Enrichment of Sociolinguistic Nasality Research with Phonetic Data: Methodological Considerations

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Abstract

Research into nasal voice quality can be seen to split itself quite neatly into two streams. In one, we find sociolinguistic studies of nasality, based on impressionistic analyses and the perceptions and opinions of naïve listeners. These studies form the basis of what we know about the social attitudes and motivations behind nasal voice, but often do not clearly define the empirical boundaries of what is and is not nasal. On the other side lies the phonetic study of nasalization. This stream of research has focused on the articulatory and aerodynamic realities of nasalization, developing methods to directly measure airflow through the mouth and nose during speech, and later turning to finding acoustic correlates to accurately represent this ratio of airflow using less intrusive means. Many of these methods are quite robust but have seldom been used to observe non-laboratory speech. Crossover between the aforementioned streams of nasality research is rare but could be extremely beneficial. In this article, established approaches to studying nasal voice in sociolinguistics and phonetics are outlined and evaluated. Existing examples of research combining the two approaches are discussed and suggestions made for future study.

Nasality, like any aspect of speech, plays different roles in different places, cultures, and languages. An extreme example of this is the “ceremonial” function the quality of nasality

fulfils in the Cayuvava language of Bolivia, in which its presence is a show of respect to the interlocutor (Crystal 1970; Wilhelm 2019). In English, however, nasality does not carry meaningful information, at least not in a phonological sense. Despite this, the concept of "nasal voice" has been shown to be perceptually very salient in laypeople's descriptions of voice quality in English (Key 1975; Payá Herrero 2019). In the majority of accents of US English, in fact, coarticulatory nasalization (non-phonological vowel nasalization caused by a preceding nasal consonant) is widely studied by phoneticians because of its influence on the language variety (Beddor et al. 2013; Malécot 1960; McDonough et al. 2009; Ohala and Ohala 1995; Zellou et al. 2016). Within sociolinguistics there is also a range of studies on the feature, as its perceptual salience marks it as a distinctive characteristic of speech to which social judgements might be attached. These judgements have a strong tendency to be negative (cf. Wiener and Chartrand 2014). For example, one such study found that "increased simulation of nasality … provoked such a wide array of socially undesirable characteristics as to make the isolation of any clear cut images difficult if not impossible" (Addington 1968: 502).

Studies such as Addington's uncover the role that phonetic qualities of speech play in influencing listeners' attitudes towards an individual speaker or social group, but their methods rely heavily on auditory perception, which is widely recognized to be somewhat unreliable (see Pisoni 1981). In the perception of nasality, specifically, there are many intricacies surrounding the interface between laypersons' definitions of nasality and those of phonetically trained experts. What a lay listener hears and categorizes as nasal may not in actual fact be classified as nasal speech by phonetic standards. This issue could be addressed, however, by the inclusion of acoustic phonetic data in sociolinguistic studies of nasality. Acoustic data provides an objective representation of vocal tract configurations during speech, and in recent times methods have been developed to predict the extent of nasality to a

high degree of accuracy, despite complexities (Carignan 2021; Chen 1997; Liu et al. 2019; Pruthi and Espy-Wilson 2004). The addition of phonetic data to sociolinguistic investigations of nasality would enable the establishment of more precise phonetic cues that both speakers and researchers use to label what they perceive as nasality, as well as clarifying how the acoustic and aerodynamic evidence of nasalization aligns with perceptions of the feature. Not only would this enrich future sociolinguistic research, but it also has practical implications for forensic speech science.

In this article I will give an overview of the existing methods for research into nasality in the fields of sociolinguistics and phonetics. Regarding approaches in the field of sociolinguistics, I will discuss their strengths and contributions to the literature before pointing out some methodological limitations. I suggest that methods such as those discussed in the following section could be strengthened by incorporating acoustic phonetic measures of nasality, examples of which are then examined. Case studies demonstrating the successful combination of sociolinguistic and acoustic approaches to nasality are then discussed, along with possibilities for future study, before some concluding remarks on the great contribution of the works discussed here within and beyond their respective fields of study.

Auditory methods in the sociolinguistic analysis of nasality

Much of the existing sociolinguistic research concerning nasality from the last fifty years or so has taken a mainly auditory and/or perceptual approach. That is, the analysis in these studies hinges almost entirely on the researchers' auditory analysis or analysis of naïve listeners' perception of speech data. These studies, which I will review in the following section, have formed the basis of what we know today about the social implications of nasality and nasal voice quality, but share a common theme: their analyses are based on methods which often use highly subjective judgements, based in perception rather than

empirical fact, and thus are not entirely reliable. Additionally, in many of these studies, nasality is often not the primary variable under observation, sometimes even forming part of an unexpected finding, so perhaps might not receive the attention required to make any particularly strong conclusions about its presence (or absence).

Impressionistic auditory analyses

The first of the range of methods I will touch upon also tends to be situated chronologically at the emergence of research into voice quality and nasality, especially in the UK. These are impressionistic auditory analyses of voice quality by trained phoneticians and sociolinguists, in which the researcher provides a descriptive account of voice quality in a certain area or social group. This is achieved simply by recording speakers and making judgements or "abstractions" (Esling 1978; Laver 1972) of the phonetic features of a speaker's voice quality. It was through the use of this method that the now widely recognized conclusion that nasality is a prominent feature of the Received Pronunciation (RP) accent long associated with middle-class speakers in the UK came to fruition (Laver 1972). Another example of this method can be found in Trudgill (1974), who claims that nasality forms part of the voice quality setting of working-class speakers in Norwich.

The studies discussed here were instrumental in launching further work surrounding general voice quality in the UK, laying foundations on which future research could build. Additionally, at the time of their writing, methods for observing nasality outside of the auditory had barely begun to see any serious development. These methods resulted in highly influential sociophonetic studies; the first of their kind in the UK.

Vocal Profile Analysis

Vocal Profile Analysis (VPA) is a protocol developed by Laver and colleagues (Laver 1991;

Laver et al. 1981) in the 1980s for auditory identification and rating of voice quality features. The protocol covers a wide range of features affecting voice quality, including velopharyngeal setting, and concerns a speaker's vocal setting. Vocal setting, the habitual configuration of a speaker's vocal apparatus, is contrasted by Laver and Trudgill (1979) with anatomically induced voice characteristics. The latter are limited by the physical properties of a person's vocal (and nasal) tract, while the former is more adaptable and can be manipulated by the speaker, usually motivated by social or psychological factors (Biemans 2002). VPA was created to define the idiosyncratic combination of anatomically induced voice characteristics and habitual vocal setting in a speaker, which Laver et al. (1981) refer to as "speaker-characterizing long-term features" of the voice.

The VPA protocol consists of two steps. The first is to listen to a stretch of speech, auditorily identify the absence (neutral setting) or presence (non-neutral setting) of each setting listed, and, for those that are detected, to determine whether the setting is normal or abnormal, which is then rated on a six-point continuum in the second step. VPA was developed as a framework for use by speech therapists and pathologists to diagnose speech conditions (e.g. Fraser et al. 1998), but has been used elsewhere, for example in forensic casework (see San Segundo et al. 2016) and non-applied research (Pittam 1986), and is still being adapted for continued use today (San Segundo et al. 2019; San Segundo and Mompean 2017; San Segundo and Skarnitzl 2021).

The protocol described above was used in Stuart-Smith's (1999) seminal sociophonetic study on Glasgow speech, in which the author gave a phonetic description of the Glaswegian accent, followed by a VPA report on the voice quality of 32 speakers equally stratified by age, gender, and social class. While, like many of the studies discussed here, nasality was not the sole feature undergoing analysis in this work, some interesting findings were reported nonetheless. To some degree, nasality was observed across all speaker groups,

and no differences were found between social classes. Male speakers were seen to show more nasality than females and working-class girls displayed nasalization of oral segments but did not tend to fully nasalize nasal segments.

Stuart-Smith's study was one of the first to discuss Glasgow speech in detail and paved the way for future research into the accents of the area. The author cites "a relatively high degree of consistency in setting, and setting values, in speakers across speech types" (Stuart-Smith 1999: 139) as confirmation of the validity of her transcriptions and subsequent analysis. However, as is the case with all the approaches discussed in this section, a drawback of using VPA is the high level of subjectivity in the method. Pittam (1994: 37–8) points out that, in order to accurately and consistently perceive the settings of the VPA protocol, considerable training is required, but even trained phoneticians have been shown to be inconsistent in their applications of the method (San Segundo et al. 2019). Additionally, there are several steps to the protocol at which the analyst must make decisions about each setting. For example, should the researcher make a mistake in identifying the neutrality of the setting, the entire process for the given setting is distorted, and so on.

VPA is a highly valuable and adaptable tool, helping to further standardize procedures in fields such as speech pathology and forensic speech science, but reliable application requires extensive training and practice by the analyst. An inadequately trained VPA user runs the risk of inaccuracies and inconsistencies, reducing its validity. This certainly doesn't rule out VPA as a tool for observing nasality in sociolinguistic research, but it is perhaps not the most straightforward approach for an untrained researcher.

Imitation rating experiments

This section concerns methodologies in the sociolinguistic analysis of nasality which employ ratings by experts (other than the researchers themselves) and/or naïve listeners, usually of

imitations of certain voice qualities by recruited speakers. Naïve listeners may be listeners with some level of phonetic training (usually undergraduate students enrolled on courses taught by the researchers) or laypeople with little to no understanding of speech science in general. These methodologies make up the majority of the existing research relevant to this work.

The general content of the methodologies in research of this type consists of the recruitment and training of speakers by the researcher and/or phonetically trained colleagues to elicit approximations of various voice qualities, which are then recorded and played to listeners to be rated on a number of dimensions, usually social or personality based. Some studies (Addington 1968; 1971; Hutchinson 1982; Pittam 1987; 1990) employ an additional stage before launching the experiment in which further experts rate the recorded speech to ensure it is representative of the relevant quality that is supposed to be conveyed. The addition of this stage is positive, as it provides some validity to the studies' findings, but the standards for inclusion of a recording vary among different works. For example, Hutchinson (1982: 463) required that speech pathologists rate the voice quality simulations of two speakers as "mild to moderate" as a condition of inclusion in the experiment. Pittam (1987) went a step further to control recordings, having a sociolinguist and a phonetician compare speakers to ensure there were no discernible differences based on accent as well as rating each voice quality from (1) "marginally" to (6) "very", but excluding no recordings based on their voice quality ratings, despite some being rated as low as one. Pittam also took care to use reading passages with no nasal phonemes to avoid confusion with coarticulatory nasalization, whereas most other works use passages such as the Rainbow passage (Fairbanks 1960),[1] enabling the effect of coarticulatory nasalization to influence their findings.

[1] The Rainbow passage is a reading passage with phonetic balance similar to that of spoken

One such study which employed the Rainbow passage is the most recent of the studies of this type discussed here, Wiener and Chartrand (2014), which found statistically insignificant evidence to suggest that a female speaker was perceived to be marginally "warmer" when using nasal voice. This study employed a similar method to those previously outlined here, foregoing the extra step of using expert ratings before presenting stimuli to participants, but reaching the greatest number (300 participants) and most diverse cohort of respondents through the use of Amazon Mechanical Turk, an online crowdsourcing platform often used by researchers to recruit large numbers of participants.

These studies certainly all have advantages in their methodologies and reveal interesting results about the opinions and attitudes to perceived nasality in different cultures and settings. Some (Hutchinson 1982; Wiener and Chartrand 2014) demonstrate the importance of interdisciplinarity and the application of linguistic methods for the furthering of different fields such as marketing and broadcasting research. However, there is an issue which runs throughout all of the studies that employ the general methodological structure explored in this section. The problem is twofold and occurs at the speech elicitation stage. First, the method of having speakers actively approximate voice qualities carries with it myriad complications. The speech science community increasingly favours spontaneous, conversational speech over lab-recorded speech (see Rischel 1992), due to the tendency of speakers in the latter situation to adopt a more formal speech style which is not necessarily representative of their everyday speech. The effects of this "unnatural" speech style combined with the effort on the speaker's part to create a voice quality that does not necessarily come as second nature to them, based on guidance from researchers, creates an

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American English, devised for use in the diagnosis of hypo- and hypernasality in children with adenoidal issues or cleft palates, respectively.

output which is something entirely different from the everyday speech that authors might wish to extend their conclusions to.

In addressing the second problematic aspect of speech elicitation in studies of this ilk we arrive at the crux of this article's aim. In fact, it is a problem shared by all of the sociolinguistic methods discussed thus far, which is that there are no attempts made to verify that the speech analysed or used as perceptual stimuli is actually, in phonetic terms, *nasal* speech. None of the studies mentioned make any attempt to define exactly what nasal speech is in articulatory, aerodynamic, or acoustic terms. Rather, they depend on the alignment of the researchers' and listeners' own auditory impression of what constitutes nasal speech in order to model that of their speakers' recordings. As such, the approximation of nasal voice quality that is taught to speakers may sound to researchers like what they believe to be nasal voice while not actually requiring the articulatory gestures and aerodynamics of objectively nasal speech. Alternatively, a researcher might somehow train a speaker to perform a perfect passage of completely nasalized speech, with complete opening of the velopharyngeal port and strong nasal airflow, but this may not turn out to be what a listener has come to recognize as "nasal" in their experience. For example, Wilhelm (2019) notes how denasal voice, which often arises when someone has a cold, caused by total obstruction of the velopharyngeal port, is often labelled as nasal in quality, despite the opposite being the case in phonetic terms. Without some sort of objective measure to verify what is happening in the vocal and nasal tracts, we cannot reliably ascertain that neither of the two scenarios outlined above is the case, which subsequently greatly impacts the validity of any results that may be found. Additionally, Kreiman and Gerratt (1998) demonstrated that inter-rater agreement in voice quality perception tends to be very low unless the example of a voice quality feature is extreme or completely absent, so there is the possibility that perceptual methods are less reliable unless there is complete velopharyngeal port opening or closure.

Aerodynamic and acoustic approaches to measuring nasality

In the previous section, I discussed tried and tested methods used in sociolinguistic research for analysing nasality. These methods have served researchers well and are widely relied upon to this day, but all have certain drawbacks relating to potential subjectivities and inconsistencies, and issues surrounding validity. As such, in this section I will discuss alternative approaches to analysing nasality in speech that may be applied to sociolinguistic research. These consist of the recording of aerodynamic and/or acoustic phonetic data, which could be used to supplement auditory and perceptual analyses of nasality.

Aerodynamics of nasality

Nasal sounds occur when the velum (soft palate) is lowered, allowing air from the lungs to flow through the opening at the top of the pharynx (the velopharyngeal port) into the nasal cavities. This is known as velopharyngeal port coupling (VP-coupling). Increase in nasal airflow and decrease in oral airflow is a direct result of VP-coupling, making aerodynamic approaches a reliably objective measure of nasality.

The most widely recognized method for measuring airflow through both the oral and nasal cavities is the use of a screen-type pneumotachograph mask. One such type of mask is the Rothenberg mask, which can simultaneously record oral and nasal airflow. The mask is made of plastic, with a rubber baffle and seal creating separate oral and nasal chambers and avoiding any leakage (Rothenberg 1973). A number of holes are situated throughout the mask, covered by a steel wire screen of known acoustic resistance. A tube is inserted into each chamber and connected to a transducer, which is in turn connected to a computer. In addition, a microphone records the acoustic signal from the mouth and nose. The speaker typically holds the mask to their face using a handle attached to the mask.

Many researchers have used screen-type pneumotachograph masks to investigate nasality (Chi et al. 2015; Merrifield and Edmondson 1999; Nguyễn Văn Lợi and Edmondson 1998). The Rothenberg mask specifically has been found to have relatively low acoustic impedance (Rothenberg 2013), but nonetheless does not result in an acoustic signal akin to that of unmasked speech. Moreover, it has displayed sound leakage caused by the vibration of the internal separator (Rothenberg 2006). The device is adequate for laboratory speech, and, with respect to sociophonetic applications, would be particularly useful for verifying the degree of nasalization in stimuli used for perception experiments. However, it is perhaps not especially suitable for sustained periods of speech (e.g. sociolinguistic interviews) and does not lend itself to capturing spontaneous speech.

Nasometry and nasalance

A more indirect but less intrusive method for measuring nasality is the use of nasometry. Nasometry involves the non-invasive measurement of the acoustic energy radiating from the nose and mouth using directional microphones attached to the top and underside of an acoustic baffle which the speaker holds above their top lip. By combining the resultant acoustic signals and calculating the proportional nasal amplitude (the percentage of the total amplitude that can be attributed to acoustic energy from the nose), the degree of nasalization, known as *nasalance*, can be attained. While nasalance is not a direct measure of nasal airflow, it is an objective measure of the degree of nasalization; it is an acoustic method in that it utilizes amplitude, but oral and nasal amplitude is directly related to rates of airflow in the respective cavities. Nasometry causes no acoustic impedance, is less restrictive upon the speaker's lip movements, and has been used successfully both in clinical settings (Dalston et al. 1991; Hirschberg et al. 2006) and linguistic research (Brunnegård and van Doorn 2009; Van Lierde et al. 2001).

Direct measurement of airflow using screen-type pneumotachograph masks and indirect measurement of nasalance both provide an accurate and objective measurement of nasality. The use of screen-type pneumotachograph masks can provide a direct measure of nasal airflow in laboratory speech, and nasometry provides a less intrusive approach to measure nasalization. Both comprise a strong baseline for analysis of nasality but become somewhat redundant when we turn to sociophonetic production research. If nasality is to be analysed across long stretches of spontaneous speech, it must be done without the need for speakers to hold a contraption to their face throughout the recording process, as this undoubtedly renders the speech "unnatural".

Acoustic correlates of nasality

Due to the fastidious nature of methods for obtaining airflow and nasalance rates, researchers have turned to acoustics in an attempt to quantify nasality from more easily acquired audio recordings. However, while it may be less intrusive and, in some ways, less labour-intensive, it is a notoriously difficult task because VP-coupling allows airflow from the lungs to flow up into the nasal cavity, thus splitting airflow between the vocal and nasal tracts. As a result, the singular acoustic path from the glottis to the lips that is observed during oral phonation is made more complex by the introduction of an additional invariant resonator (the nasal cavity). Despite the complexity of this alteration, researchers have identified some generally agreed-upon spectral changes in the acoustic signal during nasalization:

Extra resonances

Around 250 Hz (Delattre 1954; Hattori et al. 1956; House and Stevens 1956; Tarnóczy 1948)

Around 1000 Hz (Joos 1948; Kataoka et al. 2001; Smith 1951)

Weakening or dampening of formants

F1 only (Delattre 1954; Hattori et al. 1956)

F1 and F2 (House and Stevens 1956; Maeda 1982; Smith 1951)

F2 only (Kataoka et al. 2001)

Increase in F1 bandwidth (Delattre 1954; Hawkins and Stevens 1985; House and Stevens 1956)

The extra resonances around 250 Hz and 1000 Hz are utilized most often for their amplitudes, labelled P0 and P1, respectively. These additional resonances, or peaks, are associated with pole-zero pairs that are introduced to the transfer function[2] when VP-coupling occurs, and have been found to play a fundamental role in the perception of nasality (Hawkins and Stevens 1985).

Proposed methods for acoustically quantifying nasality

Acoustic measurement of nasality is famously so difficult because the resonators involved are all connected and interdependent, rendering it impossible to identify any isolated contributions to the final acoustic product (Baken and Orlikoff 2010; Dunn 1950). As such, phoneticians have had to devise methods that utilize multiple acoustic correlates to properly capture the extent of nasalization in speech. The first attempt at this was made by Maeda (1993), in which the author proposed a method using two spectral correlates: A1-P1. The value obtained by subtracting P1 from the amplitude of the first formant, A1, determines the extent of nasalization. The resultant value shares an inverse relationship with nasalization: lower values suggest increased nasalization and vice versa. This approach, however, turned

[2] A transfer function is a mathematical function used to theoretically model a system's output (in this case air escaping from the vocal tract) based on each possible input (pulmonic egressive airflow).

out to be useful for only two vowel types, and Chen (1997) later proposed an alternative correlate: A1-P0, subtracting the amplitude of the first nasal peak, P0, from the F1 amplitude, rather than the second. Chen found this measure to be more robust than A1-P1 but noted that A1-P1 may be more useful for high vowels, where A1 and P0 might be associated with the same harmonic. Since then, A1-P0 has undoubtedly become the most frequently used measure for predicting nasalization (Garellek et al. 2016; Kim and Kim 2019; Tamminga and Zellou 2015).

Although it has come to be the most widely recognized acoustic correlate of nasality, A1-P0 can be a troublesome measure, because it relies greatly on harmonic placement, which displays great variation across differing fundamental frequencies (Carignan 2021), so much ensuing research has involved the exploration of additional correlates to augment the prediction of nasalization. These include measures of nasal murmur (energy onset and offset, ratio of energies between 0–320 Hz and 320–5360 Hz, and spectral peak frequency; Pruthi and Espy-Wilson 2004) and the use of Mel-Frequency Cepstral Coefficients (MFCCs; Liu et al. 2019), which have been found to accurately represent vocal tract dimensions (Davis and Mermelstein 1980), making them highly appropriate for the prediction of nasality, given the influence the physical characteristics of the vocal tract have on it. Recently, Styler (2017) assessed the accuracy of 22 acoustic features for predicting nasality, finding that A1-P0, F1 bandwidth, and spectral tilt (A3-P0) prevailed as the most promising correlates. Carignan (2021) then combined all 22 of the features used by Styler with MFCCs to create a "shotgun" method for estimating the time-varying degree of nasalization, comparing linear regression models of principal component analysis (PCA) transformations of the data with nasalance scores, and found correlations as high as $r = .94$. All of these recent approaches used machine-learning algorithms, whether support vector machines (SVMs; Pruthi and Espy-Wilson 2004), recurrent neural networks (RNNs; Liu et al. 2019) or linear regression

(Carignan 2021; Styler 2017), and all approaches garnered accuracies that rarely fell lower than 80%.

The methods for predicting nasalization based on acoustic data discussed in this section have proven to deliver results with high levels of accuracy, based on a wide range of acoustic correlates so as to avoid missing anything in the acoustic signal that might influence nasality. Methods such as these are readily available to sociolinguists and/or phoneticians wishing to explore nasality in their research, with the most difficult calculations and formulae having already been developed and automated for quicker and easier analysis, so I believe it is pertinent that they be applied to sociolinguistic research into nasality.

Sociolinguistic and Acoustic Methods: Case Studies

While enriching sociolinguistic research into nasality with acoustic and aerodynamic data is not yet necessarily the norm, there are some examples that demonstrate the benefits and success of the approach. One such example is that of Podesva et al. (2013). This study made use of nasal airflow data and found that hired actors exhibited increased nasal airflow when portraying tropes such as *nerd* or *party girl*, going on to suggest that nasality in US American English indexes a non-aggressive stance and "hyperwhiteness".

Another study, which does not deal with overall vocal setting but does employ acoustic methods, is Tamminga and Zellou (2015). In this paper, the researchers used the acoustic measure of A1-P0 to find the difference between vowels preceding nasal and oral consonants. It was found that the overall amount of nasal coarticulation is larger in speakers from Philadelphia, Pennsylvania, than in those from Columbus, Ohio, and the researchers argue that the gradual reduction of coarticulatory nasalization in both dialects is a socially motivated change. The use of linear regression allowed the authors to estimate the extent of nasalization; however, we know that A1-P0 alone is volatile, and a study such as that of

Tamminga and Zellou (2015) might benefit from the addition of extra acoustic correlates to round out the data, thus providing a more robust basis for analysis.

Most recently, in a study analysing voice onset time (VOT) in the speech of actors and "self-identified code-switchers from Southwest Virginia" (Walker 2020: abstract) while producing Southern and Standardized US English accents, Walker (2020) analysed formant structures in voiced stops to conclude that the actors tended to use nasalization in their Southern guises, although the finding was not statistically significant. She attributed this to previous findings that VP-coupling alleviates the difficulty in sustaining voicing during stop closure (Arvaniti and Joseph 2000; Kong et al. 2012; Sole 2009) and agrees with Jacewicz et al. (2009) that this could be responsible for the stereotype that Southern speakers have a "nasal twang". However, nasality is not the central variable under study in Walker's work, and as such its analysis could be more comprehensive. Further study, using airflow data or nasalance, could provide clearer confirmation of whether or not speakers of Southern US English do, in fact, maintain VP-coupling during non-phonemically or coarticulatorily nasalised segments.

Conclusion

In this article I have discussed a number of issues relating to the sociolinguistic study of nasality in speech. Existing methods in the field were discussed, highlighting areas where issues arise. The solution proposed, to supplement such research with aerodynamic and/or acoustic data, was explored. Methods for measuring and predicting nasality using airflow and acoustics were examined, followed by studies that have successfully combined the two fields, and suggestions for how these might be improved upon using additional data.

Nasality has not often played a starring role in sociolinguistic research over the years. Generally, it is included in studies of voice quality, likely because of its perceptual salience,

but when it is investigated the results tend to provide interesting insights. Past sociolinguistic studies tend to agree that, the majority of the time, nasality carries negative connotations of, for example, stupidity, laziness, and dullness (Addington 1968; Biemans 2002), forming part of "whining" and "moaning" voice settings (Poyatos 1991). That the (reported) presence of nasality evokes such an array of reactions in listeners, wide in description but decidedly negative, is a testament to its salience, making it the perfect variable to focus on for speaker recognition, perhaps in forensic or clinical settings. In order to do so, however, the methods used in studying such a variable need to be much more reliable. By including aerodynamics and acoustics in sociolinguistic research into nasality, scholars can not only apply their research to real-life scenarios such as forensic speech recognition, but could also make invaluable contributions to sociolinguistics and phonetics by verifying how naïve speech perception relates to expert phonetic standards and judgements of nasal speech.

While the measurement of nasal airflow is somewhat cumbersome and results in a speech style that is not always desirable for sociolinguistic analysis, there are several ways it can be used to supplement sociolinguistic nasality research. First, if a researcher only requires laboratory speech for their analysis, it is advisable to have speakers do their tasks while using an airflow measurement system in order to verify the degree of nasality. Furthermore, as I have mentioned, an overarching issue with existing auditory analyses and perception experiments on nasality is the lack of a standard for what objectively is and is not nasality. Studies such as Addington (1968; 1971), Hutchinson (1982), Pittam (1986; 1987; 1990), and Wiener and Chartrand (2014) claim to observe lay-listeners' perceptions of nasality but cannot truly assert that what their participants hear is in fact nasal phonation without first confirming it. The ideal way of doing this would be to record the stimuli while measuring oral and nasal airflow to ensure there is an adequate amount of both for the appropriate stimulus.

In terms of acoustic methods, while these are a more indirect measure of nasality and usually require the measurement and calculation of multiple correlates, I believe that, given enough time and research, a somewhat standardized approach has the potential to greatly develop sociolinguistic research into nasality. While direct aerodynamic methods are preferable, these are not always possible due to the equipment they require. The use of acoustics instead affords us the opportunity to look into nasality on a much bigger scale, lending itself to a wider variety of data (e.g. sociolinguistic interview, existing corpora, public domain audio-visual media).

The existing bodies of work examined in this article display great feats of innovation, often pioneering methods or areas of study. The sociolinguistic works discussed here provide the groundwork necessary to launch further, more detailed and robust research into nasality and its social influence. The acoustic methods for measuring nasalization reviewed here and the sociophonetic studies thus detailed have paved the way for researchers like myself to continue exploring and improving the approaches to studying a feature of voice quality that was once considered all but impossible to reliably quantify. Hopefully, the blending of subdisciplines such as those relevant here will continue to shine a light on the important role of language as a social tool, perhaps providing a clearer picture of the linguistic landscape as it evolves over time.

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