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SPEAKER IDENTIFICATION – A JUDICIAL PERSPECTIVE

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The need to identify persons by their voices arises from time to time in legal proceedings, particularly in criminal proceedings. A witness may have heard an offender speak at the scene of a crime, for example, or there may be a recording of a person's voice obtained by telephone intercept or by the recording of a threatening telephone call or a 000 emergency call. Identification of the speaker may then be an important issue in the proceedings.

This is a field where considerable scientific work is proceeding. It may be of use to those undertaking this work, particularly to those who do so with a view to producing material that can be used as evidence in legal proceedings, to have a legal perspective on this field.

In this talk, I will start by outlining some general principles concerning the receipt and use of evidence in legal proceedings, which are relevant to evidence about speaker identification. I will then outline some principles that have particular application to speaker identification. I will then deal in turn with a number of ways in which evidence bearing on speaker identification may arise and be dealt with. Then I will focus on the particular type of evidence that I understand is the main concern of this conference, namely expert scientific evidence directed to identification of persons by their voices. In doing so, I will consider issues concerning legal admissibility, evaluation and helpfulness of scientific evidence.

In discussing the law concerning evidence, I will generally be referring to the law of New South Wales, which is partly contained in a New South Wales statute, the Evidence Act 1995. There are similar statutes operating in the Australian Capital Territory and Tasmania. There are differences in the law in other States of Australia; but in most respects the differences are not great. The law seems similar in the UK, but it may be somewhat different in the USA because of the requirements for expert evidence laid down by *Daubert* v *Merrell Dow Pharmaceuticals* (1993) 113 S Ct 2786, which I will refer to later.

GENERAL PRINCIPLES OF EVIDENCE

The basic principle of evidence is that evidence is legally admissible if it is *relevant* to an issue in the proceedings. That proposition has some elaboration in ss 55, 56 and 57 of the Evidence Act:

> 55 Relevant evidence
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> (1) The evidence that is relevant in a proceeding is evidence that, if it were accepted, could rationally affect (directly or indirectly) the assessment of the probability of the existence of a fact in issue in the proceeding.
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> (2) In particular, evidence is not taken to be irrelevant only because it relates only to:
>
> (a) the credibility of a witness, or
>
> (b) the admissibility of other evidence, or
>
> (c) a failure to adduce evidence.
>
> 56 Relevant evidence to be admissible
>
> (1) Except as otherwise provided by this Act, evidence that is relevant in a proceeding is admissible in the proceeding.
>
> (2) Evidence that is not relevant in the proceeding is not admissible.
>
> 57 Provisional relevance
>
> (1) If the determination of the question whether evidence adduced by a party is relevant depends on the court making another finding (including a finding that the evidence is what the party claims it to be), the court may find that the evidence is relevant:
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> (a) if it is reasonably open to make that finding, or
>
> (b) subject to further evidence being admitted at a later stage of the proceeding that will make it reasonably open to make that finding.
>
> (2) Without limiting subsection (1), if the relevance of evidence of an act done by a person depends on the court making a finding that the person and one or more other persons had, or were acting in furtherance of, a common purpose (whether to effect an unlawful conspiracy or otherwise), the court may use the evidence itself in determining whether the common purpose existed.

Thus, the test is whether evidence, if accepted, "could rationally affect ... the assessment of the probability of" a fact in issue in the proceedings. If it could, then it is relevant and is admissible.

However, the court has a *discretion to exclude evidence* if it is considered prejudicial, confusing or time-wasting. This matter is dealt with in ss135-137 of the Evidence Act:

135 General discretion to exclude evidence

The court may refuse to admit evidence if its probative value is substantially outweighed by the danger that the evidence might:

(a) be unfairly prejudicial to a party, or

(b) be misleading or confusing, or

(c) cause or result in undue waste of time.

136 General discretion to limit use of evidence

The court may limit the use to be made of evidence if there is a danger that a particular use of the evidence might:

(a) be unfairly prejudicial to a party, or

(b) be misleading or confusing.

137 Exclusion of prejudicial evidence in criminal proceedings

In a criminal proceeding, the court must refuse to admit evidence adduced by the prosecutor if its probative value is outweighed by the danger of unfair prejudice to the defendant.

These sections have greatest application in criminal cases heard by juries.

Prejudicial evidence is evidence that may influence a tribunal's decision otherwise than by rationally affecting its assessment of probability. For example, it is considered that evidence that a person charged with a sexual assault has committed such an assault against another person on another occasion may influence a jury's decision otherwise than by rationaiiy affecting its assessment of probability.

This consideration may apply to scientific evidence generally, if the court thinks that more weight would be given to it than its rational persuasiveness deserves. It may apply with particular force to identification evidence: as we will see, the law recognises that there may be particular problems with this kind of evidence.

There are also principles limiting the admission of *opinion evidence.* These are dealt with in ss 76 and 78-80 of the Evidence Act:

76 The opinion rule

(1) Evidence of an opinion is not admissible to prove the existence of a fact about the existence of which the opinion was expressed.

(2) Subsection (1) does not apply to evidence of an opinion contained in a certificate or other document given or made under regulations made under an Act other than this Act to the extent to which the regulations provide that the certificate or other document has evidentiary effect.

> 78 Exception: lay opinions
> The opinion rule does not apply to evidence of an opinion expressed by a person if:
> (a) the opinion is based on what the person saw, heard or otherwise perceived about a matter or event, and
> (b) evidence of the opinion is necessary to obtain an adequate account or understanding of the person's perception of the matter or event.
>
> 79 Exception: opinions based on specialised knowledge
> If a person has specialised knowledge based on the person's training, study or experience, the opinion rule does not apply to evidence of an opinion of that person that is wholly or substantially based on that knowledge.
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> 80 Ultimate issue and common knowledge rules abolished
> Evidence of an opinion is not inadmissible only because it is about:
> (a) a fact in issue or an ultimate issue, or
> (b) a matter of common knowledge.

Thus, evidence of a person's opinion as to the existence of a fact is generally inadmissible to prove that fact.

However, under s78, the opinion of a non-expert is admissible if it is based on what the person "saw, heard or otherwise perceived" *and* evidence of opinion is necessary "to obtain an adequate account or understanding of the person's perception". Thus, for example, if a person believes a voice to be that of a friend, an adequate account of what the person heard cannot be given if the person is restricted to describing the characteristics of the voice. To give an adequate account, it is necessary to include the person's belief or opinion that this was the friend's voice.

Under s79, the evidence of an expert is admissible, the requirement being "specialised knowledge based on the person's training, study or experience" and that the opinion be "wholly or substantially based on that knowledge". I will say more about this later.

An opinion may be given about an issue the court has to decide: s80. As we will see, this can give rise to problems where the court has other evidence on this issue that needs to be taken into account, along with the expert's opinion.

VOICE IDENTIFICATION EVIDENCE

In addition to the principles on relevance and opinion, the Evidence Act has particular rules about identification evidence generally, which can affect voice identification. The relevant sections are ss114-116 and s165.

Sections 114 and 115 deal with visual identification and identification by pictures; and they are relevant in that they exemplify the particular caution with which the law regards identification evidence. In effect, s114 requires that, wherever possible, visual identification be by way of properly conducted line-ups; and s115 places restrictions on identification on the basis of pictures kept by police officers. There are no similar requirements or restrictions imposed in relation to voice identification; but it would be reasonable to assume that the considerations underlying these sections, notably the danger of a person being influenced into making an erroneous identification, would be relevant to the question of whether evidence of voice identification should be excluded as a matter of discretion under s135 or s137. Indeed, since voice identification is regarded as significantly more unreliable than visual identification, it might be expected that it be approached with greater caution.

The law's cautious approach to identification evidence is confirmed by s116 and s165 of the Evidence Act, relevant parts of which are as follows:

> 116 Directions to jury
> (1) If identification evidence has been admitted, the judge is to inform the jury:
> (a) that there is a special need for caution before accepting identification evidence, and
> (b) of the reasons for that need for caution, both generally and in the circumstances of the case.
> (2) It is not necessary that a particular form of words be used in so informing the jury.
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> 165 Unreliable evidence
> (1) This section applies to evidence of a kind that may be unreliable, including the following kinds of evidence:
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> (b) identification evidence,
>
> (2) If there is a jury and a party so requests, the judge is to:
> (a) warn the jury that the evidence may be unreliable, and
> (b) inform the jury of matters that may cause it to be unreliable, and
> (c) warn the jury of the need for caution in determining whether to accept the

evidence and the weight to be given to it.
(3) The judge need not comply with subsection (2) if there are good reasons for not doing so.
(4) It is not necessary that a particular form of words be used in giving the warning or information.
(5) This section does not affect any other power of the judge to give a warning to, or to inform, the jury.

Evidence relating to voice identification can take five different forms, which engage the rules of evidence in various ways.

First, evidence may be led of samples of recorded voices for direct comparison by the tribunal, which in criminal cases will usually be the jury.

Next, evidence may be given by a non-expert that, in his or her opinion, a voice heard on a relevant occasion by that witness was the voice of a particular person.

Then there is what has been called evidence by "ad hoc" experts, whose evidence is not based on scientific training, but on such matters as close and repeated listening to a large quantity of recorded material, or perhaps on familiarity with the language used by speakers in recorded material. The courts sometimes accept that such persons have, by their experience, a greater ability to make appropriate comparisons than the tribunal itself.

Next, there is evidence of speaker identification by what might be called "true" experts, that is, persons who have made a scientific study of the relevant area.

Finally, there is the possibility of expert evidence being given about the reliability of comparisons that may be made by *other* persons, in particular, as to the reliability of evidence from witnesses giving evidence of their own opinion as to identification of speakers, or as to the reliability of comparisons that might be made by the tribunal itself.

As I understand it, this conference is most concerned in the second-last of the categories I have mentioned, and I will return to this. But to put it in context, I will first say a little about the law relating to each of the other categories.

COMPARISON BY TRIBUNAL

The first situation involving voice identification is in comparison of voices by the tribunal itself. A tribunal such as a jury is allowed to compare a recording of a voice with another recording, or with the voice of a person heard in the court itself, so long as the quantity and quality of the material is considered sufficient to enable a useful comparison to be made.

However, at least where such a comparison is relied on by the prosecution, it will generally be necessary for a judge to give very careful directions to a jury as to considerations which could make the comparison difficult, and to give a strong warning as to dangers involved in making this kind of comparison. This matter was considered by the High Court of Australia in *Bulejcik* v *The Queen* (1996) 185 CLR 375, especially at 397-9; and by the Western Australian Court of Criminal Appeal in *Nguyen* (2002) 131 A Crim R 341.

In a more recent Western Australian case, *Neville* v *The Queen* (2004) 145 A Crim R 108, where it was the accused who sought to rely on this kind of comparison, it was held to be an error, sufficient to justify quashing the conviction, for a judge to have told a jury that they should refrain from using their own observations in deciding whether two recordings were of the same person.

A question has recently arisen in New South Wales as to whether a jury ought to be permitted to compare voices in this way, in the special circumstances where one language was used on one occasion and a different language is used on the other occasion. In *Korgbara* v *The Queen* [2007] NSWCCA 84, a majority of the New South Wales Court of Criminal Appeal held that the jury could make such a comparison; but one judge disagreed, and would have allowed the appeal against a conviction reached after this process was permitted. I think that, in some cases at least, there could be a real question as to whether a jury should be permitted to

make this kind of comparison; and, as I will suggest later, it might be appropriate to allow expert evidence as to the reliability of such comparisons.

IDENTIFICATION BY NON-EXPERTS

The second form of voice identification evidence is identification by non-experts. Before the Evidence Act was passed, it had been held in New South Wales that evidence, from a person who heard the voice of a person at a crime scene, that it was the voice of the accused, could only amount to positive identification where the witness was familiar with the voice before hearing it at the crime scene, or where the voice was very distinctive: R v *E.J. Smith* [1984] 1 NSWLR 462.

But in *R* v *Ad/er* [2000] NSWCCA 357, 52 NSWLR 451, it was held by the New South Wales Court of Criminal Appeal that the effect of ss114-116 of the Evidence Act was to remove that kind of threshold, and to leave the matter to the discretion of the trial judge given by ss135 and 137 of the Evidence Act, to exclude prejudicial evidence, and to make the matter subject to the requirement for warnings contained in s165. This was confirmed in R v *Riscuta* [2003] NSWCCA 6 at [34].

However, the cautious approach of the law to identification evidence would mean that discretionary exclusion must be a significant possibility; and also that, if such evidence is admitted, strong warnings of the kind referred to in ss116 and 165 would be given. And unless identification is by a person who was previously familiar with the voice, I would expect a jury to be told that they could not convict on this kind of evidence alone.

"AD HOC" EXPERTS

The third form of voice identification evidence is evidence of "ad hoc" experts. The leading case in New South Wales on "ad hoc" experts in speaker identification is *R* v *Leung* [1999] NSWCCA 287, 47 NSWLR 405. In that case, a qualified interpreter translated tape-recorded conversations, during the course of which he became familiar with the voices on the tape recordings. In addition, he was familiar with the accents and the use of language of the participants, and familiar with the languages in which they spoke, so as to enable him to bring a greater understanding to the voice comparison than a person without that language skill. It was held that the

interpreter was qualified as an ad hoc expert witness within s79 of the Evidence Act, for the purpose of identifying the voices by means of voice comparison.

However, in a case in Victoria, *R* v *Harris (No.3)* [1990] VLR 310, a Supreme Court judge excluded evidence of this nature in the exercise of the Court's discretion to exclude prejudicial evidence, because the judge considered the identification could have been suggested to the ad hoc expert in ways that could not adequately be dealt with by cross-examination of her.

My own view is that the admission of this kind of evidence is reasonable and convenient if the accused does not choose to make a serious issue as to identification of voices - and it may often be counter-productive for an accused to do this, because there may be strong circumstantial evidence as to who is talking in intercepted telephone calls. However, if the accused does make this a serious issue, then the cautious approach to this kind of evidence taken in *Harris* seems justified.

Evidence of this kind will not in any event be admitted unless there is some matter of experience that puts the witness in a better position than the jury to make the comparison. This may well be the case if the recording materi'al is long and requires careful and/or repeated listening, or if different languages are used. On the other hand, if the recorded material is short and in English, it is unlikely that there could be an ad hoc expert who would be in any better position than the jury. The situation would then be analogous to that in *Smith* v *The Queen* [2001] HCA 50, 206 CLR 650, where the High Court excluded evidence by police officers that a person depicted in security camera photographs was the accused. The High Court held that, in the case of that kind of visual identification, the witnesses could not bring any expertise to the task that the jury did not have itself.

EXPERT EVIDENCE ON RELIABILITY

An area on which, so far as I am aware, there is little legal authority in New South Wales is whether the expert evidence is admissible as to the *reliability* of voice comparisons by juries or non-expert witnesses. My understanding is that there is quite cogent scientific material on this. Some of it is referred to in an article "Hearing

voices - speaker identification in court" by Lawrence M. Solan and Peter M. Tiersma published in (2003) 54 Hastings LJ 373.

In *R* v *Madigan* [2005] NSWCCA 170, evidence of this nature, submitted by the accused, was rejected by the trial judge, and this was confirmed on appeal. However, this rejection was not on the basis that this kind of evidence could not be admissible in any case, but on more particular grounds, including procedural grounds. Interestingly, one ground was that the evidence depended partly on the application of Bayes' theorem, which an appeal judge said was the subject of *criticism* in the *R.* v *GK* [2001] NSWCCA 413,53 NSWLR 317. Now, *GK* concerned DNA evidence; and in my understanding, contrary to what was said in *Madigan, GK* generally approved of a Bayesian approach, but required care in how it was presented to the jury.

It does seem clear that evidence will not be admitted as to the reliability of visual identification, that is, of face recognition, by juries or non-expert witnesses: see *R* v *Smith* (Victorian Court of Criminal Appeal 17 December 1987), and the application for special leave in that case to the High Court of Australia (1990) 64 ALJR 588. This is because both ordinary people and the courts have extensive experience in face recognition, and the courts have long experience of problems that can arise in relation to face recognition. I doubt if the same is true in relation to voice recognition.

The article by Solan and Tiersma I referred to earlier considers scientific studies supporting conclusions about these matters. Some of these conclusions might be considered plain common sense, but others are less obvious. Thus, a conclusion that familiarity with a voice enhances reliability of identification is pretty obvious; but a conclusion that less familiarity produces not just less true positives but also more false positives is perhaps not so obvious. Again, a conclusion that increased exposure improves accuracy is not surprising; but a conclusion that frequency of exposure is more important than overall length of exposure is also not obvious. Scientific research can also give some quantification of these effects, and also of effects of different emotional states, voice disguise, the use of different languages, and so on. Apparently such research also supports the somewhat surprising

conclusion that there is very little correlation between a witness's confidence about an identification and its accuracy.

I am inclined to think that such evidence, if soundly based and properly presented, should be admissible in relation to voice identification, at least in relation to matters where the experience of the courts may be inadequate; and that it could be particularly helpful in cases like *Korgbara,* which as mentioned earlier involved comparison of an accused's voice with a voice recorded using a language with which the witness or the jury was not familiar.

EXPERT SPEAKER IDENTIFICATION

Fifthy and finally, I come to what I understand to be the main focus of this conference, namely direct identification of speakers by persons with scientific expertise. I will start by referring briefly to some relevant court decisions.

In *R* v *Gilmore* [1977] 2 NSWLR 935, an accused sought to tender evidence from an expert in voice analysis, who had made tape recordings of the accused's voice speaking the same words as contained in recordings of a number of telephone conversations made by the police, and who had compared the two sets of recordings by means of a spectrograph and had formed an opinion as to whether it was the same person whose voice was recorded on each of these sets (presumably, that it was not the same person). The trial judge rejected that evidence, and the accused was convicted on police evidence that the voice in the telephone conversations was that of the accused. The Court of Criminal Appeal held that spectrographic voice analysis by a qualified expert was a proper field for expert evidence, and that the evidence should have been admitted; and the appeal was allowed and a new trial ordered.

In *R* v *McHardie* [1983] 2 NSWLR 734, similar evidence was tendered for the prosecution (to the effect that it was the accused's voice in the incriminating recordings) and it was admitted at the trial. The Court of Criminal Appeal held that an expert could, having analysed the material coming from a Kay Sonograph, to the point where it could be fed into a computer properly programmed for the purpose of mathematical analysis of some of the features of sound spectrograms with a view to

accurate conclusions as to their significance, express an opinion in a court of law based on that analysis and state whether the voices he is considering are or are not different. The appeal was dismissed.

In 1990, in the case of *Harris* referred to earlier, the Victorian judge referred to evidence before him suggesting that the reliability of mechanical or computerised acoustic analysis of voices was now considered doubtful, so that there might be grounds for considering whether the cases of *Gilmore* and *McHardie* should be applied in Victoria.

More recently, the matter was discussed in the 2003 Northern Ireland case of R v *O'Doherty* [2003] 1 er App R 5 (pages 77-98). In that case, on the basis of expert evidence led before the Court of Appeal of Northern Ireland, that court expressed the view that, in the present state of scientific knowledge, no prosecution should be brought in Northern Ireland based on voice identification given by an expert which was solely confined to auditory analysis: there should also be expert evidence of acoustic analysis, including formant analysis. The court specified some exceptions to this, which I need not go into here.

Courts in Australia have not generally required that expert evidence satisfy criteria laid down in the USA - either the criterion laid down in *Frye* (1923) 54 AppDC 46 requiring general acceptance in the scientific community, or the criteria laid down in *Daubert* requiring falsifiability, peer review, published error rates and capability of replication.

However, the NSW requirement that there be specialised *knowledge,* and that the opinion be wholly or partly based on this knowledge, could possibly support an argument that knowledge requires a well-established basis, and that the *Frye* and *Daubert* requirements are relevant in determining whether what is proffered by an expert can be considered to be based on 'knowledge'.

There is a deal of academic writing suggesting that UK and Australian courts, and even USA courts, have been too lax in admitting evidence, and in particular expert evidence, of voice identification: see the article by Solan and Tiersma, and also two

articles by David Ormerod in [2001] Crim Law Review ('Sounds familiar - voice identification evidence') and [2002] Crim Law Review ('Sounding out expert voice identification'). These articles, and also evidence referred to in *O'Doherty,* suggest that after the 1970s and 1980s when *Gilmore* and *McHardie* were decided, considerable doubt developed as to the scientific soundness of auditory analysis and, perhaps to a lesser extent, acoustic analysis.

It is possible that courts in Australia may in future be persuaded to take a stricter view on the admissibility of this evidence. If evidence is offered that does not have foundations of the type referred to in *Frye* or *Daubert,* a court could perhaps find that *knowledge* is not established, or that the evidence is prejudicial because the jury might give weight to evidence given by a professed expert that the evidence does not deserve.

FORM AND USEFULNESS OF EVIDENCE

The ultimate question in criminal cases is not one of numerical probability. The requirement is proof *beyond reasonable doubt;* and in Australian courts, and I believe in common law courts generally, this is never equated with any numerical probability. Thus a probability of 0.9 or even 0.95 is not regarded as beyond reasonable doubt. Juries are directed that the prosecution must prove the guilt of the accused beyond reasonable doubt; and if any explanation is given of this expression, it is no more than that if the jury has a doubt about the guilt of the accused that it considers reasonable, then it must acquit.

Even in civil cases, although proof is said to depend on the balance of probabilities, courts generally look for what they call reasonable satisfaction; and they resort to numerical probabilities generally only where this is necessary and where the court considers the material on which the numerical probabilities are based is such that it is reasonable to act on this material and on the probabilities derived from it. Thus, the circumstance that only 49 people paid for admission to an entertainment, and the defendant was one of 100 people who actually attend,ed, would not justify a conclusion that the defendant did not pay for admission, because it would not be reasonable to act on a 0.51 probability based on that material: see generally my

article in (1995) 69 ALJ 731 ('The scales of justice - probability and proof in legal fact-finding').

However, my view is that reasoning with mathematical probabilities can play an important role in reaching conclusions of the kind courts have to reach, and that it is useful and sometimes important that courts have sufficient understanding of relevant rules of probability.

Expert evidence of voice identification will generally only be one piece of evidence in a case, and there will often be other evidence that bears on the identity of the speaker. Indeed, in a criminal case, the identity of the speaker may be the very question that is crucial to the question of guilt of the accused.

In such a case, it is of course important to avoid the prosecutor's fallacy of moving directly from a probability as to the identity of the speaker, based solely on voice identification evidence, to probability of guilt. This is illustrated by the consideration that if, apart from voice identification evidence, anyone of (say) five million adult males could have committed the crime, a probability or likelihood ratio based on voice identification alone even as high as a million to one, that the voice was that of the accused, would only produce a one in five chance that the accused was guilty.

It is necessary to integrate voice identification evidence satisfactorily into the whole ofthe evidence in the case. There are problems whatever way it is done.

I've seen it suggested that while evidence that two samples are the voice of the same person is objectionable, because it invites the commission of the prosecutor's fallacy, evidence that two voice samples are inconsistent would be acceptable. However, an expert giving that evidence could be expressing a view, based just on an analysis of voices, about the very question the court must determine *on the whole of the evidence.* It is unlikely, at least in the present state of the science of voice identification, that such a view could be both reliable and without doubt; so that, unless degrees of unreliability and/or doubt can somehow be quantified or otherwise made understandable, it would be very difficult to know how much weight to give to the evidence and how to weigh it in relation to other evidence in the case.

Evidence that two samples are consistent is perhaps less problematic, and this could be coupled with evidence as to the distinctiveness of the voice; but it would still be difficult to know how to integrate evidence of this kind with the rest of the evidence in the case.

On the other hand, if the evidence is given in the form of a likelihood ratio, this could be used with Bayes' theorem to incorporate it into the whole of the evidence. There are two major problems with this. First, the other evidence in the case will not generally be in a form of numerical probabilities or odds to which a likelihood ratio can be applied; and secondly, as mentioned earlier, the end result of the court's consideration is not, at least in criminal cases, a numerical probability but satisfaction beyond reasonable doubt, or absence of such satisfaction.

In the case of DNA evidence, this has turned out not to be a major problem, because it is based on widely accepted theories and procedures, and it produces likelihood ratios that are so high that they can justify a finding beyond reasonable doubt, so long as the other evidence in the case at least makes the guilt of the accused possible and plausible. Thus, if a person who could plausibly have committed the crime has DNA which matches DNA found at the scene of the crime, if there is no plausible innocent explanation of this, if contamination of samples is excluded, and if the chance of the sample from the crime scene coming from a random person is one in several billion (as it often is), there may well be proof beyond reasonable doubt. The jury can be told that the likelihood ratio is such that one would expect there to be no more than about one other person in the world with matching DNA; and this, coupled with other evidence in the case, can often be sufficient.

I do not know what likelihood ratios are achievable with acoustic analysis. I assume it will become possible to achieve general acceptance of theories and procedures, and to have a sufficiently large database and sufficiently small error rates to produce soundly-based likelihood ratios. I'm not sure how error rates would be dealt with in the evidence. If they are given separately from and in addition to likelihood ratios, this could be confusing. Perhaps they could be dealt with by giving conservative likelihood ratios that take error rates into account.

Let us suppose a likelihood ratio of twenty to one is given. How would this be integrated into other evidence in the case? Perhaps the jury could be told that this likelihood ratio would turn odds of one to one into odds of twenty to one, giving a probability of about 0.95; so that if otherwise they thought the odds *just* favoured guilt, this would make the probability of guilt more than 0.95; while if they otherwise thought the odds were two to one against guilt, this likelihood ratio would change the odds to ten to one in favour of guilt, giving a probability of guilt of about 0.91. However, they would also have to be told that the question they have to decide is not a mathematical one, but rather is the question whether they are satisfied beyond reasonable doubt of the accused's guilt; and that the mathematics can be no more than a rough guide to assist them in deciding this question.

Despite the possible difficulties and awkwardness of this, I'm inclined to think that evidence in terms of likelihood ratios will probably be the most useful way to go. **It** does seem to be the most scientific way for this kind of evidence to be given; and I think that the courts will become experienced in handling evidence in this form and in explaining it to juries - so that the evidence will be scientifically sound and will neither confuse juries nor involve giving up the idea that proof in criminal cases must be beyond reasonable doubt.