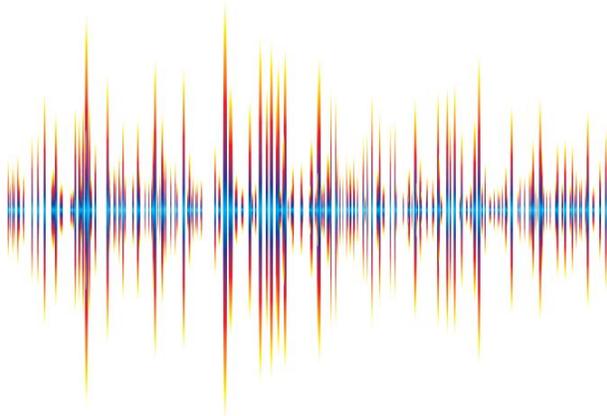# Forensic Language Analysis

Forensic linguistics and phonetics are sciences that examine text and speech. They have applications in criminal, civil and asylum legal proceedings, and in the private sector (for example, in verifying identity). They are also used in counter-terrorism, intelligence and surveillance. This note examines the scientific validity of procedures and their applications, and explores the issues surrounding their use.

Overview

- Forensic linguistics and phonetics are used in criminal investigations, counter-terrorism, intelligence and surveillance.
- Some forms of forensic linguistic and phonetic evidence are routinely used in criminal courts.
- There are guidelines on who can provide expert evidence; however, expertise is not statutorily regulated.
- The Home Office uses language analysis to help determine the origin of asylum seekers. There has been no independent assessment of these practices and they have been criticised both by academics and in the UK Supreme Court.
- Voice is increasingly used as a biometric in the public and private sector.
- Automatic speaker recognition systems can process thousands of speech samples, enabling law enforcement agencies to focus on persons of interest.

Background

Linguistics is the study of language and its structure.[1] Forensic linguistics and forensic phonetics are sub-disciplines which have a range of applications.

- **Forensic linguistics** concerns the analysis of written and spoken language for legal purposes. Analyses are done both for investigative purposes and when a specimen (such as a text, email or internet chat) is due to be presented as evidence in court (Box 1). The police engage experts to assist with investigations as does the Crown Prosecution Service (CPS) or defence solicitors where specimens may be admissible as evidence.[2]
- **Forensic phonetics** concerns the scientific properties of speech (such as sound wave frequencies). An expert is engaged when there is a speech specimen from a crime.[3]

Beyond the forensic context, phonetic analysis along with analysis of vocabulary and grammar is also used as a tool in the asylum process. The Home Office contracts two companies to interview an applicant, analyse his or her language and assess the degree to which it matches the language found in the region he or she claims to come from.[4] Linguistic and phonetic procedures are also used as intelligence and surveillance tools, to detect fraud, malpractice[5,6] or plagiarism,[7] and to verify identity.

Procedures and Techniques

There are two main types of expert analysts: linguists and phoneticians. These experts use a combination of software, expertise and statistical approaches in their analyses. Computer scientists have developed technologies to automate linguistic and phonetic analyses. These approaches do not require an expert to implement them but do need expert interpretation. The next section looks at the main procedures used.

Authorship Analysis (Written Language)

- **Sociolinguistic profiling:** when the author of a piece of writing such as an email or text message is unknown, experts analyse it and make inferences about the author's background such as their age or education. They do this, for example, by scrutinising the use of slang terms, dialect words and spelling mistakes.[2]
- **Comparative authorship analysis:** if authorship of a piece of writing is in dispute, an expert compares the

Box 1. Court Cases Admitting Linguistic and Phonetic Evidence
These cases have involved forensic experts giving evidence in court:

- *R v Uter, Abouakkour, Roberts, Wood and Williams [2014]*. An expert compared recordings of telephone calls made by the suspects with interview recordings made by the police and concluded that the samples were highly similar. The defendants were convicted for kidnapping, torture and witness intimidation.[8]
- *R v Julie Dawn Lunn [2012]*. West Yorkshire Police commissioned an expert to compare blackmail letters with written specimens known to be written by the defendant, leading to her conviction.[9]
- *R v Rizwan Ahmed and others [2012]*. Two experts[9] acted for the defence in a murder case, analysing slang text messages between the co-accused. Charges were dropped against one defendant.
- *R v Ogundele [2010]*. An expert analysed internet chat that contained abbreviations and dialect terms and appeared to contain a conspiracy to murder. He determined the meaning of one term as having associations with shooting and killing.[10]

disputed text with samples of known authorship, assessing linguistic similarity and distinctiveness, such as repeated spelling errors. The expert gives an opinion of the likelihood that the texts were written by the same person.[2]

Meaning Analysis (Written and Spoken Language)

- **Determination of meaning:** this involves analysing words or phrases – often slang or regional dialect terms – in text or speech.[2] The expert analyses the linguistic material, for example examining its regional origin, then comments on its contextual meaning (Box 1, bullet 4).
- **Corpus linguistics:** software processes hundreds of documents such as online extremist texts.[11,12] It identifies keywords, phrases and themes, which can be used for intelligence gathering and investigative purposes.

Speaker Analysis

- **Speaker profiling:** an expert listens to speech samples and uses a highly trained ear and specialist software to analyse speech and accent features to build a profile of the speaker, localising him or her to a certain region or demographic background.[13]
- **Speaker comparison:** an expert compares speech samples of a known individual with those of uncertain origin. By analysing the features in all samples, the expert assesses the similarity and distinctiveness and considers whether the results support the view that the recordings are of the same speaker or different speakers.[14] The degree of support is expressed on a qualitative scale, for example, 'strong support'. [15,16]
- **Automatic speaker recognition and verification:** computational technology extracts biometric information (based on the physiology of an individual's vocal tract) from speech samples. These samples can be compared with others to perform automatic speaker comparison (sometimes known as recognition) or verify if the same person is speaking in multiple samples (verification). [17,18] The technology can sift through very large databases of speakers.[19] This is not the same as automatic speech recognition systems, which recognise words, not speakers (for example speech-to-text software).

Conclusions are given as numerical probabilities, which can then be expressed qualitatively.

Other Procedures and Techniques

- **Transcription:** phoneticians transcribe recordings.[20]
- **Resolution of disputed utterances**: when a recording exists from a crime and what was said is disputed, experts can analyse it.[21]
- **Authentication**: experts analyse the authenticity of recordings, for example if the date of recording is in question. Techniques include comparing patterns of fluctuation in low-level frequencies from the national power supply in the recording with those in a database.[22]
- **Detecting deception**: this procedure developed outside of the fields of linguistics and phonetics.[23] The technology analyses samples of speech (usually recorded during a phone call) and aims to detect emotions such as stress, which are purported to be indicative of deception (Box 2). Phoneticians, however, state it is not possible to make a link between patterns in speech and deception.[24,25]

Validity and reliability of techniques
Assessing the validity and reliability of these procedures is complicated because of the nature of the data and procedures. In other areas of forensic science, such as DNA analysis, data at the population level enables experts to calculate the probability that two samples have the same origin. Linguistic and phonetic population level data are limited, making it difficult to establish the prevalence of features.[26] This means that conclusions cannot be expressed statistically, or with the same degree of certainty as in other areas of forensic science. In linguistics, experts draw on their knowledge and experience as well as computational methods in their analysis. The validity and reliability of the expert cannot be easily tested. In phonetics, experts use their trained ear and speech processing software. However, because within-speaker variability makes every instance of speech unique, an expert cannot draw conclusions with certainty. [22,27,28] Computational procedures can be used in some circumstances and give numerical conclusions which also express degree of certainty. Although routinely admitted in European courts and elsewhere, computationally processed evidence is seldom admissible in UK courts.

Box 2. Detecting Deception?
Voice risk analysis (VRA) technology is purported by its advocates to indicate deception. It is mainly used as an anti-fraud tool, for example in the insurance industry and by local authorities to assist in detecting benefit fraud. The main provider of VRA in the UK is DigiLog.[29] Corporate clients assert that VRA reduces fraud,[30] but it is unclear if this is because it successfully identifies fraudsters or because customer awareness acts as a deterrent. The technology was not developed by phoneticians, who are very sceptical of its validity and reliability.[31] Research conducted by business experts[32] using simulated lab data suggests that the technology may pick up on proxies for deception. Intellectual property restrictions mean that independent experts have been unable to scrutinise many of the analytical parameters.

Linguistics, Phonetics and Criminal Justice
Use in the Criminal Justice System
In criminal investigations, expert linguists or phoneticians may be engaged by the police, Crown Prosecution Service or defence. Since its creation in 2008, experts from the Centre for Forensic Linguistics have provided more than 500 evidential and investigative reports.[9]**Error! Bookmark not defined.** J.P. French Associates, the largest private UK forensic phonetics laboratory, works on approximately 200 cases per year.

Specific Procedures
Expert sociolinguistic profiling of a specimen of writing by an unknown author can help to reduce the pool of suspects.[33] Though used in investigations, it is not used evidentially in the UK. Where a text has been sent from the mobile phone of a person who is missing and presumed dead, an expert analyses the texts of interest and reports on their similarity to known texts from the missing person, suspect or someone else (Box 1, bullet 2). The police engage experts to carry out speaker profiling when a recording of an offender's voice exists but there is as yet no suspect. This procedure is used in UK investigations, but is not admissible as evidence, unlike in other parts of Europe. If there is an earwitness to a crime, the police can use a voice parade (a line-up of voice recordings including the suspect's). A 2003 Home Office circular advises that police should collaborate with phoneticians who apply techniques of speaker comparison when selecting voices.[34] When there is doubt over who was speaking in a criminal interaction and there are several suspects, the CPS or defence engage an expert analyst, who presents their findings as evidence.

One current research interest in linguistics is in police interviews in rape and sexual assault cases. The CPS often decides not to prosecute following the initial police investigation.[35] In cases where consent is an issue, suspect and victim interviews are particularly important sources of evidence. Research indicates that current interviewing practices may not enable the best quality evidence to be elicited.[36] Training developed in collaboration with linguists could improve this.

Concerns about use in Criminal Investigations
Academic researchers and practitioners have four main areas of concern.

Regulation of Expertise
The main concern is that substandard expertise may lead to miscarriages of justice. Although it is not known whether this has happened in the UK, a person was wrongly jailed in Italy because of errors in the forensic phonetic report.[37,38] Since there is no statutory regulation or accreditation of experts in the UK (Box 3), individuals with inadequate expertise can present themselves as experts.

Understanding Limitations
Researchers and practitioners highlight the danger of the 'CSI effect' whereby TV and film representations of forensic

Box 3. Forensic Science Regulation and The Expert Witness Regulation
The Forensic Science Regulator (FSR) seeks to ensure that all forensic science used in the criminal justice system meets quality standards,[39] but it does not have statutory powers. The Science and Technology Select Committee supported statutory regulation in 2013,[40] which the Home Office is reviewing.[41] Guidance on legal obligations and codes of practice and conduct for the profession are produced by the FSR. Forensic phonetics is classed by the FSR as a branch of digital forensics, and organisations performing analyses and laboratory procedures (rather than the experts themselves) must be accredited by October 2017.[42] Forensic linguistics is not recognised by the FSR as forensic science as it argues that analyses are subjective. However, forensic linguists must conform to Ministry of Justice expectations laid out in the Criminal Procedure Rules.[43] The International Association of Forensic Linguists[44] and the International Association for Forensic Phonetics and Acoustics[45] have codes of practice, but these are guidelines and are not enforced.

The Expert Witness
The Ministry of Justice's Criminal Procedure Rules[46] and Criminal Practice Directions[47] specify who can act as an expert witness and what can be admitted as expert evidence. The CPS also provides guidance for experts and on expert evidence.[48,49] Its guiding principles[50] are in line with those set down by the Forensic Science Regulator. Admissibility is determined by common law:[51] R v Turner [1975] set the precedent that expert evidence must be 'outside of the experience of a judge or jury'.[52] In 2011, the Law Commission reviewed the use of expert evidence and recommended standardisation but this was not taken up by Government. [53,54]

science raise expectations.[3] This presents two problems:
- jurors expect certain procedures to be possible which experts assert are not, such as personality analysis, determining truth and falsity, and assessing threat in speech intonation (although this is a research interest).[55]
- jurors expect conclusions to be presented with certainty.

Expressing Conclusions
Some phoneticians and linguists are frustrated by the pressure to present numerical conclusions and express certainty, since these are not generally possible.[2] Expressing conclusions so that judges and juries can understand and evaluate them has been highlighted as an issue across forensic science.[56,57,58] There are concerns as to how understandable probability statistics are and how and whether it is possible to convert them accurately to qualitative conclusions.

Technical Limitations
Some academics and practitioners highlight limitations in various procedures used in criminal investigations. They assert that whilst sociolinguistic profiling is used in investigations, it cannot and should not be submitted as evidence.[59] Voice parades are deemed effective by phoneticians but are lengthy and costly.[60] Academics are researching how to streamline the design and use of voice parades.[61] Some psychologists are sceptical about voice parades because of the complex nature of memory of voice.[62] They consider voice recognition less reliable than face recognition, the reliability of which is itself uncertain.[63]

Asylum and Language Analysis

If there is doubt surrounding an asylum applicant's claimed origin, the Home Office carries out several procedures including Language Analysis (LA) to test the claim (Box 4). Claimed nationalities associated with a high number of fraudulent asylum applications (currently Palestine, Syria and Kuwait)[64] are tested systematically. As well as detecting fraud in asylum claims, the Home Office's rationale for using LA includes speeding up application processing, cutting costs and deterring fraudulent claims.[65] However, a Home Office report (2011)[65] concluded that it is not possible to know whether LA is a deterrent. Between 2008-2010, 2,198 LAs were carried out at a cost of £174,000.[66] Home Office data on more recent costs and cost savings is not available.

Issues of using LA in Determining Refugee Status

Although phoneticians and linguists support the theoretical concept of language analysis[67,68] some,[69,70] along with social scientists[71,72] and legal practitioners,[73,74] criticise procedures that attempt to determine nationality or origin such as LA. They all assert that the relationship between language and nationality or origin is complex; language does not always map neatly onto geographical boundaries.[69] Displacement (often repeated) is a common experience for refugees, which often affects language.[75]

Standards, Methods and Practice
LA practitioners do not have to conform to the standards for experts in the criminal justice system. There are calls to raise the standard of expertise.[76] Unlike some other European countries (such as Norway) the UK, does not have statutory minimum requirements. Internationally authored non-statutory guidelines (2004)[67] exist, but academics argue that they need updating.[77] Practitioners wrote a set of 'minimal requirements' in 2008 but they were not pursued.[77] There are varying practices across Europe: some agencies use a 'specialised linguist method'; others use a trained native speaker and a linguist.[77] There has been no independent analysis of methodologies, though studies indicate that procedures can be accurate.[78] The lack of research means LA's reliability is unknown.[79,77] The ESRC funded research to address this, but a lack of access to some providers' data prevented any meaningful analysis.[80,81] Academics criticise the lack of methodological transparency in the field.[77] The practices of Sprakab (the primary commercial provider until August 2014) were criticised in a 2014 UK Supreme Court judgment in which guidance for the role of the analyst was laid out.[82] The Home Office has addressed some of the issues identified.

Biometrics: Verification and Identification

The use of voice in biometric recognition offers new opportunities in various domains.

Automatic Speaker Verification (ASV)

ASV uses voice instead of a password as a means of verifying identity to access a system. In the UK it is used commercially, for example by Santander and Barclays[83] and will be used by Atom Bank (one of the first internet-only UK-

Box 4. Language Analysis in Refugee Status Determination
When someone seeks asylum, the Home Office takes the applicant's details and checks if he or she has already sought asylum.[84] The applicant is then interviewed. Since August 2014, the Swedish company Verified is the principal LA provider, with the Swedish company Sprakab providing secondary support. An in-house analyst, who is a native speaker of the applicant's language, interviews the applicant by telephone and then, with a linguist, assesses the linguistic behaviour against predetermined criteria. They produce a report concluding how consistent the applicant's speech is with speech in the claimed place of origin or former places of residence.

banks). A Government Digital Service-sponsored project is looking into the potential use of ASV for telephone access to government services and to confirm online identity.

Automatic Speaker Recognition (ASR)

This is used to identify whether one specimen of speech consistently closely resembles another (for example from a database) to help determine whether it is likely to be the same person speaking. ASR technology was used to identify a perpetrator of the 2006 Madrid airport bombing[85] and has been used by UK security agencies since 2007. ASR output is used evidentially in 35 countries[86] but not in the UK. J.P. French Associates is carrying out research with ASR with a view to integrating it into future practice.

Issues with ASV and ASR

ASV and ASR give numerical conclusions but the inherent variability in voice means 100% certainty is impossible. ASV and ASR are usually used with other personal data to increase reliability. In simulations, error rates are low (in the range of 1.5-2.6%)[87,88] but real data may be of poorer quality and environmental and cross-channel distortions (if one sample comes from a telephone and another from Skype) make the technology less successful. Fraudulent access using stolen voice recordings is a technical concern that industry is addressing: the company Agnitio reports detecting up to 99% of spoofs.[89] Improving reliability is a research interest. Standardisation of voice biometrics is not as advanced as other biometrics; however, an International Standards Organisation code of practice for implementing biometric systems is expected in 2016.[90]

Intelligence and Counter-Terrorism

The security services use technologies and engage experts to carry out procedures outlined earlier, as well as:[91]
- **Infiltration and disruptive policing:** forensic linguists are training West Midlands Police in assuming online identities to infiltrate paedophile networks. The ESRC is funding research (£400k) into methodologies for this.[92]
- **Analysing digital personas:** computer scientists are researching technology to develop a language 'fingerprint' of online personas.[11] These are of interest to law enforcement agencies as a way to identify cybercriminals.
- **Speaker Identification Integrated Project:** in response to a European Commission call[93] (€15m funding), a consortium of 17 European partners is developing transnational technology to identify criminals.[94]

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