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# Unmasking Identity: Speaker Profiling for Forensic Linguistic Purposes

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ABSTRACT

When an anonymous speech sample is associated with a criminal matter, for example in the case of a phoned-in bomb threat or ransom demand, forensic linguistic profiling may be used to infer attributes of the speaker from his or her linguistic characteristics. In this review, we present research and case examples outlining what types of speaker characteristics are discoverable via speaker profiling by expert linguists, for example, gender, age, and region of socialization. We also consider different methods in speaker profiling, including aural-perceptual, acoustic phonetic, and automated, and briefly discuss expert versus nonexpert speaker profiling, as well as the proper role of linguistic profilers versus law enforcement and legal professionals, government agencies, and others with whom forensic linguists work. Finally, we address the problem of voice and dialect disguise, including what types of disguises criminals may effect and what methods can be used to unmask them, including human and automated. We illustrate our points by alluding, throughout the review, to various elements of a case in which we recently served as expert linguistic profilers.

In 1981, 13-year-old "Mary Doe" goes missing from her central California home. Her parents tell her siblings that she has run away and that they are never to speak of her again. More than 20 years later, in 2003, Mary's siblings report the case to the police, who immediately suspect homicide. Mary's parents, now living in New York State, are interviewed, and her stepfather comes close to confessing. A short time later, a woman is stopped by the police in Phoenix, Arizona, for a traffic violation. She has an Arizona driver's license in the name of Mary Doe and claims to be the missing girl and to have spent 20-plus years as a runaway in Arizona and California, living under various assumed names. For a number of reasons, the detectives who interview this woman, hereafter referred to as the Person of Interest (POI), suspect that she is an imposter. Not least of these reasons is the POI's strong Southern accent, a seeming impossibility in someone who spent most of her first 13 years in the Northeast, the West Coast, and Hawaii. The POI claims that her accent comes from brief visits to New Orleans and Georgia, again, a dubious claim at best. This clearly is a case for a forensic linguist, and experts are consulted to help unmask the imposter's real identity by creating a forensic speaker profile of the POI's regional background.



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A forensic investigation is very much about identity—what is the identity of the perpetrator and how can it be proven? Sometimes the only clue to a criminal's identity is his or her language. When that is the case, a linguistic profile can be a useful tool. Forensic linguistic profiling is the analysis of language to infer attributes of a speaker or writer from his or her linguistic characteristics. Speaker and author profiling are used when there is an unknown perpetrator, and investigators need to narrow down the pool of potential suspects by identifying linguistic features that can be associated with particular geographic areas, social groups, or unusual pathologies (Watt, 2010). Forensic linguistic profiling can also aid in the verification or refutation of a speaker or author's claimed identity, as in the case of Mary Doe, or in cases of asylum seekers whose assertions of particular national, ethnic or tribal origins fall under dispute. Profiling, which involves using linguistic evidence to obtain information about an unknown individual, can be contrasted with comparative techniques like authorship attribution and speaker identification. Authorship attribution involves the comparison of one or more writings of unknown authorship (for example, an anonymous ransom note) with writings of known authorship (for example, suspects) in order to help determine whether one of the known authors may also have written the anonymous communication. Speaker identification, often called speaker comparison, involves using the same comparative technique with anonymous bits of speech (for example, a threatening phone call) and a pool of suspect voices. Speaker identification is also sometimes referred to as voice recognition. However, speaker identification (and speaker profiling, the subject of this review) typically involves the examination of features beyond what may be properly considered "voice"—that is, matters pertaining to voice quality and intonation—including morphosyntactic and discourse features, as well as nonlinguistic features such as throat-clearing, coughing, or (nonlinguistic) tongue-clicking mannerisms. Hence, speaker identification is a more precise term than voice recognition. Speaker and author profiling, authorship attribution, and speaker identification are all types of forensic linguistic analysis—that is, the application of linguistic knowledge and analytic techniques to matters of law.

For space considerations, the current review focuses on speaker profiling by expert linguists. We begin with a discussion of which speaker characteristics are considered to be inferable from speaker profiling. We then consider methods used in speaker profiling, in both real-life and research settings, including aural-perceptual, acoustic phonetic, and automated methods. We briefly address expert vs. nonexpert speaker profiling, and in addition consider profiling tasks in which nonexpert native speakers of the language varieties in question may be of special importance. Speaker profiling is complicated by the possibility of deliberate disguise, and so we review studies of voice and dialect disguise, from both the speaker's point of view (what elements of speech can and do people disguise) and the listener's (how good are nonexperts and experts at detecting disguise, what methods can be used in the detection of disguise). Throughout the review, we stress that speaker profiling is also complicated by issues facing forensic linguistics in general—and indeed forensic science more broadly—namely, the need to apply rigorous analysis to reach defensible conclusions from data which are typically far less than ideal (for

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example, of limited quantity and quality), often while under tight time pressure. We illustrate this problem by explicating the expert linguistic analysis we performed in the Mary Doe case—in essence demonstrating what can happen when linguistic science runs up against the need to perform a practical job for specific forensic purposes.

## WHAT SPEAKER CHARACTERISTICS ARE INFERABLE FROM FORENSIC PROFILING?

Though there are a number of factors that can affect the ability to identify or profile voices, it is a well-acknowledged fact that humans have the ability to recognize hundreds of vocal features and individual voices (Hollien, 2002). One popular theory is that this ability is evolutionarily based on the need to distinguish members of one's own group (for example, family, tribe, nation) from individuals belonging to other groups, who cannot offer the same support and indeed may inflict harm (Hollien, 2002; Watt, 2010). Interestingly, this ability is not exclusive to humans. Research suggests that birds, cetaceans and amphibians can also identify individuals within their species based on vocalizations (Clark, Boersma, & Olmsted, 2006). It seems to follow that the identification of class characteristics, such as characteristics of regional or ethnic group membership, in addition to individuating and idiosyncratic characteristics, would have similar evolutionary benefits; identification of a familiar dialect even in an unfamiliar individual might mean the difference between a potential friend or a deadly stranger. It is easy to see how knowledge of the larger social networks of individuals not personally known to the hearer would be an evolutionary benefit.

Based on his own studies as well as synthesis of results of studies and cases in forensic speaker profiling, forensic phonetician Michael Jessen (2007) maintained that the features which are most easily identifiable from an unknown voice are: sex, age, so-called "sociolect" (see below), nonnative accent, regional dialect of one's native language, and medical conditions. Sex is held to be generally easy to determine because of the strong correlation between average pitch level and sex, explained by anatomical differences between the vocal folds in men and women, as well as correlations between sex and body size. However, Jessen did emphasize that pitch level is not always conclusive, since there is much intrasex variation and overlap across sexes. Furthermore, biological sex intersects with the social construct of gender, and biologically based pitch differences can be heightened, or more problematically for speaker profiling purposes, attenuated, for sociocultural, interpersonal, and personal reasons, including shaping and projecting particular kinds of masculine and feminine identity (e.g., Bing & Bergvall, 1996; Queen 2013; Schilling, 2011). Hence, profilers need to guard against a bias toward automatically assigning higher pitched voices to females and lower pitches voices to males. Intonational contours and voice quality can also be implicated, since there are common though not always accurate perceptions that females in certain societies use particular pitch contours more so than males, such as the well-known case

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of high rising terminal intonation, or so-called "uptalk," in much of the English-speaking world, as well as voice qualities like creaky and breathy voice.

Age of an unknown speaker may be separated into chronological age, an individual's years of life, and biological age, which accounts for damage that might prematurely age a voice. As with sex/gender, the determination of age via factors such as pitch is not always foolproof. The difficulty of accurately narrowing in on speaker age is exacerbated when damage to the vocal folds, for example from prolonged heavy smoking, causes the biological age to strongly diverge from the speaker's chronological age (Jessen, 2007). Furthermore, sociolinguists have pointed out that, as with sex vs. gender, chronological and biological age are not always neatly correlated with what might be termed "social age," or "life stage" (Eckert, 1997). For example, a 22-year-old American male living in his parents' home working a part-time service job and spending most of his leisure time with same-age and younger peers can be considered to be at a younger life stage than another 22-year-old male with a spouse and children who holds one or more full-time jobs and is responsible for his family's financial support. And it is easy to see that the linguistic usages of the two will likely be quite different as well, based on matters such as social network influence and attitudinal factors.

What Jessen calls "sociolect" encompasses the level of education and profession of the speaker. These are cued, not by voice per se but rather by linguistic features such as lexical and morphosyntactic choices indicative of particular registers and jargons. For example, Jessen (2007) cited the case of a blackmailer who was profiled by the analyzing linguist as being professionally involved with the railway system through the anonymous speaker's use of a specialized term, *Langsamfahrstrecke*, to refer to a low-speed section of railway. But whereas profiling for speaker profession based on highly specialized jargon may be relatively straightforward, profiling for level of education is more difficult, since it is not uncommon for a speaker or writer to be quite skilled in "educated" forms of language despite a relative lack of formal education, most likely due to being an avid reader. Forensic linguist and criminal profiler James R. Fitzgerald has urged that rather than identifying speakers and authors in terms of "level of education," linguistic profilers should more cautiously render opinions as to individuals' degree of facility with professional, standard and/or literary registers (J. R. Fitzgerald, personal communication, September 2014).

While it can be relatively easy to determine that a speaker has a nonnative or foreign accent—that is, the influence of a first language on a second language—it is much more difficult to determine which specific native language or languages is or are involved. In addition, the pervasiveness of multilingualism and the increasing intercommunication of the world's peoples, and hence increased impact of dialect and language contact, renders the identification of native vs. nonnative speaker status very difficult, and indeed problematizes the very nature of the concepts (Jessen, 2007; Rampton, 2005, 2011). Furthermore, some dialects have features whose roots lie in L1 influence on an original L2 even though they may now be spoken by monolinguals in the original L2, as for example in the case of Chicano English in the Southwestern U.S. This dialect is characterized by

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such seeming "transfer" features as relatively monophthongal productions of /i/ and /e/, and raised/tensed /ɪ/ in *–ing* suffixes, as in pronunciations like "walkeeng" and "talkeeng" for "walking" and "talking." However, many of its speakers are not proficient in Spanish and are often even monolingual in English (Fought, 2003). Given the various difficulties in identifying nativeness or nonnativeness, as well as the particular L1 involved, Jessen (2007) suggested that it is prudent for forensic linguists to provide their profiles in terms of the broad characteristics of the L1 influences (e.g., a Slavic L1).

Though foreign accent and native regional dialect are separated as characteristics by Jessen (2007), they are related since both involve identifying speakers' community/region of socialization through their linguistic usages; and again, the same complications arise due to issues of mobility, dialect contact and mixing, and the use of dialects and dialect features other than one's "own" (that is, "crossing" into other dialects; see Rampton, 2005) for stylistic, interactional, and identity purposes. In addition, both language and dialect contact may result in different degrees and types of mastery of nonnative language varieties for different speakers, and forensic linguistic profilers need to take into account the possibility that even a native speaker of a particular language may speak an imperfect form of a target second dialect (D2), with fossilized forms reminiscent of incomplete L2 learning (see Chambers, 1992; Labov, 2007; Payne, 1976, 1980; Siegel, 2010 on D2 acquisition). Despite the various issues in profiling regional identity, there is a vast body of solid research on features and patterns of regional and social variation (for example, variation by ethnicity, by localized communities of practice such as gangs), in a number of locations across the world, particularly in major languages. Investigators, legal professionals, and forensic linguists specializing in other subfields have benefitted and continue to benefit from the expertise of the authoritative descriptions of sociolinguists and dialect geographers.

Whereas two of the characteristics listed above, sex and age, have at least some basis in physicality, medical condition is obviously more clearly rooted in the physical body. By this, Jessen (2007) refers to any stable speech pathological condition which is permanent enough to be consistent across time—unlike an acute case of bronchitis which might significantly impact the voice but is likely to clear up in a few weeks—and does not have a strong negative impact on cognition or communicative abilities (e.g., stuttering, stammering). If a medical condition is severe enough as to render the speaker cognitively or physically incapable of having committed the crime in question, it is not likely to be of help to an investigation.

Less clearly amenable to discovery through the examination of linguistic characteristics are psychological characteristics and states. Analysts have purported to identify factors such as stress, deception, guilt and neuroticism via voice characteristics (Eriksson & Lacerda, 2007; Koppel, Schler, & Argamon, 2009); however, there is a good bit of debate over the validity of profiling for psychological matters such as those through analyzing speech and/or voice, and much research remains to be done. For example, heated discussion was occasioned by the publication of a critique of commercial "voice stress analyzers," which purport to detect lies via measuring "voice stress" (Eriksson & Lacerda, 2007), as well as by the recanting

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of the critique by the *International Journal of Speech, Language and the Law*, the journal of the International Association of Forensic Linguists.

Crosscutting the various difficulties in profiling all of the above speaker characteristics via linguistic analysis is the fact that, in forensic linguistic cases, data are usually sparse, and language features indicative of the various class attributes may or may not occur in any given bit of linguistic evidence.

## WHAT METHODS ARE USED IN SPEAKER PROFILING?

Speaker profiling can be accomplished through aural-perceptual analysis, acoustic phonetic analysis, automated analysis, or a combination of these methods. In addition, reference works on the speech features of various class groups (regional, ethnic, gender) as well as corpora of spoken language data can be brought to bear. Though studies show that trained linguists are better than nonexperts at speaker profiling (see below), nonexperts are sometimes called upon to make or assist in creating linguistic profiles. For example, earwitnesses may be asked to provide witness testimony in court, and native speakers of underdocumented language varieties may be asked to assist linguistic experts in identifying a speaker's language or dialect origins. The only method available to nonexperts is, of course, auditory analysis (listening), and often they do not even have audiorecorded evidence at their disposal when offering their profile, but must rely on previous experience with the voice or language variety in question (Watt, 2010). Furthermore, when naïve listeners provide profiles based on auditory methods, they cannot properly said to be conducting "analysis," since they seem to listen only holistically and usually cannot articulate which specific speech features lead them to reach their conclusions (Jessen, 2008). Though naïve speaker profiling is not the primary focus of this article, it is a rich area of research that has been and continues to be explored. Purnell, Idsardi, and Baugh (1999) and Baugh (2002) provided discussion of untrained linguistic racial profiling (and its implications for linguistic discrimination—that is, racial discrimination based on voice). Clopper and Pisoni (2004); Van Bezooijen and Gooskens (1999); Van Bezooijen and Ytsma (1999); and Williams, Garrett, and Coupland (1999) discussed untrained linguistic geographic profiling.

Aural-perceptual analysis performed by expert linguists goes far beyond impressionistic listening and involves careful examination of the voice quality, rhythmic, intonational and segmental features of recorded speech evidence for indicators of the various social and perhaps physical factors listed above. The "perception" component of aural-perceptual analysis typically involves the trained perceptions of linguistic scientists; in some instances, as in language analysis for the determination of origin (LADO) cases, discussed in detail below, these are supplemented by the perceptions of native, often nonexpert, speakers of suspect varieties. Aural-perceptual methods are sometimes supplemented by acoustic phonetic analysis, in an effort to provide objective measures of features such as fundamental frequency (F0), vowel quality (via measurement of formant frequencies), and

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voice qualities like breathy and creaky voice. Expert opinions based on quantitative measures and objective, replicable methods are often viewed by the courts as more worthy of qualifying as true expertise than more impressionistic auditory methods; and indeed many linguists also maintain that acoustic phonetic measures are more scientific than aural-perceptual analyses. Such a view, however, runs the risk of undervaluing the abilities of human analysts when expertly trained and highly experienced in distinguishing regional and other types of phonetic/phonological variation and, conversely, of overvaluing the objectivity of computer-based acoustic measures, since human analysts must decide how, what and where to measure (for example, whether vowel formants should be measured at the midpoint of the vowel nucleus or at some other point, how one determines where the midpoint of a vowel nucleus lies). In addition, as noted above, matters other than phonetics and phonology come into play in speaker profiling, including lexical choices. Furthermore, on a strictly practical level, anonymous data associated with criminal matters is often of too short duration and too poor sound quality to be amenable to acoustic phonetic analysis, and often linguists are called upon to render expert opinions quite quickly, for example in cases where a violent offender is being sought.

> The forensic linguistic experts in the Mary Doe case are provided with two audiorecorded interviews conducted by police detectives shortly after the Person of Interest (POI) surfaces in Arizona. The interviews are each about an hour in length and are of relatively poor quality, in terms of both amount of speech elicited from the POI and sound quality. (In fact, the second interview is via telephone, which degrades the audio signal.) As with most other cases of speaker profiling, the linguists must rely on auditory analysis, coupled with consultation of authoritative sources such as Labov, Ash, and Boberg's (2006) *Atlas of North American English* (see also the companion website: http://www.atlas.mouton-content.com/). In line with the police investigators' impressions, the linguists find that the POI indeed possesses a number of features characteristic of the U.S. Southern dialect area. These include lexical items such as "y'all" for plural you and "Daddy" to refer to her father in the third person (e.g., "Daddy brought me back on base"), as well as the phonological feature of Southern "breaking"—that is, the lengthening, diphthongization (and even triphthongization) of particular vowels, to the extent that monosyllables may be rendered as bi- and tri-syllabic, as in "bay-id" for "bad," "yay-ih" for "yeah" and "nay-oh" for "no." In addition, the POI has most elements of the Southern Vowel Shift (SVS), a chain shift pattern that distinguishes the U.S. South quite sharply from other American dialect regions. These include the fronting of back vowels /u/ and /o/, the lowering and diphthongization of /e/ and raising of /ɛ/, so that /e/ and /ɛ/ in effect "trade places," with words like "name" being pronounced almost as "nime" and "guess" as "gay-iss." Crucially, the POI also shows reversal of /i/ and /ɪ/ (whereby words like "seat" are pronounced as "say it" and "sit" like "see it"), which is characteristic of the most advanced form of the SVS, found only in a limited subset of speakers centered on the Inland South, a region encompassing the Appalachian Mountain area of western North Carolina, Tennessee, Alabama and parts of western South Carolina and northern Georgia. At first glance, then, it seems we have a "hit"—and the POI really is an imposter—someone whose socialization took place in the

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> Inland South, not in New York State, where the real Mary Doe spent most of her formative dialect years, from birth to age eight, or in California and Arizona, where the POI claims to have spent most of her time after age 13. Because the acquisition of complex systems like the SVS requires sustained exposure, ideally before age nine or 10, the POI's claimed short visits to Louisiana and Georgia wouldn't account for her very advanced SVS, nor would the fact that the real Mary lived for a short time in Georgia, with her (New York State area) family, prior to moving to Hawaii and then the West Coast.
>
> But there's a wrinkle: Although the POI has almost all of the features of the SVS, she seems to be lacking one crucial element—indeed, the one feature that is held to trigger all the other shifts in the chain—the monophthongization of diphthongal /ay/, as in well-known stereotypical Southern pronunciations like "tahm" for "time." The POI uses monophthongal and glide-shorted /ay/ only rarely, and when she does, it is only in the phonological environment where it is commonplace throughout the South, before voiced obstruents (as in "tahd" for "tide"). In contrast, the Inland South is characterized not only by the strongest Southern Shift in the U.S. but also by the generalization of /ay/ monophthongization to both prevoiced and prevoiceless positions (as in "raht" for "right").
>
> In the words of the detectives who questioned the POI shortly after she surfaced in Arizona, "That's an interesting dialect you have, Mary." Indeed it is!

Regardless of method(s) used for forensic linguistic analysis, researchers, legal professionals, and jurors must bear in mind that even if a voice can be readily profiled or identified, this does not mean that the person whose voice has been captured is actually the criminal in question (e.g., Nolan, 2003). For example, in the case of the "Yorkshire Ripper Hoaxer," the speaker on an anonymous tape-recording who purported to be the serial killer known as the Yorkshire Ripper (active from 1975 to 1980) was profiled as having been socialized in the Sunderland area of Northeast England. However, the linguistic expert in the case, renowned dialect geographer Stanley Ellis, also opined that the speaker who made the tape was not actually the murderer, since, as part of the profiling process, the recording had been played for numerous people in the Sunderland area, and no one had come forward and identified the voice as belonging to a murderer. The police refused to believe that the tape was a hoax until an individual from West Yorkshire rather than Sunderland, Peter Sutcliffe, was arrested and convicted of the murders, in 1981. A hoax investigation ensued, and Ellis was finally vindicated in 2005, when John Samuel Humble—from Sunderland—was arrested and confessed to having made the hoax tape (Ellis, 1994; French, Harrison, & Windsor Lewis, 2007). An expert linguist can never render an opinion as to whether or not the voice examined is that of a perpetrator. Instead, a profiler can only opine as to the likely social (and perhaps some physical) characteristics of the speaker in question, while those conducting speaker comparison provide only very guarded expert opinions in the form of statements regarding the degree of consistency between the voice in question and the voice of the suspect and, if consistent, the

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extent to which the voice is distinctive, and hence, implicitly *suggestive* of being that of the suspect. (See French & Harrison, 2007, for the "Position statement concerning use of impressionistic likelihood terms in forensic speaker comparison cases" in which the rationale for presenting opinions in speaker comparison cases in this manner is set forth.)

In addition to conservatively expressing their opinions, linguistic profilers must also ensure that their methods are as reliable and transparent as possible. To enrich the understanding of these methods, Köster, Kehrein, Masthoff, and Boubaker (2012) devised an experiment to examine the regional profiling abilities and methods of German linguistic profilers. Fifteen native speakers of German, all experts in voice profiling with university degrees in phonetics or speech science, were given 20 samples of speech from a database of contemporary regional German dialects and asked to identify the regional dialects as accurately as possible. They were able to use the analytical method(s) of their choice and had all accessible research available to them in order to best replicate the circumstances of an actual case. To that end, they were also asked to replicate the conservativeness regarding analyses and conclusions that they would use in a real case. In addition to the identifications, Köster et al. (2012) also collected information about which methods the analysts employed and how much time they spent analyzing each file. To facilitate quantitative comparability, dialect judgments were given in a forced-choice categorization task from among the 14 main German regional dialects. In total, 300 responses were collected, 20 from each of the 15 participants. Of those 300, 47 were incorrect, meaning that the speaker came from a dialect area other than that indicated by the respondent, for an overall error rate of 15.7%. To contextualize the results of these experts, Clopper and Pisoni (2005) found that untrained native speakers of American English asked to identify speakers of six U.S. dialect regions had a much higher error rate, at nearly 70%. In terms of the methods, the most popular was aural-perceptual analysis, employed in all cases by all 15 analysts. Approximately 57% of the analyses included the consultation of an audio database, approximately 30% included consultation of dialect research, and only 6.5% of the cases were analyzed with acoustic techniques. Most likely, these numbers reflect the fact that acoustic analysis is often not possible in genuine cases of speaker profiling, and so linguists must rely on aural-perceptual methods. Audio databases are another rich source of information. However, these are not (yet) as plentiful as written descriptions, and in addition, ideally they must be continually updated, since language and dialect change can proceed quite rapidly, especially in terms of phonological features (see French & Stevens, 2013). In fact, one of the bases of sociolinguistic variation study is that language change can be observed in progress, through analyzing the speech of as few as three generations of speakers in a given speech community (Cukor-Avila & Bailey, 2013; Labov, 1994, pp. 9–112).

The rapidity of language change and the great breadth of language variation pose difficulties for forensic linguistic profilers that may be partially overcome by involving native speakers of the dialects and languages in question. As noted above, one type of speaker profiling in which linguistic experts often work in tandem with

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native speakers is that associated with language analysis for the determination of origin (LADO), in which linguistic assessment is used to aid in the verification or refutation of individuals' claims to particular national and ethnic identities in seeking political asylum. Today, there are eight federal units in five countries (Sweden, Switzerland, the Netherlands, Germany, and Belgium) that analyze approximately 100 cases per year. Far more cases are handled by commercial LADO agencies, which work internationally in at least 10 additional countries (Cambier-Langeveld, 2010).

The procedures of the various LADO agencies are unfortunately rather opaque, and linguists and other analysts have been pushing for more transparency. In 2004, the Language and National Origin Group published the *Guidelines for the Use of Language Analysis in Relation to Questions of National Origin in Refugee Cases*, which, although they do not actually provide detailed guidelines for how to perform or evaluate language analyses, do provide guidance regarding general practices in the field. Among other matters, these guidelines state that language analyses should be conducted by trained linguists whose role is to advise governments, who in turn actually make nationality determinations, based on the results of the language analysis as well as other evidence at their disposal. In addition to providing conclusions, linguists should qualify the certainty of their conclusions and should be careful to state that their conclusions concern socialization, not origin, ethnicity, nationality or citizenship. The guidelines also urge caution in situations of language mixing, in cases where the language of the interview is not the interviewee's first language, and in cases where the dialect of the interviewer or interpreter may encourage accommodation on the part of the speaker (Language and National Origin Group, 2004). Indeed, Patrick (2010) has pointed out that accommodation is more likely than not, and that interviewees are likely to use a language of wider communication in a bureaucratic interview setting rather than a small language that might more accurately pinpoint their region or social group of socialization.

As noted earlier, another issue in LADO assessments is that even when a trained linguist conducts the analysis, he or she may not be an expert in the language(s) in question, and there may exist little or no documentation of the smaller languages and dialects that are often involved in asylum cases. Hence, LADO cases often involve the judgments of native speakers in addition to those of expert linguists. Of course utilizing nonexpert native speakers has its own problems; for example, nonexperts are not likely to have systematic knowledge of their language, including intraspeaker variation, and they may equate command of their language with command of a standard variety rather than the various vernacular varieties asylum speakers are likely to use in everyday life (Patrick, 2010).

To make the best use of linguistic and native speaker analyses and judgments in LADO cases, in 2009 the International Association for Forensic Phonetics and Acoustics' Working Group on Language Identification adopted a resolution which urges that LADO be carried out by "linguists and trained native speakers with the latter working under the guidance and supervision of the former" or "linguists with in-depth research knowledge of the language(s) in ques-

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tion" (http://www.iafpa.net/langidres.htm). However, as with the guidelines, the resolution does not provide specific guidance on the methods LADO professionals should use for training or analysis. In addition to calling for more specific guidelines, as well as a means of ensuring their implementation, researchers such as Cambier-Langeveld (2010) and Fraser (2011) maintained that LADO would be much improved if it were treated as a forensic linguistic task rather than proficiency testing, since disguise may come into play. Fraser (2011) pointed to further issues in LADO, for example the bureaucratic nature of the task compared with other types of forensic linguistic analysis, and the tensions between human rights and national security inherent in cases of asylum seekers that further complicate efforts at unbiased and accurate analyses.

Cambier-Langeveld (2010) presented analysis of eight cases which seems to confirm the efficacy of the combined efforts of native speakers and linguistic experts in LADO cases, although Fraser (2011), in a rebuttal, noted that most of the "experts" in the cases examined by Cambier-Langeveld would not qualify as linguistic experts if current best practices had been followed. Foulkes and Wilson (2011) expanded on Cambier-Langeveld's evaluation of LADO by conducting a study assessing the ability of three different groups of listeners, LADO professionals, academic phoneticians and phonetics students, and untrained native speakers, to determine whether language samples were genuinely produced by speakers of Ghanian English, a well-researched language variety with many native speakers. Native Nigerian English speakers were used as foils. Listeners were given a three-page document describing the features of Ghanian English and then asked to determine the genuineness of the samples, as well as to rate their confidence by providing responses to a forced-choice task from which they could select *genuine*, *not genuine* or *unsure*. For all groups of listeners the false hit rate, when a foil was incorrectly identified as a native speaker of Ghanian English, was higher than the miss rate, when a genuine speaker was rejected. No significant correlation was found between confidence and accuracy for any group, though native speakers and LADO professionals tended to report higher confidence than academic phoneticians or students. When *unsure* responses were disregarded, native speakers were correct at a rate of 86%, academic phoneticians at 81%, phonetic students at 68% and LADO practitioners at only 55%. The study thus supports the inclusion of native speakers in LADO analysis, though it again echoes Patrick's concern (2010) that untrained native speakers may lack subtlety in their linguistic judgments.

In concluding this section on methods in speaker profiling, we make brief note of automated methods. One type of automated method in speaker identification involves measuring resonances of the supralaryngeal vocal tract that arise from the geometry of individual speakers (French & Stevens, 2013). Conceivably this method could be applied to speaker profiling if it could can be determined that there is convergence among speakers of like social categories and divergence across speakers of different social groups. And whereas French and Stevens point out that such convergences can be found, including by region, ethnicity, gender, and social class (and that such convergences present a problem for the identification of

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*individuals* via automatic speaker recognition, or ASR), there are other issues that complicate matters for both automated profiling and comparison. These include intraindividual variability (for example, tissues may be temporarily swollen due to illness, yielding different measures), the need for current comparison corpora of speakers of various regional and social backgrounds, the fact that speech consists of far more than voice alone, and as with all methods in forensic speech analysis, a dearth of data of high audio quality.

It is also possible to indirectly conduct automatic speaker profiling through subjecting transcribed speech data to the techniques of automated author profiling. Rico Sulayes (2012) provided an overview of studies in statistical and machine learning techniques in author profiling that use a range of feature selection, feature reduction, and classification techniques to profile for features such as gender, age, regional dialect, and time period of writing (as in cases of the questioned authorship of literary works). In addition, Rico Sulayes (2009) presented results of his own study applying a common machine learning technique to speaker/author profiling using the transcribed Switchboard section of the Open American National Corpus, consisting of transcripts of naturalistic telephone conversations (http://www.anc.org). His results show that gender appears somewhat amenable to automated profiling, as does age, though to a lesser degree; other characteristics tested (regional dialect, educational background) were less accurately profiled. In part, the less than ideal results achieved in automated speaker and author profiling stem from the problematic nature of the first step in automated analysis, feature selection (Rico Sulayes, 2012). Hence, while it may be possible to compile definitive lists of features associated with certain speaker characteristics (e.g., regional or ethnic dialect), other types of characteristics, notably gender, tend to be profiled based on unprincipled lists of features seemingly grounded in stereotypical impressions rather than actual data on intergender speech differences. Furthermore, it is likely that feature selection will always need to be tailored to the particular data set at hand, and analysts must exercise caution in simply adopting lists of features purportedly indicative of gender or other sociodemographic characteristics from quite different cases or research projects.

## WHAT ABOUT DISGUISE?

No matter what method(s) analysts use in uncovering identity through forensic speaker profiling, they must always consider the possibility of disguise. Criminals have a vested interest in concealing their identity, and when their voices are introduced as part of a crime (for example in a bomb threat, mugging or ransom demand), there are many methods of disguise they may employ (for example, whispering, electronic manipulation, accent imitation). Künzel (1987) cited statistics from the speaker identification section of the German Federal Criminal Bureau that estimate that 15–20% of their cases involve voice disguise. JP French Associates, a highly regarded independent forensic speech and acoustics laboratory, estimate that one in 40 of their cases involve disguise (Clark & Foulkes, 2007,

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p. 198). Other figures estimate that disguise is employed in 52% of the cases in which the criminal might reasonably have expected to be audio recorded (Masthoff, 1996). When disguise is employed, it can have "considerable detrimental effect" on identifying speakers and speaker characteristics (Eriksson, 2010, p. 87) and is therefore a worthy area of research.

Though exciting work in this area has been conducted recently, research into voice disguise has been conducted for decades. For example, Pollack, Pickett, and Sumby (1954) established the effectiveness of whispering as a method of disguise, which they found reduced correct identifications of familiar voices from 95% to 30%. Several decades later, Reich, Moll, and Curtis (1976) confirmed that the introduction of disguise significantly reduces the identification accuracy of even expert identification using spectrographic analysis.

More recent work has examined the use of dialect disguise and imitation on nonexpert listeners' ability to make speaker identifications. Though this research has focused on identification rather than profiling tasks, one can extrapolate that what obscures identity in speaker comparison task will have a similar negative impact in speaker profiling. In 2009, Sjöström, Eriksson, Zetterhol, and Sullivan examined the use of dialect switch as a means of disguise. They staged four earwitness lineups using a bi-dialectal Swedish speaker and four foils. In two control tests, there was no disguise present; the target spoke the same dialect in his speech presented in isolation and in the lineup in which his voice was presented along with that of the four foils. There was one control each for each of the speaker's two dialects, D1 and D2. Two more tests were conducted, one in which the speaker used D1 for the target sample and D2 in the lineup, and one in which he used D2 for the target and D1 in the lineup. The control lineups established a baseline for identification rates of the target and showed that the speaker was equally easy to identify in each of his dialect guises. Similarly, the two disguise scenario lineups were equally difficult for listeners. A statistical analysis of the experimental group showed that with the introduction of the dialect shift, correct identification fell to an almost random chance level. From this, Sjöström et al. (2009) concluded that dialect is such an important characteristic of voice identification that it may override the distinguishing characteristics of voice proper, for example pitch and voice quality. However, it is important to note that this speaker was truly bi-dialectal, and so results may not be reflective of people's ability to identify voices in cases where dialects are actually feigned.

Researchers conducting studies of actual dialect performance have examined not only how performers are perceived but how they perform—that is, what types of features they manipulate and how accurate they are in comparison with authentic versions of the target dialect. For example, recent work has investigated native speakers' performance of the dialects of nonnative speakers (i.e., foreign accents). Künzel (1987) proposed that, when performing a regional dialect of their native language, speakers will vary their features at the phonetic/phonological level more so than the grammatical level. Conversely, Künzel suggested that when effecting a foreign accent, speakers will vary lexicon and syntax. Neuhauser (2008) tested this latter hypothesis by examining German speakers' performances of a French

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accent in both prewritten passages and self-composed texts. She found no evidence to support Künzel's proposition that pronunciation would be less likely to vary than grammar and lexis in foreign accent imitation; all the speakers in her study varied their pronunciation during disguise, while some did not vary their lexical, morphological or syntactic features at all. Neuhauser also found that, in addition to providing performances that were incomplete in the sense of not utilizing features on all levels of dialect variation, people were also unsuccessful in maintaining consistent disguise over the course of the dialect performance task.

In a study investigating the imitation of Spanish-accented English by native speakers of American English, Gunn (2014) also found that people tended to perform quite poorly, in the sense that the study participants adopted few, if any, of the phonological features of Spanish-accented English for which he tested, using a reading task consisting of sentences designed to yield well-known pronunciation features of the L2 English of L1 Spanish speakers. However, Gunn pointed out that there may well have been test effects on participants' performance, since native speakers of American English may be hesitant to effect dialect performances they fear may be viewed as racist parodies and so may underperform in dialect imitation tasks. Gunn (2014) further noted that inconsistency in performance is not necessarily evidence of disguise, since there is wide variation in native-like competence, and consistency of production patterns, among authentic L2 speakers. Furthermore, as variationst sociolinguists well know, even first languages and dialects are replete with (patterned) variation, and so failure to use a particular feature in all instances where it could occur cannot automatically be taken by an analyst as a sign of dialect disguise. Conversely, because language is inherently variable, when dialect features are used too consistently, this too can be evidence of disguise (see Markham, 1999).

It is especially useful in cases of dialect disguise for linguists to be familiar with subtle linguistic conditioning on variable patterns, since people effecting dialects are unlikely to effect subtle patterns that lie below their conscious awareness (Ash, 1988; Butters, Espy, & Altsuler, 1993; Preston 1993, 1996). For example, if an anonymous speaker is impressionistically judged to be a speaker of African American English, but quantitative analysis reveals that the speaker produces monophthongal /ay/ in all linguistic environments, including both prevoiced and prevoiceless contexts (as in "rahd" for "ride" and "raht" for "right"), most likely the speaker is faking an African American English (AAE) dialect, since the authentic language variety is characterized by frequent monophthongization of /ay/ but almost exclusively in non-prevoiceless contexts (so that "right" is realized as "right"), a subtlety that will escape non-linguists (including both performers and listeners), who may be familiar with stereotypical pronunciations but not their authentic linguistic patterning.

Despite the complications involved in uncovering linguistic disguise, Eriksson (2010) noted that trained forensic linguists can quite readily detect disguise. However, disguise poses a significant problem for automated analyses, in large part due to the difficulty of developing a representative database of disguised speech on which to train automated systems. Eriksson therefore advocates for the creation

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of a database of paired speech samples of individuals producing samples of both undisguised and disguised speech.

While the automated detection of dialect disguise still lies in the future, researchers are working on improving automatic systems for the detection of other types of vocal disguise. Perrot, Morel, Razik, and Chollet (2009) explored the abilities of an automatic speaker recognition algorithm to identify the presence of voice disguise and distinguish between the four most common methods of disguise reported by the forensic research institute of the French Gendarmerie: a hand covering the mouth, pinched nostrils, performance of a high pitched voice and performance of a low pitched voice. The researchers drew a number of conclusions. First, their system had some success in identifying the presence of disguise, once the system had been trained on a set of 40 disguised voice samples. However, when background noise was added, to more accurately approximate the conditions of a real forensic scenario, the results were significantly affected. Finally, discrimination among the various disguises was very difficult for the automated system, especially in the case of the low pitch disguise and the hand over the mouth.

Another line of inquiry involves examining the effects of face-concealing garments, based on Peter French's claim that "an appreciable proportion of forensic-phonetic casework involves facial disguise of one form or another" (Fecher & Watt, 2012). This project (Fecher & Watt, 2011, 2012) has so far involved examining the effects of different types of face-concealing garments (such as surgical masks, motorcycle helmets, and balaclavas) on the distinguishability of different consonants by nonexpert listeners (and viewers, in experiments testing the effects of the addition of the visual channel on intelligibility) and via acoustic analysis. The decline in distinguishability that results, including in spectrographic analysis, has implications for speaker profiling and identification; however the specific effects of face-concealing garments on these forensic linguistic tasks has yet to be directly tested. To date, it seems that when disguise is involved, the most reliable method of analysis continues to be careful auditory analysis conducted by trained forensic linguists.

Eriksson (2010) also provided the important reminder that when it comes to speaker profiling, a disguise may still meet the criminal's goals even if it is wildly inaccurate and its presence obvious to the analyst. The purpose of disguise in criminal contexts is to conceal the speaker's identity, not necessarily to provide a convincing imitation of a performed dialect, voice quality, or speech pathology—unless the criminal is seeking to deflect suspicion to a specific individual or group. An analyst may be able to tell based on inconsistent patterns of variability and under- or overuse of expected dialect features that a dialect or other qualities of voice are inauthentic, but the faked features may still successfully obscure the speaker's true speech patterns and therefore successfully interfere with a profile.

> Given that she strangely has all the features of the Southern Vowel Shift (SVS) but its trigger, could it be that the person claiming to be the long-lost Mary Doe is faking her accent, and, as is typical for dialect performers, doing a rather bad job of getting the details correct? This seems improbable for several reasons. For one, as we have seen, it is highly unlikely that the Person of Interest (POI) would effect complex,

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subtle features such as the shifted positions of the front vowels /i/ and /ɪ/ and /e/ and /ɛ/ while neglecting to put on the most stereotypical feature of Southern U.S. speech, monophthongal /ay/. Instead, we would expect a dialect imitator to do the opposite—to effect monophthongal /ay/ "across the board" while ignoring the subtleties of the SVS. In addition, the POI's accent, though unusual, is consistent throughout each recording and across the two tapes, made several months apart, an impressive feat if indeed the POI is faking, given that people cannot sustain consistent disguise in even short bits of scripted speech in experimental settings, let alone in lengthy interview conversations in which pressure is high and speech content is crucial. Furthermore, there are the case facts themselves: Why would someone purporting to be a person who grew up chiefly in upstate New York and then lived as a teenager and adult in western U.S. go through the trouble of putting on a Southeastern U.S. accent when that accent would only undermine her identity claims? For these reasons, the expert linguists working the case opine that the POI's accent is genuine.

After discounting possible disguise, the researchers decide that one of two conclusions is likely to hold. First of all, not only does the POI show the unusual combination of features (and lack thereof) just noted, she also occasionally exhibits a feature that is quite unusual in U.S. dialects but is found in some coastal Southern areas: the raising and backing of the nucleus of /ay/ in words like "mind" to something like "moind." Labov et al. (2006, p. 244) noted that this feature can also trigger the SVS, as it has in Southern England, Australia, New Zealand, and South Africa—and in certain areas of the U.S. Southeast, for example the Pamlico Sound region of coastal North Carolina (Labov, Yaeger & Steiner, 1972; Wolfram, Hazen & Schilling-Estes, 1999). So one conclusion is that the POI was socialized in coastal North Carolina or another coastal Southern region, not in the Inland South—and not in her claimed areas of socialization, New York State, California, and Arizona.

A second possibility relates to the complications pertaining to dialect contact and mixing that were outlined above. The real Mary Doe and her siblings were moved around a number of times by their mother and stepfather, due to his military employment. In addition, the mother put at least one child up for adoption, and several of her children were in and out of foster care during their formative dialect years. To add to the complications of the case at hand, DNA tests reveal that the adult POI is actually the biological daughter of Mary's mother. Hence, the POI may also have been moved around in her childhood and may have a somewhat imperfectly acquired Southern dialect, one which includes all the elements of the U.S. SVS except its trigger, and which also includes occasional use of a possible coastal Southern feature.

Ultimately, the forensic linguistic profilers consulted on this case cannot confidently point to a single place where the POI acquired her unusual accent. This level of caution is entirely appropriate, given the fact that the data are of limited quantity and quality, that sociolinguistics and dialect geographers have not documented every U.S. dialect, especially the smaller ones, and that dialect mixing and imperfect second (and even first) dialect acquisition are commonplace, particularly in today's age of ever-increasing mobility and intercommunication. At the same time, the linguist experts can confidently assert that dialect disguise is highly unlikely; and, most important for the case at hand, that the POI's dialect is inconsistent with what we would expect for

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the long-lost Mary Doe. It is of course up to the investigators to determine whether the POI is an imposter or not, but we are as confident as we can reasonably be, given the various caveats regarding speaker profiling outlined in our chapter, that we have provided the investigators with a valid, and we hope helpful, speaker profile.

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The author provided an overview of studies of accent and voice disguise over the past 10+ years, noting that while disguise is not necessarily very common, it can have quite an adverse effect on profiling efforts when employed. In particular, while expert analysts are quite adept at detecting disguise, there currently exist no reliable automatic systems for the detection of disguise. Eriksson advocated for the creation of a database of paired disguised-undisguised speech samples on which to train automated systems. He also called for more research on foreign accent imitation. He discussed the factors that impact people's perceptions of speaker identity, including familiarity with the spoken language/dialect and method/type of disguise (e.g., accent vs. voice).

Jessen, Michael. (2007). Speaker classification in forensic phonetics and acoustics. In Christian Müller (ed.), *Speaker classification I* (pp. 180–204). Berlin, Germany: Springer.

Based on his own and a review of others' studies and casework, Jessen discussed voice analysis (i.e., speaker profiling) and voice comparison (i.e., speaker identification). The focus is on which class characteristics seem to be inferable from speech. These include gender, age, so-called "sociolect" (profession, education level), foreign accent, native dialect, and medical conditions. Jessen also noted that it is possible to infer physical characteristics like height from frequency measurements. Jessen pointed to a number of complications in identifying each of the various speaker attributes; the current review further problematizes class characterizations from a sociolinguistic perspective.

Watt, Dominic. (2010). The Identification of the individual through speech. In Carmen Llamas & Dominic Watt (eds.), *Language and identities* (pp. 76–85). Edinburgh, Scotland: Edinburgh University Press.

This article presents an overview of speaker identification, which includes profiling unknown speakers for linguistic features indicative of class characteristics, as well as identification of specific individuals. Watt discussed both "lay" or "naïve" speaker identification—day-to-day, impressionistic identification of individuals by listeners untrained in phonetics—and "technical" speaker identification—the examination of a speech sample by a trained speech analysts, using auditory analysis, acoustic phonetic analysis, and automatic speaker recognition technology. The focus is broader than the current review, which focuses more narrowly on expert speaker profiling.

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