned a unique code used in the logging of the measurements and in statistical analyses. It is best not to use phonetic symbols, as those may not be read by statistical software. The ANAE, for example, adopts the numerical codes used in the Plotnik program (Labov 2011), with a single

digit identifying short vowels and double-digit codes identifying long vowels.

Normally only vowels in fully stressed syllables in mono- or disyllabic words should be selected for analysis. They should not be preceded by obstruent-liquid clusters, as those have a lowering and backing effect on the position of vowel nuclei. Therefore, for example, it is not a good idea to use the words representing Wells's (1982) lexical sets, such as *dress*, *trap*, *strut*, or *fleece*; other words representing those classes, ones without initial clusters, should be used instead. The point is not necessarily to exclude tokens with initial clusters from the study entirely, as there may be good reasons for looking at them, but to be sure to exclude them from the calculation of the vowel's mean formant values. Similarly, vowels preceded by glides, as in *weed* or *you*, are best avoided, as it is difficult to determine reliably where the consonants ends and the vowel begins in such tokens. Words with initial /h/, as in *hat* or *hit*, are the best because of the minimal effect of /h/ on the following vowel; they should be the first candidates for wordlist items.

A related requirement in selecting tokens for analysis is that they should occur in different phonological environments. Our view of the acoustic position of a vowel might be skewed if, for instance, all our tokens should have coronal onsets. One well-known case of strong allophonic differentiation in English is the influence of the preceding consonant on the extent of the fronting of /uw/: after coronals, as in *two* or *do*, /uw/ tends to be more fronted than after non-coronal consonants, as in *move* or *hoot* (ANAE: Ch. 12; Fridland & Bartlett 2006). Therefore tokens of /uw/ in both environments should be measured.

Following liquids and nasals require special attention. In rhotic dialects of English, the influence of a following /r/ on the preceding vowel is so strong that such vowels form a separate sub-system and as such should be analysed separately from tokens of the same vowel in non-

rhotic environments. The influence of a following lateral is often quite strong as well. For example, in most dialects of English the fronting of back upgliding vowels /uw/, as in *too* and *food*, and /ow/, as in *go* and *boat*, is markedly less advanced when the vowel is followed by /l/, as in *tool*, *fool*, and *goal* and *pole*, respectively. Therefore tokens with a following /l/ should be analysed separately, i.e., they should not be included in the calculation of the mean formant values of a vowel. Similarly, tokens with following nasals may need to be analysed separately because of the strong effect of nasals on the quality of a preceding vowel, which can lead to marked allophonic differentiation between nasal and non-nasal tokens, e.g., in short-*a*, as in *ban* and *sad*, in many dialects of American English (ANAE: Ch. 13.2). The influence of a following nasal can also lead to the loss of phonemic distinctions between vowels, as in the *pin-pen* merger (ANAE: 67; Baranowski 2013; Brown 1990). In the *cot-caught* merger, tokens followed by nasals and laterals tend to be higher and more retracted than when followed by other consonants, therefore they should be analysed separately.

Finally, for those vowels which can occur in either checked or free position, e.g., /ow/, as in *go* and *goat*, respectively, i.e., for phonologically long vowels, both should be represented in the measurements and should be coded separately. In free position, /ow/ (*go*) tends to show more advanced fronting than in checked position (*goat*) (Labov 1994; Baranowski 2008). In Philadelphia, the nucleus of /ey/ in free position, as in *pay*, is quite open, aligning itself with the South, whereas in checked position, as in *pace*, it is being raised, a reversal of a previous lowering trend (Labov 2001; Conn 2005). Without tokens measured in both positions, coded separately, it would have been difficult to spot such differentiation. This also suggests that the coding needs to go beyond the words representing Wells's (1982) lexical sets, where FACE stands for both *pay* and *pace*, and GOAT includes *goat* and *go*.

Assuming that checked and free vowels are coded separately, the minimum number of tokens required for analysis in each category ranges from ten to fifteen. This way, the complete vowel system of a speaker of American English can be captured with the measurement of 300 to 400 tokens. Whilst more tokens can be measured if we are particularly interested in a phoneme undergoing a change or if there are lexical effects at play, it is probably not a good idea to include more than three or four tokens of the same word.

### **Selection of the Points of Measurement**

The number of points of formant measurement in the vowel can vary from a single point in the nucleus (with another at the glide) to a measurement at regular intervals, e.g., every 10 ms, throughout the duration of the vowel. The choice is determined by the research questions of the study. Vowel trajectories, for example, are best studied with multiple points. They may reveal important differences between regions or social groups, as found in the studies of vowel diphthongization and shifting in the South (Feagin 1996; Koops 2010; Yaeger-Dror & Thomas 2010). Detailed investigations of vowel trajectories can also improve our understanding of the mechanisms of vowel mergers, such as the *cot-caught* merger (Di Paolo 1992; Majors 2005) or the *pin-pen* merger (Scanlon & Wassink 2010).

However, while multiple measurement points can give us a wealth of information about the trajectory of a vowel, they make comparing large numbers of tokens and speakers difficult. In order to illuminate the mechanisms of language variation and change, we often need to compare speakers representing different generations and social groups. A single point of measurement in the vowel nucleus (and another at the glide) has proved to be effective at distinguishing social groups and dialect regions and identifying leaders of linguistic change. This is the approach adopted in the ANAE, which had been pioneered in LYS and has been used in



numerous sociophonetic studies of vowels since, e.g. Baranowski (2007), Boberg (2008), Conn (2005), Dinkin (2009), Labov (1994, 2001, 2010).

The main difficulty in this approach is deciding where in the vowel that point should be, given that the formant measurements taken at that point should best represent our overall impression of the quality of the vowel. There are two main approaches to this problem. One is to select a point after some specified amount of time from the beginning of the vowel, in order to avoid the transition from the preceding consonant. All tokens are then normally measured at the same point in time, e.g., 50 milliseconds. More commonly, the point is identified as a proportion of the duration of the vowel. Evanini (2009) tested a number of different percentage points, comparing the resulting measurements with the ANAE measurements (selected individually for each token) using the same tokens, and concluded that whilst for monophthongs the 50% point is usually fine, the best point for diphthongs is earlier, at around 30% of the vowel duration.

The other approach is to try to select a point in time that is the best indication of the central tendency of the nucleus of the vowel, i.e., its most important perceptual cue, which may be different for different phonemes (ANAE: 38). This is usually a point of inflection where the tongue has reached an extreme position in the nucleus before it starts moving into the glide. For short monophthongal vowels and for long upgliding vowels, this usually coincides with the lowest position of the tongue, indicated by a maximum F1 and a steady state, before it moves up again for the production of the glide or consonantal transition; the F2 is taken at the same point in time. The central tendency of ingliding vowels does not coincide with a steady state in F1 but rather with a movement towards and then away from the front or back periphery of the system. This point of inflection appears to be the best indication of the vowel's target, as in, e.g., short-*a* before nasals, as in *ban* and *Sam*, in American English, or the short front vowels /ɪ/ and /ɛ/, as in

*sit* and *set*, respectively, which are tense and ingliding in Southern Shift systems (ANAE: Ch. 11; Feagin 1996). In such cases, the point of measurement is at the maximum F2, indicating the maximum peripheral displacement of the tongue, with F1 measured at the same point. For ingliding vowels at the back of the vowel space, as in the long-o vowel (*caught*, *off*) in New York City or Philadelphia (Labov 1994, 2006a) the maximum displacement of the tongue towards the periphery of the system is indicated by a minimum F2, which is where the formant measurement is taken for such vowels. This is the approach taken in the ANAE and in many other large-scale studies of vowel variation and change, e.g., Baranowski 2013, Boberg 2008, Dinkin 2009.

This method of selecting the point of measurement, individually for each token, while ultimately more accurate and therefore better for the purposes of investigating the often subtle differences found between speakers in studies of sound change in progress, is fairly time-consuming, as it requires the visual and auditory inspection of each token. It is also less amenable to automated formant measurement, where a Praat script (Boesma & Weenink 2011) can take measurements at some pre-defined point in time for each vowel token automatically. There is ongoing work on improving the accuracy of automatic formant measurement for the purposes of studying vowel variation and change. William Labov's current project at the University of Pennsylvania (Labov & Rosenfelder 2010, 2011) has had promising results in this area; it provides automatic formant and duration measurement for a few thousand tokens per interview in a matter of seconds. The system requires that the complete interview be transcribed beforehand, so that the vowel tokens in the sound file can be automatically aligned with the transcript using the Penn Phonetics Lab Forced Aligner (Yuan & Liberman 2008); the formant measurements are then taken automatically at the 30% point. Although more work is needed—

high vowels do not yet reach the level of accuracy obtained for non-high vowels—and the need for a complete transcript is a potential resource issue, this is the direction in which the field is moving, particularly for studies involving large numbers of tokens. However, for smaller sociophonetic projects, with a limited number of speakers and tokens, selecting the point of measurement individually for each token may still be the best approach.

### **Logging and Plotting of Measurements**

Once the point of measurement is selected, the values obtained are logged in a text file, together with the appropriate vowel code, along with additional coding, e.g. for style, which is then imported for plotting and statistical analyses. The logging of the measurements, even when the measurement point is selected individually for each token, can be automated with the help of a Praat script; see the Praat User List at <http://uk.groups.yahoo.com/group/praat-users/> for advice on Praat scripting. Alternatively, Bartek Plichta's (2011) Akustyk package helps automate the analysis of formant frequencies, bandwidths, amplitudes, voicing parameters, duration, intensity, nasalisation, and voice quality.

Before the measurements can be analysed statistically, a critical next step is correcting gross errors and identifying outliers through the visual inspection of the vowel plots for each speaker. Gross errors are often due to the miscoding of a token as belonging to the wrong vowel class; such tokens can be easily spotted on a vowel plot because they usually occupy an unexpected position on the F1-F2 plane. There may also be tokens coded correctly which are clearly separated from the other tokens of the same phoneme. It is important to listen to those tokens and re-measure them if necessary. For example, if a vowel which looks to be much fronter than the other tokens of the same phoneme does *not* sound fronter than the other tokens, then this is most likely a measurement error, due to the influence of the surrounding consonants.

If, however, it does sound different from the other tokens, then it is a genuine outlier which should not be discarded, as it may be an advanced token pointing in the direction of a sound change in progress; see Labov, Baranowski, and Dinkin (2010) for a discussion of how to identify outliers and of their role in the perception of sound change.

The most commonly used tool for plotting vowels on an F1-F2 chart is the Plotnik program developed by William Labov (2011); the vowel plots in the ANAE were produced with Plotnik. It is much more than a plotting system—for many researchers, it is an indispensable analytical tool. It is used to display complete vowel systems or selected subsystems, e.g. back upgliding vowels, short vowels, etc., or selected phonemes or tokens. Plotnik automates the coding of tokens for their phonological environment on the basis of the spelling of the word, so that we can quickly display or highlight vowels with, e.g., following nasals or liquids, or voiceless consonants; the selection criteria can also include style and stress. It calculates and displays mean values (excluding tokens before nasals and laterals) and standard deviations for all or selected vowels, and calculates T-tests of statistical significance between the mean positions of any two vowels. Tokens can be labelled automatically and connections between nuclei and glides can be plotted.

### **Normalization**

Because young children, women, and men have different vocal tract lengths, and consequently different formant values for the same vowel phonemes, their formant measurements cannot be directly compared unless they are adjusted through normalization. The main goal of vowel normalization in sociophonetic studies is to eliminate variation due to the physical differences between speakers while preserving dialectal or sociolinguistic differences present in the speech community.

There are two main approaches to vowel normalization: vowel-intrinsic and vowel-extrinsic. Vowel-intrinsic methods use information obtained for a single vowel, such as fundamental frequency and formant values, without relying on information about the speaker's other vowels. For example, the method proposed by Syrdal and Gopal (1986) computes differences between Bark-converted F0, F1, F2 and F3 to model the degree of vowel advancement and height. One major advantage of vowel-intrinsic methods is that they do not require the measurement of the complete vowel system of a speaker. In addition, since they do not refer to the other vowels in the system, they work better in comparing language and dialects with different vowel inventories. Their main drawback, however, is that they rely heavily on F3, whose accurate measurement can be problematic. For some voices and in poor-quality recordings, a given setting of the expected number of formants may work well for F1 and F2 but not for F3; this is a particular problem for automatic formant measurement. These methods are also affected by rhoticized vowels, where F3 is lowered.

Vowel-extrinsic normalization methods use information on the formants of other vowels (usually F1 and F2) of the same speaker. They tend to work better than vowel-intrinsic methods for the purposes of studying vowel variation and change, but they are most effective when the speaker's complete vowel system has been measured. The two most commonly used methods are those devised by Lobanov (1971) and Nearey (1977), where the formant values of a token are adjusted through an algorithm using a grand mean of the formant values of all vowel tokens; Lobanov based on z-scores, Nearey based on log-means. In a more recent method by Watt & Fabricius (2002), the centroid value used in the calculation of normalized values is based on the F1 and F2 means of the most peripheral vowels in a speaker's system: one for high front, one for high back, and one for the bottom region of the vowel space. One potential problem with

this method is that it assumes a triangular shape of the vowel system, with one vowel at the bottom periphery of the system, whereas many vowel systems, at least in American English, show a butterfly-like pattern, with two low groups of vowels. Although a number of comparisons between the different normalization approaches have been made (Fabricius, Watt, and Johnson 2009; see also Labov 2006b), none of these methods can be said to be better than the others in all respects. Nearey is probably the most commonly used method in studies of American English vowels; a modified version is used in the ANAE and is implemented in the Plotnik program.

The NORM website (Thomas and Kendall 2007) provides a tool for normalizing formant measurements using different methods, including the three mentioned above, and discusses their advantages and disadvantages; see also Thomas (2011) for an accessible discussion of the differences between different normalization methods.

### *Consonants*

The study of consonantal variation has played a central role in sociolinguistics from its beginning, with many of the early studies exploring consonantal variables, e.g. rhoticity and TH-stopping in New York City (Labov 2006a [1966]), T-glottalling in Norwich (Trudgill 1974) and Glasgow (Macauley 1977), and lenition of /tʃ/ to /ʃ/ and /r/-spirantization in Panama City (Cedergren 1973), and consonantal variables in AAVE (Wolfram 1969). In fact, the bulk of variationist sociolinguistics dealing with sounds has involved the study of consonantal variation and change. This is particularly true of the UK, where the consonants have been affected by a number of changes, such as the glottalization of voiceless stops, TH-fronting, or the retreat of H-dropping (Williams & Kerswill 1999). Variationist studies of consonants in North America have focused on stable variation in the obstruents, e.g., in Philadelphia (Labov 1994, 2001), and have explored variation and change in the liquids, e.g., the decline of r-lessness in the South (Feagin

1990) and New England (Nagy and Irwin 2010), the change from alveolar to dorsal /r/ in Montreal French (Sankoff & Blondeau 2007), and /l/-vocalization (Ash 1982).

The vast majority of consonantal sociolinguistic studies conducted to date, including the ones mentioned above, have used impressionistic measurement methods. This is because in many cases, impressionistic analysis has proved sufficient and less time-consuming than instrumental analysis. Another reason is that clear-cut correlates of auditory impressions in the acoustic domain have often proved hard to find. On the other hand, auditory analysis is more subjective and tends to impose binary categorization on what may actually be phonetically gradient phenomena. Foulkes and Docherty (2006) stress that the use of instrumental methods, in addition to auditory analysis, can provide us with important new detail, unavailable through impressionistic measurement.

This approach is illustrated by their seminal work on the voicing and glottalization of voiceless stops in Newcastle and Derby (Docherty & Foulkes 1999), where acoustic displays of the speech signal were used to determine the presence or absence of an oral gesture, the presence and timing of voicing and creaky voice, the presence of a release burst and the presence and type of stop frication. The acoustic measurements were critical in distinguishing between a number of different glottalized variants of /t/ present in Tyneside, each showing social correlations, which would have been difficult to detect impressionistically. Similarly, in Straw and Patrick's (2007) study of glottal variation in /t/ in the speech of Barbadians in Ipswich, the visual inspection of spectrograms and waveforms of every token was used to determine the presence or absence of a glottal occlusion, the duration of the gap, and the presence and location of laryngealization; see Thomas (2011) for hands-on guidance on using acoustic methods in the analysis of t-glottaling. Instrumental methods have also benefited studies of variation and change in Voice Onset Time,

e.g., in the English of the Shetland Islands (Scobbie 2006), and investigations of substrate effects on the voicing of final consonants, e.g. in Wisconsin English (Purnell, Salmons, & Tepeli 2005).

Liquids show a particularly high level of variation, both within and across languages. One well-known case is the variation between clear and dark /l/ in English, with clear /l/s tending to be produced in syllable onsets and dark /l/s in syllable rimes. There is regional variation in both the distribution of the two variants and degree of /l/ darkening. Some dialects have been described as preferring one of the variants in both positions, e.g. Welsh English and many dialects of Irish English have traditionally been reported to use clear /l/ in all positions, whereas Lancashire English, most dialects of Scottish English, New Zealand English, or American English tend to use dark /l/ in all positions (Wells 1982).

Although Sproat and Fujimura (1993), using acoustic and X-ray microbeam data, concluded that l-darkening is a purely gradient process, with the two variants forming a single phonological entity, Yuan and Liberman's (2009) large-scale study measuring l-darkening through forced alignment suggests that there are indeed two distinct categories. F2 and the difference between F2 and F1 appear to be the most important acoustic correlates of the difference between clear and dark /l/: clear /l/ shows higher F2 values than those seen in dark /l/. Carter and Local (2007) used differences in F2 in their investigation of regional variation in the distribution and degree of /l/-darkening in Newcastle-upon-Tyne and Leeds. Similarly, Recasens & Espinosa (2005) used F2 and the difference between F2 and F1 as a measure of /l/ darkening in Catalan.

Another source of sociolinguistic variation in the liquids is /l/-vocalization. It is found across the English-speaking world, e.g. in many urban varieties of British English (Wells 1982, Foulkes and Docherty 1999), Glasgow (Stuart-Smith, Timmins, and Tweedie 2006), Philadelphia



(Ash 1982) and Australian English and New Zealand English (Horvath & Horvath 2001). As opposed to /l/ darkening or velarization, /l/ vocalization has proved a much bigger challenge to study acoustically, as the acoustic picture of a vocalized /l/ is almost identical to that of [w] or [o]. Although F3 has a lower amplitude (it is fainter in the spectrogram) in dark /l/ in comparison with a vocalized /l/ (Thomas 2011), in practice it is difficult to distinguish between the two reliably. The search for a robust acoustic correlate of /l/ vocalization continues, with promising attempts such as Dodsworth, Plichta & Durian (2006) using formant amplitude differences between /l/ and the preceding vowel, though the effectiveness of their method has yet to be replicated.

Articulatory methods have substantially improved our understanding of variation in /l/ production. They include X-ray microbeam mentioned above, electropalatography (Scobbie and Pouplier 2010), and ultrasound tongue imaging (UTI) (Gick et al. 2006). UTI holds particular promise as it is safer and less intrusive than the other methods, and it offers better coverage of the tongue.

The study of rhotics can also benefit from modern instrumental techniques. The term *rhotics* subsumes quite a diverse group of sounds, all spelt as “r” (see Van de Velde & van Hout 2001). There is the well-known effect of a lowered F3 in approximant variants of /r/, so F3 can be used as a measure of the degree of rhoticity in most dialects of English (though see Heselwood 2009). While there may be some lowering of F3 during apical trills, this is not the case in vernacular Scottish English accents, where F3 is normally flat (Stuart-Smith 2007). Uvular variants of /r/ show some raising, rather than lowering, of F3, with a lowered F2 (Thomas 2011). Another variant which shows no lowering of F3 is labiodental /r/ found in British English (Foulkes and Docherty 2000). This suggests that acoustic techniques by themselves are not

sufficient for a full understanding of the production of different rhotics, and should be supplemented with articulatory methods. Indeed, considerable progress has been made in recent years in uncovering the details of /r/ variation thanks to the use of UTI, e.g., in the study of /r/ in Glasgow by Lawson, Scobbie, and Stuart-Smith (2011).

### *Beyond segments*

Suprasegmentals have received limited attention in variationist studies in comparison with consonants and, especially, vowels. The areas that have been explored sociophonetically include variation in speech rate, rhythm, and intonation. There has been recent work on dialectal differences in speech rates, e.g., between New Zealand English and American English (Robb, Maclagan and Chen 2004), Dutch spoken in the Netherlands and in Belgium (Verhoeven, De Pauw, and Kloots 2004), or dialects of American English (Jacewicz et al. 2009). Kendall (2009) looks at variation, both individual and across speakers, in speech rate and silent pause duration in four ethnicities in North Carolina, Ohio, Texas, Washington, DC, and Newfoundland.

In the area of prosodic rhythm, sociophonetic studies have looked at substrate effects by measuring and comparing rhythm in English, a strongly stress-timed language, with varieties of English influenced by languages closer to the syllable-timed end of the rhythm spectrum. Low, Grabe, and Nolan (2000) established much of the current methodology of measuring rhythm and tested their formulas for the normalized Pairwise Variability Index by comparing rhythm in British and Singaporean English. Thomas and Carter (2006) compare the rhythm of African Americans born in the mid-19<sup>th</sup> century with the speech of European American Southerners born in that period and with Southerners of both ethnicities born in the 20<sup>th</sup> century. White and Mattys (2007) compare Standard Southern British English with Welsh, Shetland, and Orkney English, where substrate influences have resulted in more syllable-timed characteristics. Similar

comparisons have been made for other languages, e.g., Arabic dialects (Ghazali, Hamdi, and Barkat (2002), and Parisian French of European and North-African origin (Fagyal 2010).

Sociolinguistic studies of intonation have focused on dialectal variation. They tend to be studies of single dialects, whose goal was not to look at inter-speaker variation, e.g. Manchester (Cruttenden 2001) and Belfast (Wells and Peppe 1996), though a number of studies have looked at inter-speaker variation in one dialect, e.g., London English (Peppé, Maxim, & Wells 2000). There have also recently been a number of projects comparing different dialects, e.g., the Intonational Variation in English project (Grabe 2004), exploring intonational variation in nine dialects of English spoken in the British Isles, based on different speakers controlled for dialect, age, peer group and gender.

One prosodic feature that has attracted particular attention from sociolinguists is the rising intonation at the end of statements, referred to as uptalk or the High Rising Terminal, found particularly in Australian English (Guy et al. 1986), New Zealand English (Warren 2005), and American English (Lieberman 2008). This is also one of the areas where gender differences in prosody have been explored; another is variation in F0 range and in average F0 as affected by gender and sexual identity (Podesva 2007).

Sociophonetic studies of voice quality remain a much under-researched area deserving more attention from sociolinguists. The few variationists studies that have been conducted suggest that voice quality may show correlations with social factors (Esling 1978) and may play a role in sound change. Stuart-Smith (1999), for example, found in her Glasgow study that tongue settings and other voice quality parameters were significantly correlated with age, social class, and gender. Phonation differences have been found to play a role in maintaining a distinction between tense and lax /u/ before /l/ (*fool-full*, etc.) in Utah English, where the two

vowels overlapped in F1-F2; the measure used (Voice Quality Index) was the difference between the amplitudes of F0 and F1 (Di Paolo and Faber 1990). Finally, there is a growing body of research investigating correlations between the use of voice quality features such as falsetto, breathy voice, or creaky voice, and gender identity (Henton & Bladon 1988; Podesva 2007; Yuasa 2010).

### **Perception Studies**

Although sociophonetic research has largely focused on the production side of linguistic variation, studies of speech perception have played an increasingly important role in illuminating both the mechanisms of sound change in progress and the construction of the social meaning of variation (see Drager 2010; Thomas 2002). There is a sizeable body of research exploring the connection between phonetic variables and the social characteristics of the speakers as attributed to them by listeners. One group of studies deal with the identification of speakers' dialect, i.e., how accurate listeners are and what phonetic cues they rely on in their perception of different dialect regions (e.g. Clopper & Pisoni 2004; Preston 1999). Other studies explore the phonetic cues involved in the identification of speakers' ethnicity (Graff, Labov, & Harris 1986; Purnell, Idsardi & Baugh 1999; Preston & Niedzielski 2010), sexuality (e.g. Levon 2006), and children's gender (Foulkes et al. 2010).

There is also a growing body of experimental work exploring the perception of stable sociolinguistic variation. In a series of matched-guise experiments, Campbell-Kibler (e.g. 2007) looks at the social evaluation of the (ING) variable, finding interaction between the social characteristics attributed to speakers on the basis of the phonetic realisation of the variable and different social contexts, including other linguistic cues, in which the variants occur. Labov et al. (2011) test listeners' sensitivity to differences in the frequencies of (ING) variants used in the

same context through matched-guise experiments using a technique of magnitude estimation (Bard, Robertson, & Sorace 1996); they draw inferences on the window of temporal resolution of the sociolinguistic monitor, its sensitivity and the pattern of attenuation over time.

There have been a number of studies exploring the perception of sound change in progress. Labov et al. (1991) studied listeners' ability to discriminate between the vowels in the Philadelphia near-merger of /ε/ and /ʌ/ before intervocalic /r/ (*ferry-furry*, etc.) using unsynthesized tokens; a follow-up study used a series of tokens resynthesized along the *ferry-furry* continuum (Labov 2006b). Similarly, Di Paolo and Faber (1990) investigated the perception of the near merger of lax and tense vowels before /l/ in Utah English. Labov and Baranowski (2006) manipulated the duration of /ε/, as in *sex*, and /o/, as in *socks*, overlapping in F1-F2 space due to the Northern Cities Shift, to test the role of duration in category identification. Labov et al. (2010) studied the role of outliers in the perception of vowel shifts in Philadelphia by using tokens of the vowel in *bad* resynthesized along the front diagonal and registering listeners' impressions of the quality of the vowel through magnitude estimation (Bard et al. 1996). Plichta and Rakerd (2010) tested the perception of the fronting of the vowel of *hot* and *sock* involved in the Northern Cities Shift by using resynthesized tokens with varying F2 values; see Plichta's Akustyk package for a vowel synthesis tool with multimedia tutorials.

In addition, a number of studies have looked at the role of active sound changes in the perception and comprehension of dialects. Labov and Ash (1997; Labov 2010: Ch. 4) conducted gating experiments with spontaneous speech tokens to test the ability of listeners from Philadelphia, Chicago, and Birmingham, Alabama, to identify advanced tokens of the sound changes characterizing each of the areas, i.e., Philadelphia sound changes, the Northern Cities Shift, and the Southern Shift, respectively; they concluded that the changes can lead to

miscomprehension by both outsiders and members of the same speech community. Preston (2010) tested the comprehension of single-word tokens containing vowels involved in the NCS by listeners affected by the shift, and Fridland, Bartlett, and Kreuz (2004) explored the perceptual salience of the Southern Shift and back vowel fronting by using resynthesized tokens with shifted formant values.

Another recent line of research explores the influence of stereotypes and speakers' social characteristics on the perception of their speech. Niedzielski (1999) played tokens of /aw/, as in *house* and *about*, produced by a Detroit speaker to listeners from the same area and asked them to match their impressions of the quality of the vowel to a series of resynthesized tokens. Those listeners who had been told that the speaker was from Canada perceived the vowel to be higher than those who had been told she was from Michigan, who in turn perceived the Michigan-labelled vowel to be lower than it actually was, suggesting that dialect stereotypes affected their perceptions. Similarly, in an experiment using video guises, Plichta (2001) demonstrated that the ethnicity attributed to speakers can affect the evaluation of their speech.

Hay, Warren, and Drager (2006) showed that the perception of the distinction between the vowels in *near* and *square*, which have been undergoing a merger in New Zealand English led by low-status groups, depended on the age and socio-economic status attributed to the speakers on the basis of photographs showing the same speakers in different guises. Similarly, Koops, Gentry, and Pantos (2008) used eye-tracking to show that the perception of the *pin-pen* merger in Houston is affected by the perceived age of the speaker. These results bear directly upon the question of the direction and incrementation of linguistic change, suggesting that children may use correlations between speakers' social characteristics, such as age and social class, and the degree of the advancement of a change in progress (which may be below the level

of conscious awareness) in the construction of a vector pointing them in the direction of the change.

The last decade has seen a dramatic rise in the popularity of the term *sociophonetics*. This is at least partly due to its convenience in that it denotes both an area within sociolinguistics dealing with speech sounds and a methodological approach involving the use of modern instrumental techniques; at the same time it differs from lab-based phonetic studies in its focus on naturally occurring speech and greater emphasis on the representativeness of the speaker sample. However, the research questions, at least for now, are essentially those of variationist sociolinguistics, centering on the mechanisms of linguistic change and on the social evaluation of variation, i.e., the way social information is stored and processed. Although the use of sociophonetic methods has grown tremendously in the last decade or so, it remains to be seen whether sociophonetics develops into an independent discipline. Whilst some sociophoneticians have suggested that their results disprove traditional architectures of grammar and models of linguistic change (e.g. Foulkes & Docherty 2006), this claim remains controversial (cf. Labov 2006b). In any case, one of the biggest challenges in this area of research will be to ascertain whether newly discovered correlations between fine phonetic detail and social characteristics of speakers (or between fine phonetic detail and social meanings in the ‘indexical field’ (Eckert 2008)) are more than correlations: in short, to determine to what extent the socio-indexicality of variation is cognitively real and under cognitive control.

### References

- Ash, S. 1982. The vocalization of /l/ in Philadelphia. University of Pennsylvania dissertation.  
Ash, S. 1996. Freedom of movement: /uw/-fronting in the Midwest. In J. Arnold, R. Blake, B. Davidson, S. Schwenter, & J. Solomon (eds). *Sociolinguistic variation: Data, theory, and analysis: Selected papers from NWAV 23 at Stanford*. Stanford, CA: Center for the Study

- of Language and Information.
- Baranowski, M. 2007. *Phonological variation and change in the dialect of Charleston, South Carolina*. Publication of the American Dialect Society 92. Durham, NC: Duke University Press.
- Baranowski, M. 2008. The fronting of the back upgliding vowels in Charleston, South Carolina. *Language Variation and Change* 20:527-551
- Baranowski, M. 2013. On the role of social factors in the loss of phonemic distinctions. *English Language and Linguistics* 17/2: 271-295
- Bard, E., Robertson, D., & Sorace, A. 1996. Magnitude estimation of linguistic acceptability. *Language* 72:1-31.
- Bigham, D.S. 2009. Correlation of the low-back vowel merger and TRAP-retraction. *University of Pennsylvania Working Papers in Linguistics* 15(2), Article 4.
- Boberg, C. 2005. The Canadian Shift in Montreal. *Language Variation and Change* 17:133-54.
- Boberg, C. 2008. Regional phonetic differentiation in Standard Canadian English. *Journal of English Linguistics* 36:129-154.
- Boersma, P., & Weenink, D. 2011. Praat: doing phonetics by computer [Software]. Ver. 5.2.38, retrieved 6 September 2011 from <http://www.praat.org/>
- Bowie, D. 2008. Acoustic characteristics of Utah's *card-cord* merger. *American Speech* 83:35-61
- Brown, V. R. 1990. Phonetic constraints on the merger of /ɪ/ and /ɛ/ before nasals in North Carolina and Tennessee. *SECOL Review* 14:87-100.
- Bybee, J. 2002. Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change. *Language Variation and Change* 14:261-290.
- Campbell-Kibler, K. 2007. Accent, (ING), and the social logic of listener perceptions. *American Speech* 82:32-64.
- Carter, P., & Local, J. 2007. F2 variation in Newcastle and Leeds English liquid system. *Journal of the International Phonetics Association* 37:183-199.
- Cedergren, H. 1973. The interplay of social and linguistic factors in Panama. Ph.D. dissertation, Cornell University.
- Clopper, C. G., & Pisoni, D. B. 2004. Some acoustic cues for the perceptual categorization of American English regional dialects. *Journal of Phonetics* 32:111-40.
- Conn, J. 2005. Of "moice" and men: The evolution of a male-led sound change. Ph.D. dissertation, University of Pennsylvania.
- Cox, F. 1999. Vowel change in Australian English. *Phonetica* 56:1-27.
- Cruttenden, A. 2001. Mancunian intonation and intonational representation. *Phonetica* 58:53-80.
- Deterding, D. 2003. An instrumental study of the monophthong vowels of Singapore English. *English World-Wide* 24:1-16.
- Di Paolo, M. 1992. Hypercorrection in response to the apparent merger of (ɔ) and (ɑ) in Utah English. *Language and Communication* 12:267-292.
- Di Paolo, M., & Faber, A. 1990. Phonation differences and the phonetic content of the tense-lax contrast in Utah English. *Language Variation and Change* 2:155-204.
- Dinkin, A. 2009. Dialect boundaries and phonological change in upstate New York. Ph.D. dissertation, University of Pennsylvania.
- Docherty, G. J., & Foulkes, P. 1999. Derby and Newcastle: Instrumental phonetics and variationist studies. In P. Foulkes & G. J. Docherty (eds.), *Urban voices: Accent studies in the British Isles*, 47-71. London: Arnold.



- Dodsworth, R., Plichta, B., & Durian, D. 2006. An acoustic study of Columbus /l/ vocalization. Paper presented at NAWAV 35, Columbus, OH.
- Drager, K. 2010. Sociophonetic variation in speech perception. *Language and Linguistics Compass* 4:473–480
- Eberhardt, M. 2008. The low-back merger in the Steel City: African American English in Pittsburgh. *American Speech* 83:284-311.
- Eckert, P. 2004. California Vowels. <http://www.stanford.edu/~eckert/vowels.html>
- Eckert, P. 2008. Variation and the indexical field. *Journal of Sociolinguistics* 12/4:453–476
- Esling, J. 1978. The identification of features of voice quality in social groups. *Journal of the International Phonetic Association* 8:18-23
- Evanini, K. 2009. The permeability of dialect boundaries: A case study of the region surrounding Erie, Pennsylvania. Ph.D. dissertation, University of Pennsylvania.
- Fabricius, A. 2002. Weak vowels in modern RP: An acoustic study of happy-tensing and kit/schwa shift. *Language Variation and Change* 14:211-237
- Fabricius, A., Watt, D., & Johnson, D.E. 2009. A comparison of three speaker-intrinsic vowel formant frequency normalization algorithms for sociophonetics. *Language Variation and Change* 21:413–435.
- Fagyal, Z. 2010. Rhythm types and the speech of working-class youth in a banlieue of Paris: the role of vowel elision and devoicing. In D.R. Preston & N. Niedzielski (eds.) *A reader in sociophonetics*, Part I, 91-132. Berlin: Mouton de Gruyter.
- Feagin, C. 1990. The dynamics of a sound change in Southern States English: From r-less to r-ful in three generations. In J. Edmondson, C. Feagin, P. Mülhäusler (eds.). *Development and diversity: Linguistic variation across time and space*, 129-146. Arlington: SIL/University of Texas.
- Feagin, C. 1996. Peaks and glides in Southern States short-*a*. In G. R. Guy, C. Feagin, D. Schiffrin, & J. Baugh (eds.), *Towards a social science of language: Papers in honor of William Labov* 135-160. Amsterdam: John Benjamins.
- Fought, C. 1999. A majority sound change in a minority community: /u/-fronting in Chicano English. *Journal of Sociolinguistics* 3:5-23
- Foulkes, P. & Docherty, G.J. (eds.). 1999. *Urban voices: Accent studies in the British Isles*. London: Arnold.
- Foulkes, P. & Docherty, G.J. 2000. Another chapter in the story of /r/: ‘Labiodental’ variants in British English. *Journal of Sociolinguistics* 4:30-59
- Foulkes, P., & Docherty, G.J. 2006. The social life of phonetics and phonology. *Journal of Phonetics* 34:409-438.
- Foulkes, P., Docherty, G.J, Khattab, G., & Yaeger-Dror, M. 2010. Sound judgements: perception of indexical features in children’s speech. In D.R. Preston & N. Niedzielski. *A reader in sociophonetics*, Part I, 327-356. Berlin: Mouton de Gruyter.
- Fridland, V. 2001. Social factors in the Southern Shift: gender, age and class. *Journal of Sociolinguistics* 5:233-253.
- Fridland, V. & Bartlett, K. 2006. The social and linguistic conditioning of back vowel fronting across ethnic groups in Memphis, Tennessee. *English Language and Linguistics* 10.1: 1–22
- Fridland, V., Bartlett, K., & Kreuz, R. 2004. Do you hear what I hear? Experimental measurement of the perceptual salience of acoustically manipulated vowel variants by Southern speakers in Memphis, TN. *Language Variation and Change* 16:1-16.

- Ghazali, S., Hamdi, R., & Barkat, M. 2002. Speech rhythm variation in Arabic dialects. *Proceedings of speech prosody*, 331-334. Aix-en-Provence, France.
- Gick B., Campbell, F., Oh, S., & Tamburri-Watt, L. 2006. Toward universals in the gestural organization of syllables: A cross-linguistic study of liquids. *Journal of Phonetics* 34:49-72
- Gordon, M. 2001. *Small-town values, big-city vowels: A study of the Northern Cities Shift in Michigan*. Durham, NC: Duke University Press
- Grabe, E. 2004. Intonational variation in urban dialects of English spoken in the British Isles. In P. Gilles & J. Peters (eds.) *Regional variation in intonation*, 9-31. Tübingen: Niemeyer Verlag.
- Graff, D., Labov, W., & Harris, W.A. 1986. Testing listeners' reactions to phonological markers of ethnic identity: A new method for sociolinguistic research. In D. Sankoff (ed.), *Diversity and diachrony*, 45-58. Amsterdam: John Benjamins.
- Guy, G., Horvath, B., Vonwiller, J., Daisley, E. & Rogers, I. 1986. An intonation change in progress in Australian English. *Language in Society* 15:23-52
- Hay, J., Warren, P., & Drager, K. 2006. Factors influencing speech perception in the context of a merger-in-progress. *Journal of Phonetics* 34:458-484.
- Henton, C. & Bladon, A. 1988. Creak as a sociophonetic marker. In L. Hyman & C. N. Li (eds.) *Language, speech, and mind*, 3-29. London: Routledge.
- Heselwood, B. 2009. Rhoticity without F3: lowpass filtering, F1-F2 relations and the perceptions of rhoticity in 'NORTH-FORCE', 'START' and 'NURSE' words. *Leeds Working Papers in Linguistics and Phonetics* 14:49-64
- Hindle, D. 1980. The social and structural conditioning of phonetic variation. Ph.D. dissertation, University of Pennsylvania.
- Horvath B., & Horvath R. J. 2001. A multilocality study of a sound change in progress: The case of /l/ vocalisation in New Zealand and Australian English. *Language Variation and Change* 13:37-57
- Jacewicz, E., Fox, R.A., & Salmons, J. 2006. Prosodic prominence effects on vowels in chain shifts. *Language Variation and Change* 18:285-316
- Jacewicz, E., Fox, R.A., & Salmons, J. 2007. Vowel duration in three American English dialects. *American Speech* 82:367-385.
- Jacewicz, E., Fox, R.A., O'Neill, C., & Salmons, J. 2009. Articulation rate across dialect, age, and gender. *Language Variation and Change* 21:233-256
- Johnson, D. E. 2010. *Stability and change along a dialect boundary: The low vowels of southeastern New England*. Publication of the American Dialect Society 95. Durham: Duke University Press.
- Kendall, T. S. 2009. Speech rate, pause, and linguistic variation: An examination through the sociolinguistic archive and analysis project. Ph.D. dissertation, Duke University.
- Kerswill, P., Torgersen, E., & Fox, S. 2008. Reversing 'drift': Innovation and diffusion in the London diphthong system. *Language Variation and Change* 20:451-491.
- Koops, C. 2010. /u/-fronting is not monolithic: Two types of fronted /u/ in Houston Anglos. *University of Pennsylvania Working Papers in Linguistics* 16/2, Article 14.
- Koops, C., Gentry, E., & Pantos, A. 2008. The effect of perceived speaker age on the perception of PIN and PEN vowels in Houston, Texas. *University of Pennsylvania Working Papers in Linguistics* 14:91-101.
- Labov, W. 1994. *Principles of linguistic change*, vol. 1: *Internal factors*. Oxford: Blackwell.

- Labov, W. 2001. *Principles of linguistic change*, vol. 2: *Social factors*. Oxford: Blackwell.
- Labov, W. 2006a. *The social stratification of English in New York City*, 2nd ed. Cambridge: Cambridge University Press.
- Labov, W. 2006b. A sociolinguistic perspective on sociophonetic research. *Journal of Phonetics* 34: 500-515.
- Labov, W. 2010. *Principles of linguistic change*, vol. 3: *Cognitive and cultural factors*. Oxford: Blackwell.
- Labov, W. 2011. *Plotnik 10*. [Software] <http://www.ling.upenn.edu/~wlabov/Plotnik.html>.
- Labov, W. & Ash, S. 1997. Understanding Birmingham. In C. Bernstein, T. Nunnally, & R. Sabino (eds.), *Language Variety in the South Revisited*, 508-573. Tuscaloosa, AL: Alabama University Press.
- Labov, W., Ash, S., & Boberg, C. 2006. *The atlas of North American English: Phonetics, phonology, and sound Change*. Berlin: Mouton de Gruyter.
- Labov, W., Ash, S., Ravindranath, M., Weldon, T., Baranowski, M., & Nagy, N. 2011. Properties of the sociolinguistic monitor. *Journal of Sociolinguistics* 15/4:431-463.
- Labov, W., Karen, M., & Miller, C. 1991. Near mergers and the suspension of phonemic contrast. *Language Variation and Change* 3:33-74.
- Labov, W., Yaeger, M., & Steiner, R. 1972. *A quantitative study of sound change in progress*. Vol. 1. Report on National Science Foundation Contract NSF-GS-3287. Philadelphia, U.S. Regional Survey.
- Labov, W. & Baranowski, M. 2006. 50 msec. *Language Variation and Change* 18:1-18.
- Labov, W., Baranowski, M., & Dinkin, A. 2010. The effect of outliers on the perception of sound change. *Language Variation and Change* 22:175-190
- Labov, W., & Rosenfelder, I. 2010. PLOTNIK/PRAAT Interaction and Automatic Vowel Analysis. Workshop at NWAV 39.
- Labov, W., & Rosenfelder, I. 2011. The Philadelphia Neighborhood Corpus.
- Langstrof, C. 2009. On the role of vowel duration in the New Zealand English front vowel shift. *Language Variation and Change* 21:437-453.
- Lawson, E., Scobbie, J. M., & Stuart-Smith, J. 2011. The social stratification of tongue shape for postvocalic /r/ in Scottish English. *Journal of Sociolinguistics* 15:256-268.
- Levon, E. 2006. Hearing “gay”: Prosody, interpretation, and the affective judgments of men’s speech. *American Speech* 81/1: 56-78.
- Lieberman, M. 2008. “The phonetics of uptalk”. Language Log post, available at: <http://languageblog ldc.upenn.edu/nll/?p=586> (accessed: 7 July 2011)
- Lobonov, B.M. 1971. Classification of Russian vowels spoken by different listeners. *Journal of the Acoustic Society of America* 49(2B): 606-608
- Low, E. L., Grabe, E., & Nolan, F. 2000. Quantitative characterisations of speech rhythm: Syllable-timing in Singapore English. *Language and Speech* 43:377-401.
- Macaulay, R. K. S., 1977. *Language, social class and education: A Glasgow study*. Edinburgh: Edinburgh University Press.
- Maclagan, M., & Hay, J. 2007. Getting fed up with our feet: Contrast maintenance and the New Zealand English “short” front vowel shift. *Language Variation and Change* 19:1-25.
- Majors, T. 2005. Low back vowel merger in Missouri speech: Acoustic description and explanation. *American Speech* 80:165-179.
- Nagy, N. and Irwin, P. 2010. Boston (r): Neighbo(r)s nea(r) and fa(r). *Language Variation and Change* 22:241-278

- Nearey, T. M. 1977. Phonetic feature systems for vowels. Ph.D. dissertation, University of Connecticut.
- Niedzielski, N. 1999. The effect of social information on the perception of sociolinguistic variables. *Journal of Language and Social Psychology* 18:62-85.
- Nycz, J. R. 2011. Second dialect acquisition: Implications for theories of phonological representation. Ph.D. dissertation, New York University.
- Peppé, S., Maxim, J., & Wells, B. 2000. Prosodic variation in southern British English. *Language and Speech* 43:309-334.
- Plichta, B. 2001. Hearing faces: The effects of ethnicity on speech perception. Paper presented at NWAV 30, Raleigh, NC.
- Plichta, B. 2011. *Akustyk 1.8.3: A free Praat plug-in for sociolinguistics*. [Software]. <http://bartus.org/akustyk/>.
- Plichta, B. & Rakerd, B. 2010. Perceptions of /a/-fronting across two Michigan dialects. In D.R. Preston & N. Niedzielski (eds.) *A reader in sociophonetics*, Part I, 223-239. Berlin: Mouton de Gruyter.
- Podesva R.J. 2007. Phonation type as a stylistic variable: The use of falsetto in constructing a persona. *Journal of Sociolinguistics* 11:478–504
- Preston, D.R. (ed.) 1999. *Handbook of perceptual dialectology*, vol. 1. Philadelphia: John Benjamins.
- Preston, D.R. 2010. Belle's body just caught the fit gnat: The perception of Northern Cities Shifted Vowels by local speakers. In D.R. Preston & N. Niedzielski (eds.) *A reader in sociophonetics*, Part I. 241-252. Berlin: Mouton de Gruyter.
- Preston, D.R. & Niedzielski, N. (eds.) *A reader in sociophonetics*, Part I. Berlin: Mouton de Gruyter.
- Purnell, T., Idsardi, W. & Baugh, J. 1999. Perceptual and phonetic experiments on American English dialect Identification. *Journal of Language and Social Psychology* 18: 10-30.
- Purnell, T., Salmons, J., Tepeli, D. 2005. German substrate effects in Wisconsin English: Evidence for final fortition. *American Speech* 80:135-164.
- Recasens, D. & Espinosa, A. 2005. Articulatory, positional and coarticulatory characteristics for clear /l/ and dark /l/: evidence from two Catalan dialects. *Journal of the International Phonetic Association* 35:1-25.
- Robb, M.P., Maclagan, M.A., & Chen, Y. 2004. Speaking rates of American and New Zealand varieties of English. *Clinical Linguistics & Phonetics* 18:1-15
- Sankoff, G. & Blondeau, H. 2007. Language change across the lifespan: /r/ in Montreal French. *Language* 83:560-588.
- Scanlon, M. & Wassink, A.B. 2010. Using Acoustic Trajectory Information in Studies of Merger. *University of Pennsylvania Working Papers in Linguistics* 16/2, Article 19.
- Scobbie, J. M. 2006. Flexibility in the face of incompatible English VOT systems. In L. Goldstein, D.H. Whalen, & C.T. Best (eds.), *Laboratory phonology 8*, 367-392. Berlin: Mouton de Gruyter.
- Scobbie, J. M., Hewlett, N., & Turk, A.E. 1999. Standard English in Edinburgh and Glasgow: The Scottish vowel length rule revealed. In P. Foulkes and G.J. Docherty, 230-245.
- Scobbie, J. M. & Pouplier, M. 2010. The role of syllable structure in external sandhi: An EPG study of vocalization and retraction in word-final English /l/. *Journal of Phonetics* 38:240-259
- Sharbawi, S. H. 2006. The vowels of Brunei English: An acoustic investigation. *English World-*

- Wide* 27:247-264.
- Sproat, R. & Fujimora, O. 1993. Allophonic variation in English /l/ and its implications for phonetic implementation. *Journal of Phonetics* 21:291-311.
- Straw, M. & Patrick, P.L. 2007. Dialect acquisition of glottal variation in /t/: Barbadians in Ipswich. *Language Sciences* 29:385-407.
- Stuart-Smith, J. 1999. Glasgow: Accent and voice quality. In P. Foulkes and G.J. Docherty, 203-222.
- Stuart-Smith, J. 2007. A sociophonetic investigation of postvocalic /r/ in Glaswegian adolescents. In J. Trouvain and W.J. Barry (eds.) *Proceedings of the 16th International Congress of Phonetic Sciences: ICPHS XVI*, 1449-1452. Saarbrücken.
- Stuart-Smith, J., Timmin, C., & Tweedie, F. 2006. Conservation and innovation in a traditional dialect: L-vocalization in Glaswegian. *English World-Wide* 27:71-87.
- Syrdal, A. K. and Gopal, H. S. 1986. A perceptual model of vowel recognition based on the auditory representation of American English vowels. *Journal of the Acoustical Society of America* 79:1086-100
- Tauberer, J., & Evanini, K. 2009. Intrinsic vowel duration and the post-vocalic voicing effect: Some evidence from dialects of North American English. *Proceedings of Interspeech 2009*. Brighton: International Speech Communication Association, 2211-2214.
- Thomas, E.R. 2001. *An acoustic analysis of vowel variation in New World English*. Publication of the American Dialect Society 85. Durham, NC: Duke University Press.
- Thomas, E.R. 2002. Sociophonetic approaches of speech perception experiments. *American Speech* 77:115-147.
- Thomas, E. R. 2011. *Sociophonetics: An introduction*. New York: Palgrave Macmillan.
- Thomas, E. R. & Carter, P. M. 2006. Rhythm and African American English. *English World-Wide* 27:331-355.
- Thomas, E. R., & Kendall, T. 2007. NORM: The vowel normalization and plotting suite. <http://ncslaap.lib.ncsu.edu/tools/norm/>.
- Trudgill, P. 1974. *The social differentiation of English in Norwich*. Cambridge: Cambridge University Press.
- Van de Velde, H., & van Hout, R. (eds.). 2001. *'r-atics: Sociolinguistic, phonetic and phonological characteristics of /r/*. Brussels: Etudes & Travaux, ILVP
- Verhoeven, J., De Pauw, G., & Kloots, H. 2004. Speech rate in a pluricentric language: A comparison between Dutch in Belgium and the Netherlands. *Language and Speech* 47:297-308
- Warren, P. 2005. Patterns of late rising in New Zealand English: Intonational variation or intonational change? *Language Variation and Change* 17:209-230.
- Watt, D. & Fabricius, A. 2002. Evaluation of a technique for improving the mapping of multiple speakers' vowel spaces in the F1 ~ F2 plane. *Leeds Working Papers in Linguistics and Phonetics* 9:159-73
- Wells, B. & Peppe, S. 1996. Ending up in Ulster: prosody and turn-taking in English dialects. In: E. Couper-Kuhlen & M. Selting. *Prosody in Conversation: Interactional studies*. Cambridge: Cambridge University Press.
- Wells, J. C. 1982. *Accents of English*. Cambridge: Cambridge University Press.
- White, L., & Mattys, S.L. 2007. Rhythmic typology and variation in first and second languages. In P. Prieto, J. Mascaró, & M.J. Solé (eds.), *Segmental and Prosodic issues in Romance Phonology*, 237-257. Amsterdam: John Benjamins.

- Williams, A. & Kerswill, P. 1999. Dialect levelling: change and continuity in Milton Keynes, Reading and Hull. In P. Foulkes & G.J. Docherty (eds.), *Urban voices: Accent studies in the British Isles*, 141-162. London: Arnold.
- Wolfram, W.A. 1969. *A sociolinguistic description of Detroit Negro Speech*. Washington, DC: Center for Applied Linguistics.
- Yaeger-Dror, M., & Thomas, E.R. (eds.) 2010. *African American English speakers and their participation in local sound changes: A comparative study*. Publication of the American Dialect Society 94. Durham, N.C.: Duke University Press.
- Yuan, J., & Liberman, M. 2008. Speaker identification on the SCOTUS corpus. *Proceedings of Acoustics '08*, Paris: Société Française d'Acoustique, 5687-5690; software available at: <http://www.ling.upenn.edu/phonetics/p2fa/>
- Yuan, J., & Liberman, M. 2009. Investigating /l/ variation in English through Forced Alignment. *Proceedings of Interspeech 2009*. Brighton: International Speech Communication Association, 2215-18.
- Yuasa, I.P. 2010. Creaky voice: A new feminine voice quality for young urban-oriented upwardly mobile America in women? *American Speech* 85/3: 315-337.