

ISSUES IN APPLIED PHONETICS: THE PROSPECTS OF FORENSIC VOICE INVESTIGATION IN NIGERIA

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Abstract

Forensic Phonetics is a rapidly developing area of the forensic sciences in the highly technologically developed countries of the world. It involves the application of expert knowledge in Phonetics (and indeed, Linguistics) in the identification of a speaker in cases involving disputed utterances. This study highlights some of the theoretical and methodological tools used in a forensic speaker identification task. It is argued that even though Nigeria (and indeed the whole of the African continent) represents a very fertile ground for the practice of forensic voice investigation by virtue of her peculiar socio-cultural, political, and economic realities, such objective may not be easily achievable, at least in the very near future, due to a general lack of awareness about the positive contributions of forensic voice identification and the prevalence of anti-social vices such as corruption, favoritism, nepotism, god-fatherism inherent in the polity.

Introduction

Forensic Phonetics, is a rapidly developing area of the forensic sciences in the highly technologically developed countries of the world. It is a common knowledge that in these countries today, the assistance of professional Phoneticians, and Linguists is highly sought in many areas of the legal system, especially with regard to the determination of disputed utterances (Tosi, O. I. 1979; Kunzel, H. J. 1987; Pisoni, D. B. et al 1989; Johnson, K. et al 1990; Ellis, S. 1990; French, P. 1990; Nolan, F. 1990; Tanford, T. J. et al 1992; Hollien, H. 1993; McClelland, E. 1994; etc), speaker dialect profile (Ellis, S. 1994; Lewis, W. 1994; etc), audio tape enhancement and authentication (Wade, N. 1973; Ford, H. D. 1974; Weiss, W. et al 1976; Hollien, H. 1977; Rothman, H. B. 1977; Broad, W. 1979; Aperman, A. 1982; Klepper, B. 1984; Koenig, B. 1991; Braun, A. 1994, etc). According to Koenig (1987:689), forensic voice investigation provides an excellent investigative aid for the Law Enforcement Agencies. This has resulted in not only identifying suspects in cases involving espionage, kidnapping, child molestation, consumer tampering, political blackmail, etc., but has also assisted in the prosecution of such suspects. In other words, the Law Enforcement Agencies in these countries can obtain certain types of expert assistance from Forensic Phoneticians, and Forensic Linguists in matters relating to speech and language. Thus, there might be situations in which the Police are carrying out their preliminary investigations with, in certain instances, a particular suspect in mind. They may be in possession of a recorded speech material of some kind, such as a recorded sample of a telephone call of an unknown speaker or a cassette recorded by an unknown person. In this case, the investigators will benefit from any information the Phonetician can provide them with respect to the unknown speaker's profile such as accent location, with particular reference to the origin of the speaker. This constitutes the "investigative" or "intelligence" category of a Forensic Phonetic Case-work (Hollien, 1990). Situations might also arise in which the investigators have advanced their investigation to a more specific target, i.e., with some specific suspects in mind. The contributions of the Phonetician in advancing the case further constitute the "evidential" category (ibid). Hollien (ibid), further points out that this category accounts for the majority of the cases handled in a forensic voice investigation task. The process by which a Phonetician arrives at his expert opinion is referred to as the speaker recognition process.

Speaker Recognition

Speaker recognition is what we do when we recognize a familiar voice, for instance, over the telephone or when we recognize an unseen speaker who is familiar to us solely from listening to his/her voice. Speaker recognition has as its sub-areas:

- i. Speaker verification
- ii. Speaker identification

Speaker Verification

Speaker verification is a process involving the acceptance or rejection of all or some aspects of the speech signal as it impinges on the ear of the listener in the case of humans, or in the "brain" of some computer driven devices on the basis of some pre-coded speech signal strategies. In human listeners,

these aspects are yet unknown, and the strategies involved in the verification process could vary from person to person, and from case to case. As it were, increasing the length of the sample does not make a great difference to the success of the verification exercise.

As pointed out in Hollien (1990:190), speaker verification is a much more easy task than speaker identification. The reason for this is that in speaker verification, the investigator is dealing with subjects who want to be recognized. Thus, the "unlocking" of such systems may be achieved through the production of a pre-coded utterance by a voice that the machine has been "trained" to recognize. Consequently, "high quality equipment is used, and many reference samples of the talker's speech are available and can be continually updated." (Hollien, 1990: *ibid*). Such speaker verification methods are now commonly in use in the banking and automobile industries, communication with astronauts, or with personnel in remote locations.

Speaker Identification

Speaker identification been defined as "the, process of identifying an unknown speaker from samples of his/her voice" on the basis of the speaker's speech characteristics (Hollien, 1990:190). Speaker identification is carried out on speech samples of a suspect by Experts in Phonetics. The Expert's identification is usually made on the basis of his auditory and acoustic analyses of the phonetic characteristics of the speech samples of the unknown speaker obtained at the scene of a crime (Koster, 1987, 1981;Koenig, 1980). Results of such analyses are matched with other speech specimens of the suspect obtained before or after the crime. This implies that "the bases of his conclusions are overt and testable by other Phoneticians" since "there is nothing mysterious about them." (Baldwin and French, 1990:21) However, in actual forensic cases, many factors militate against the identification of an unknown speaker on the basis of his speech characteristics. These include:

- a) the fact that we do not know as yet if intra speaker variability is always less than inter speaker variability in all situations and under all conditions. (Hollien, 1990).
- b) speech samples to be compared are invariably always non-contemporary and this creates difficulties in the identification task (there would be no reason to apply speaker identification procedures if for instance a hoax caller to the emergency services of an airliner, or the bomb disposal unit of a Police formation is apprehended while making the call - contemporary speech). Added to this is the fact that the subjects whose voices are to be analyzed in a forensic speaker identification task are usually uncooperative. Closely related to this problem of speaker distortions are factors such as stress, voice disguise, emotion, drug, alcohol, state of health, etc., that also hamper in many important ways, a forensic speaker identification task.
- c) Channel/System distortions (telephone, band-pass, noise, etc.) also create a lot of problems in an identification task. It is common knowledge that a recorded speech sample with a very high signal-to-noise ratio is very difficult to transcribe unless such signal is enhanced through acoustic filtering.

It must be pointed out that some of these problems that are debilitating to a forensic speaker identification task are certainly not insurmountable especially with the advancement of communication technology. The advancement of communication technology has helped considerably in improving the phonetician's knowledge about features of speech that were otherwise unknown, and techniques are now available in the enhancement of poorly recorded audio materials. It is reported in Hecker (1971), Stevens (1971), Tosi et al (1972), Kiinzel (1987), Hollien (1990), Baldwin and French (1990), etc., "that a given individual's speech signal contains features that are sufficiently unique and consistent to permit at least some successful identifications to be carried out." (Hollien, 1990:191). These idiosyncratic features present in a speaker's speech result from the "habituated speech patterns" employed in speech. Moreover, several research findings reveal that factors such as social, economic, geographic, and..educational factors, the configuration of the speaker's speech

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1. different renderings of the same speech segments by an individual speaker present Spectrographic patterns that preserve important similarities.
2. speech tokens from different speakers manifest significantly divergent patterns.

However, it is now a known fact that these assumptions are characterized by problems of empirical and theoretical nature. As pointed out in French (1994:170), speech segments are

characterized by instability in their Spectrographic patterning. Evidence of spectrographic intra-speaker and inter-speaker variability are also provided in Hollien (1990:216-219). In other words, it is a known fact in speech analysis that the same utterance produced more than once by the same speaker reveals differences in respect of their spectral properties. Similarly, it has been observed that spectrograms of utterances produced by different speakers (having the same regional or social accent) reveal certain similarities with respect to their spectral outlay.

It is reported in the literature that some of the proponents of the "voiceprint" method used it overzealously in criminal trials in those early days and this led to a judicial review of its application in some States in the United States of America.

The "Ear Method" (The Auditory-Phonetic Method)

In the British tradition, speaker identification was mainly by the auditory phonetic analysis alone from the 1960s to the 1980s. Thus, disputed utterances are analyzed by ear by a trained Phonetician and compared with those of known suspects "using a range of segmental and prosodic features to provide the basis for assessing the identity or non-identity of speakers." (French, 1994: 173). Even now, this practice is still very common in the British legal system. For instance, an English Court of Criminal Appeal ruling (Regina versus Robb 1991 (cf. McClelland, 1994)) upheld that forensic speaker identification evidence based upon auditory analysis alone is admissible in criminal trials (French, 1994:173). However, it must be pointed out that the danger inherent in relying solely on this method of investigation is that acoustically different speech tokens may produce similar auditory impressions (cf. Malmberg, 1961). Thus, the "ear method" may fail to reveal important differences between speech samples - differences that "become manifest through acoustic examinations of the configurations of their higher formants." (French, 1994: *ibid*). As a result of known limitations of both approaches, modern day practicing Forensic Phoneticians rely on a combination of the strength of both methods - the auditory-acoustic phonetic approach - in their analysis.

The Auditory-Acoustic Phonetic Approach

The need for a combined auditory-acoustic phonetic approach in a forensic speaker identification task is informed by the simple scientific principle that a conclusion based on two different and independent types of analyses is more reliable than one based on one method alone. Areas examined within the framework of the joint auditory-acoustic phonetic approach include the following:

Speech Habits

This involves a detailed analysis of segmental units of idiosyncratic nature. Such features may be selected for further acoustically based investigation that might provide the basis for the analyst's overall judgment.

Intonation, Rhythmical, And Fluency Features

Intonation patterns have been shown to vary on a regional or social basis within languages. Thus, dialectal deviations from the accent norm could be identified for further acoustic analysis. Rhythmical and fluency features that include patterns of elision and assimilation present important aspects of "individually identifying potential, as quite wide divergences may be exhibited across speakers from similar regional and social backgrounds," (French, 1994:175).

Voice Quality

Voice quality is a "combination of resonance upon which the speech signal is overlaid." (French, 1994;*ibid*) It includes resonance types such as nasal voice, velar voice, palatal voice, etc. Laver (1980), Nolan (1990) formalized a "scoring system" for the rating of speech samples based on auditory impressions of voice quality.

Speaking Fundamental Frequency (SFF)

SFF gives the impression of the overall pitch height of a voice. An estimation of the mean SFF could be made for sections of speech samples from both known and criminal recordings using the following algorithms: (i) Peak-picking, (ii) Autocorrelation, and (iii) Cepstral algorithms. These algorithms are now available in computer soft and hard wares such as the Medav Spectro 3000, SoundScope 16, Kay Elemetric's Computerized Speech Lab (CSL) 4300 series, etc. Kiinzel (1990),

Braun (1992), amongst others, have demonstrated that this parameter can be affected by a range of variables such as intoxication, excitement, stress, etc. It is also reported in Hirson et al (1994), that speakers tend to raise their fundamental frequency (F_0) in response to speaking on the telephone.

Formant Frequencies

The acoustic quality of a sound is dependent upon its characteristic overtone structure. A vowel sound for instance, is made up of a number of different pitches simultaneously. The pitch (note) on which it is actually spoken is its fundamental frequency (F_0). It is usually a function of the rate of vibration of the vocal cords/folds. Other audible overtone pitches give a vowel sound its distinctive quality that differentiates it from any other vowel. These characteristic overtones are referred to as formants. These are bands of reinforced frequencies. They are the results of the different ways in which the air in the vocal tract vibrates depending on the size and shape of the part of the tract (cavities or resonators) that modify the pulmonic air. Thus, during the production of a vowel, the air in the vocal tract vibrates at a number of different frequencies simultaneously. These frequencies are the resonant frequencies of the particular cavity configuration during the production of such vowel sound. Each cavity has its resonant frequency. As long as the position of the vocal organs remains constant, the air in the vocal tract will resonate at these resonant frequencies, irrespective of the rate of vibration of the vocal cords. In speech, the vocal tract assumes different shapes and sizes for each of the possible sounds in human languages. This is why, for instance, each of the vowel sounds has its characteristic auditory quality since each time there is a modification of the shape and size of the vocal tract, there is a resultant variation in air pressure. It should, however, be noted that formant patterns for a given speech sound exhibit considerable variation from speaker to speaker since no two speakers has exactly the same vocal tract size, Even within the speech form of the same speaker, intra-speaker variability is observed (Stevens, 1971). Generally, the first three formants are used to describe the acoustic properties of a given vowel sound. The fourth and higher formants are used to characterize the speaker - they characterize a speaker's voice quality.

It is reported in LaRivierre (1974), as well as in many authors cited above, that the average fundamental frequency (F_0) and formant frequencies, particularly the fourth and higher formant frequencies constitute valid indicators for identifying speakers. Relying on results obtained from speech analysis and synthesis, Omozuwa (2000: 108), points out that "... the relative stability of the third formant frequency (F_3)... tends to suggest that this might be a possible robust cue for speaker identification."

Jitter Estimation

This characterizes the cycle-to-cycle frequency variations in vocal fold vibration. This parameter has been used for many years in clinical pathology (cf, Wendahl, 1966; Heiberger and Horii, 1982; Wangner, 1995, etc.) as a means of assessing the degree of roughness and hoarseness in voice quality for sustained phonation by the subject with F_0 being held relatively constant as in the production of a sustained [a:.....]. The speaker identification unit of the German Federal Criminal Investigations Department (Bundeskriminalamt) and the Phonetics Department of the University of Trier, Germany, are currently working on an adjustment algorithm whereby jitter coefficients may be determined for speakers from naturally occurring vocalic elements extracted from known and criminal recordings (French, 1994:178; Wargner, 1995:18-27).

Acoustic Analysis of Voiceless Fricatives

It is reported in Masthoff (1992), Hirson and Duckworth (cited in French, 1994:176) that certain sound segments such as the voiceless fricatives /s/ and /ʃ/ are better indicators of individual speaker identity than others. /ʃ/ in particular has been shown to be a potential carrier of inter-speaker variability.

Duration of Speech Segments

Spectrograms also "provide a convenient and highly accurate basis for measuring durations of segments and sub-segmental elements of the speech chain." (French, 1994:176) Relying on acoustic measurement of sound duration, Baldwin and French, (1990), identified in a criminal recording as well as in the speech of a suspect, evidence of two sub-varieties of stammer:

1. Prolongation, which is the tendency to sustain consonants (usually the fricatives) beyond their normal duration.
2. Block, which is the tendency to arrest the development of consonants (usually the stops or

plosives). In these cases, the stops exhibit very prolonged hold phases.

Creak Transition Points

This parameter characterizes points in the pitch range "at which transitions from normal phonation into glottal creak occurs." (French, 1994:178). Creak transition points are recoverable from certain forms of FO analysis. Comparability across speech samples is then assessed. Consistency of this parameter within the speech of an individual speaker is said to be very high.

It could be seen from the above discussion that forensic voice investigation has advanced to a very high level in the technologically developed countries, and active research efforts are still going on to ensure the reliability of phonetic parameters used in a forensic speaker identification task.

Forensic Voice Investigation In Nigeria

To our knowledge, no record of the application of phonetic investigation to a forensic casework in Nigeria or indeed in the African continent (except probably South Africa) has been reported. The reason for this is not far-fetched: a general lack of awareness with regard to the roles of the Forensic Phonetician/Linguist in our society. Indeed, how many Nigerians actually know who the Linguist is, and what he does; how research results in the Linguistic Sciences can be harnessed and properly utilized for -the betterment of the society (as is the practice elsewhere)? In Nigeria today, many people still believe that a Linguist is that person who speaks many languages. For the purpose of this study, we will simply assert that a Linguist may be that but he is far more than just that. In other words, a Linguist may be a polyglot but a polyglot is not necessarily a Linguist. Thus, this general lack of awareness amongst our people as to who the Linguist really is, explains why it would not probably occur to our Law Enforcement Agents and our Legal Practitioners, for example, that the Linguist, and the Phonetician in particular, has any useful contribution to the case they are handling especially if such case involves disputed utterances that may require semantic, syntactic, or phonetic interpretations and analyses. The Audio-phonetician is probably the last person our Law Enforcement Agents will turn to for expert advice in respect of an audio recording crucial to a successful prosecution of their case(s). Little surprise then that during the display of the now famous "coup audio-videos" of the late General Abacha years, it was a serious oversight that it did not occur to the litigants that such controversial audio-videos recordings could be sent to experts in Forensic Phonetics for authentication, enhancement (if the need arises), and auditory-acoustic analyses.

The various methods employed by criminals in perpetrating their nefarious activities are getting more and more sophisticated by the day. We therefore, need a corresponding sophistication in the various methods of combating and preventing such crimes in Nigeria. The various techniques offered by forensic voice investigation should be integrated into the whole process of crime prevention "and detection, and the" dispensation of justice in Nigeria since voice evidence, when properly obtained and managed, could be of immense benefit in preventing and detecting criminal activities especially with regard to the current anti-corruption campaign of the Nigerian Government. In the now famous Rodney King video recorded by an amateur, George Holliday, in Los Angeles, USA, contributions of Forensic Phoneticians in enhancing the intelligibility of the poorly recorded amateur audio material as well as the detailed auditory-acoustic analyses of the audio-video recording is reported in Braun (1994:217-222). This report attests to one of the many examples of the possible assistance a legal system can derive from Forensic Phoneticians in the dispensation of justice. Similar tape enhancement techniques could have been applied to the poorly recorded audio components of the video clips presented as evidence by Brig. Gen. Ibrahim Sabo (erstwhile Director of the Directorate of Military Intelligence), to the Oputa panel on Human Rights Violation and Reconciliation Commission.

Today, Germany, The United States of America, countries that made up the former Soviet Union, Great Britain, France, etc., have been identified as some of the substantially enlightened countries of the world in the area of forensic voice investigation especially with the enormous contributions of the internal Security Agencies such as the German Bundeskriminalamt (BKA), the British Home Office's MI5, the United States of America's FBI, the French Direction Generale de la Surveillance du Territoire (DGST), the then Soviet's KGB, etc, in this sub-area. These Security Agencies have specialized laboratories for speaker identification. These laboratories employ both Phoneticians as well as support Engineers and Technicians. The establishment of similar organs in our security networks, both internal and external, as well as in the newly established anti-corruption commission in Nigeria, the Economic and Financial Crimes Commission (EFCC) and the Independent Corrupt Practices Commission (ICPC) will help a great deal in the dispensation of justice especially

with regard to the determination of disputed utterances. **

It is therefore, pertinent to note that Nigeria, in particular, and the African continent in general, by virtue of her peculiar socio-cultural, political, and economic realities, represent a very fertile ground for the practice of forensic voice investigation, in particular, forensic linguistics in general.

It is axiomatic to affirm that a high level of probity and professional dedication are required from all the "actors" involved in a forensic voice identification task. The question is: in a country like Nigeria plagued with the highest level of anti-social vices such as corruption, drug peddling, favoritism, nepotism, god-fatherism, indifference to research findings and their applications, etc., can this noble objective be achieved?

Conclusion

The services of Experts in Phonetics are employed by various law enforcement agencies as well as legal professionals in the technologically developed countries of the world in cases involving disputed utterances. The theoretical and methodological tools used by such Experts in a forensic speaker identification task are highlighted. It is argued in this study that even though Nigeria (and indeed the whole of the African continent) represents a very fertile ground for the practice of forensic voice investigation, it would appear that this may not be easily realizable, at least -for now, as a result of the prevalence of a myriad of anti-social vices such as corruption, favoritism, nepotism, god-fatherism in the polity. However, serious commitment by the various tiers of Government to the fight against corruption and other vices in the society will provide the enabling environment for a meaningful practice of forensic voice investigation in the country. Furthermore, awareness of members of the general public, the various law enforcement agencies (the Police and the Armed Forces, the Nigerian Drug Law Enforcement Agency (NDLEA), the Economic and Financial Crimes Commission (EFCC), and the Independent Corrupt Practices and other related offences Commission (ICPC)), and those in the legal profession regarding the positive contributions of forensic voice investigation to the cases they are prosecuting or involved in, is essential to a successful application of the knowledge of expert Phoneticians in matters relating to disputed utterances and other related matters in a litigation.

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