How to cross-examine forensic scientists: A guide for lawyers*

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This article is a resource for lawyers approaching the cross-examination of forensic scientists (and other expert witnesses). Through a series of examples, it provides information that will assist lawyers to explore the probative value of forensic science evidence, in particular forensic comparison evidence, on the voir dire and at trial. Questions covering a broad range of potential topics and issues, including relevance, the expression of results, codes of conduct, limitations and errors, are supplemented with detailed commentary and references to authoritative reports and research on the validity and reliability of forensic science techniques.

1 Introduction

This guide is intended as a resource for lawyers confronted with forensic science evidence.[1] It is, in effect, a guide to exploring the validity and reliability of forensic science evidence.[2] We have endeavored to address issues that are important in any attempt to understand the probative value of expert evidence, particularly the identification (or comparison) sciences.[3] Factors relating to experimental validation, measures of reliability and proficiency are key because they, rather than conventional legal admissibility heuristics (eg,

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1 It is primarily oriented towards the needs of defence lawyers and aims to help them evaluate expert evidence and, if appropriate, challenge insufficiently reliable forensic science evidence adduced by prosecutors. It might simultaneously inform prosecutorial decisions around disclosure, adducing expert evidence and responding to expert evidence adduced by the defence. With respect to prosecutors, see G Edmond, '(ad)Ministering justice: Expert evidence and the professional responsibilities of prosecutors' (2013) 36 *UNSWLJ* 921.

2 See App A for explanation of 'validity', 'reliability' and 'proficiency'.

3 That is, forensic science opinion evidence pertaining to identity, similarities or the origins of some sample or trace, such as voice and image recordings, shoe, foot and tyre impressions, latent fingerprints, DNA analyses, ballistics, identification by gait, document examination, bite marks and so on.

field, qualifications, experience, common knowledge, previous admission, etc), provide information about actual ability and accuracy that enable expert evidence to be rationally evaluated by judges and jurors. The issues canvassed here are those that authoritative scientific organisations (eg, the US National Academy of Sciences) suggest should be central to any attempt to assess the probative value of scientific, technical and medical evidence.[4]

This guide was designed to help lawyers as they approach and prepare for cross-examination.[5] Cross-examination requires careful attention to the facts in issue in the instant proceedings. In some cases, forensic analysts will make concessions; thereby eliminate the need for protracted cross-examination that might be onerous and prove difficult for a judge or jury to comprehend, even when conducted in an exemplary fashion. On most occasions however, determining the need for and approach to cross-examination will require considerable effort. Such decisions will generally require independent reading and preparation and very often consultation with relevant experts for advice and assistance.[6] In most cases it will be desirable to meet with the state's forensic analyst prior to the trial or voir dire. This guide aims to suggest potentially important lines of inquiry and the kinds of questions that might be put to those claiming expertise when they testify in criminal proceedings. It is designed to encourage lawyers to ask questions and engage with issues that will usually be important in any attempt to determine relevance, admissibility and probative value (ie, 'weight').[7]

Because responses to questions posed in cross-examination will often mark the limits of the evidence it is vitally important for those questioning 'experts' to attend very closely to responses.[8] Historically, lawyers and courts have

4 National Research Council (of the National Academy of Sciences), *Strengthening the Forensic Sciences in the United States: A Path Forward*, Washington DC, The National Academies Press, 2009 (NAS Report). See Section 6 and G Edmond, 'What lawyers should know about the forensic "sciences"' (2014) 35 *Adel L Rev* (forthcoming) for an overview.

5 Several of our suggested questions incorporate multiple issues. They are presented in forms that are not always conducive to actual cross-examination. We do not recommend adopting any particular question or line of questioning. Rather, they are propaedeutics. They provide an indication of the kinds of issues that ought to be considered in many cases; especially where the lawyer is attempting to explore or challenge the value of a technique or derivative opinion.

6 It is important to recognise that those able to offer advice and support will not always be from the domain (or 'field') in which the original expert operates. It may be that medical researchers, mainstream scientists, cognitive scientist or statisticians will be of much greater utility in developing appropriate lines of inquiry than, for example, a second fingerprint analyst or ballistics expert.

7 In several places in this guide we have used the term 'expert'. We caution those approaching 'expert evidence' against simply assuming that the individual proffering, and indeed allowed by courts to proffer, their opinions actually possesses *expertise*. Legal indifference to validation and reliability means that in too many cases we do not know if those permitted to proffer incriminating opinions are actually able to do the things they claim. There are important differences between 'training, study and experience' (Uniform Evidence Law s 79) and the possession of an actual ability (ie, genuine expertise) that distinguishes an individual from those without the ability. See G Edmond, 'The admissibility of forensic science and medicine evidence under the Uniform Evidence Law' (2014) 38 *Crim LJ* 136.

8 Even though rebuttal evidence might be admitted, resource constraints and concerns with finality together constrain the scope for proceeding beyond the answers provided by expert witnesses in many cases.

allowed expert witnesses considerable latitude in their responses to questioning.[9] As we explain below, those questioning expert witnesses should be careful to prevent attempts to dodge the central issue of the *reliability* (or trustworthiness) of the technique under scrutiny.[10] Too often, issues central to the assessment of scientific validity and reliability (and therefore probative value) have been circumvented by recourse to experience, formal qualifications, previous appearances in legal proceedings, previous involvement in investigations and convictions, the practice or jurisprudence in other jurisdictions, and the institutional practices and policies of police forces and forensic science institutions.[11] These substituted factors may not, however, provide actual evidence for the validity and reliability of techniques and derivative opinions. For, they do not provide independent evidence, or an actual guarantee, that a technique or method has probative value. None of them, individually and even in combination, provides information about the conditions in which a technique is valid or about its limitations. They do not answer the question of whether the analyst possesses *relevant expertise*.[12] Moreover, they provide no insights on how opinions should be expressed, or the appropriate terminology and qualifications to use.

In most cases evidence for the validity and reliability of techniques will be independent of the witness. Usually, appropriate evidence will be in the form of publicly available (and usually published) validation studies and/or rigorous proficiency studies.[13] Even if the analyst did not participate in the relevant studies, their reports and testimony should demonstrate that they

9 Too much cross-examination stalls or is subverted when an experienced witness responds with justifications that are non responsive and would not be persuasive to a scientifically-trained audience. Appeals to experience or integrity (such as 'Are you suggesting that I am not an expert, or that I'm making this up?') are good examples. Lawyers ought to be conversant with some of these rhetorical responses.

10 Unfortunately, 'reliability' has a common and a scientific meaning — see App A. The common meaning is similar to trustworthiness whereas the scientific definition refers to the degree to which a technique (or assessment tool) produces stable and consistent results. Generally, we have tried to use 'reliability' in its specialist guise, although the need for trustworthy (ie, demonstrably reliable) techniques should be a central consideration in admissibility jurisprudence and practice. See G Edmond, 'Specialised knowledge, the exclusionary discretions and reliability: Reassessing incriminating expert opinion evidence' (2008) 31 *UNSWLJ* 1.

11 It bears noting that admissibility practices in foreign jurisdiction are sometimes invoked to support particular proffers of 'expertise' even though foreign jurisdictions often follow quite different rules of admissibility. England, for example, does not require expert opinions to be based on 'specialised knowledge'. See G Edmond, 'Is reliability sufficient? The Law Commission and expert evidence in international and interdisciplinary perspective (Part 1)' (2012) 16 *Int'l Jnl of Evidence & Proof* 30.

12 It is important to distinguish between general expertise or expertise in other, apparently related domains, and expertise doing the thing on which the specific opinion is based. General or related expertise does not necessarily translate into specific expertise. Very often analysts will apply their broader training, study or experience to an associated but distinct task. For example, someone with many years of experience as a podiatrist, who is expert in diagnosing and treating foot, lower limb and postural problems may also claim that they are able to identify an individual on the basis of the features of their gait. Whether they can is an empirical question. See E Cunliffe and G Edmond, 'Gaitkeeping in Canada: Mis-steps in assessing the reliability of expert testimony' (2014) 92 *Canadian Bar Rev* (forthcoming).

13 NAS Report, above n 4, p 8.

possess *expertise* doing the specific task on which their opinion is based.[14] They should be conversant with relevant specialist literatures, including criticism. Those questioning expert witnesses should focus their attention on the specific task or claim to expertise and not allow a witness with formal training or experience (in apparently cognate fields, however extensive) to claim expert status and simply assert their 'considered opinion'. There should be demonstrable evidence of actual expertise in the specific domain (ie, doing specific tasks) rather than appeals to general 'training, study or experience'.[15] According to s 79(1) of the Uniform Evidence Law (UEL), the witness must possess 'specialised knowledge' and the opinion must be based on 'specialised knowledge'.[16] 'Training, study or experience' does not constitute 'specialised knowledge'.

Our sample questions (in italics, below) are intended to focus attention on issues that will ordinarily be significant in any attempt to determine relevance, admissibility, probative value and credibility.[17] Our questions are often complex, sometimes with multiple issues embedded within them. They are heuristics; better suited to this educative exercise than a purely forensic one. They are intended to draw the reader's attention to important issues that demand, and in many cases will reward, sustained scrutiny during contested proceedings involving forensic science and medicine evidence. Some of these questions, and questions informed by them, will be better suited to admissibility challenges on the voir dire than cross-examination before a jury. Equally, some of our questions may highlight the need to undertake research or seek pre-trial advice in order to adequately address these and other issues at trial.

2 Issues to consider when contesting and evaluating expert opinion evidence

A Relevance (on the voir dire)

Questions focused on relevance attempt to unpack whether or not the evidence can *rationally* influence the assessment of facts in issue.[18] For an opinion to be relevant, the analyst must, at the very least, possess abilities extending beyond those possessed by the judge or jury. Otherwise, their opinion is irrelevant. The High Court made relevance an issue in *Smith v R*.[19] The burden is on the prosecutor (and the analyst) to demonstrate that the analyst possesses abilities (presumably well) beyond those of ordinary persons.

Questions bearing on relevance might include:

14 M Thompson, J Tangen and D McCarthy, 'Human matching performance of genuine crime scene latent fingerprints' (2013) 38 *Law and Human Behavior* 84.

15 Evidence Act 1995 (NSW) s 79.

16 See *Honeysett v R* [2014] HCA 29; BC201406345 at [23].

17 The failure to attend to the validity and reliability of techniques will often have implications for the credibility of witnesses, particularly our understanding of their competence and partiality.

18 Evidence Act 1995 (NSW) ss 55, 56.

19 *Smith v R* (2001) 206 CLR 650; 181 ALR 354; [2001] HCA 50; BC200104729.

I accept that you are highly qualified and have extensive experience, but how do we know that your level of performance regarding . . . [the task at hand — eg, voice comparison] is actually better than that of a lay person (or the jury)?

What independent evidence... [such as published studies of your technique and its accuracy] can you direct us to that would allow us to answer this question?

What independent evidence confirms that your technique works?

Do you participate in a blind proficiency testing program?

Given that you undertake blind proficiency exercises, are these exercises also given to lay persons to determine if there are significant differences in results, such that your asserted expertise can be supported?

B Validation

Validation provides experimental evidence that enables the determination of whether a technique does what it purports to, and how well — see App A. In the absence of formal validation studies, undertaken in circumstances where the correct answer (ie, ground truth) is known, the value of techniques and derivative opinions becomes uncertain and questionable.[20] Importantly, the experimental testing associated with validation studies helps to generate standards (and protocols) to guide the application of techniques.

Do you accept that techniques should be validated?

Can you direct us to specific studies that have validated the technique that you used?

What precisely did these studies assess (and is the technique being used in the same way in this case)?

Have you ever had your ability formally tested in conditions where the correct answer was known? (ie, not a previous investigation or trial)

Might different analysts using your technique produce different answers? Has there been any variation in the result on any of the validation or proficiency tests you know of or participated in?

Can you direct us to the written standard or protocol used in your analysis? Was it followed?

Regardless of the qualifications and experience of the analyst, if their technique (and/or ability) has not been independently tested then in most

20 Criminal cases do not provide a credible basis for validation even if the accused is found guilty on trial and the conviction is upheld on appeal. See App A.

situations we do not know if they can do what they claim. Qualifications and experience (and previous legal admission) are not substitutes for scientific validation and, if substituted for it can be highly misleading.[21]

Lawyers (and judges) should be cautious about claims for validity (or ability) based on appeals to longevity of the field, previous involvement in investigations, previous admission in criminal proceedings, resilience against cross-examination, previous convictions, an otherwise compelling case,[22] analogous *but different* activities, references to books and articles on related *but different* topics, claims about personal validation or private studies that have not been published and are not disclosed, and claims that (un)specified others agreed with the result whether as peer review or some other verification process.[23] Individually and in combination, none of these provide evidence of ability and accuracy. Validation studies should apply to the circumstances and inform analysis in the instant case. Where analysts move away from the conditions in which the validation testing was originally performed they start to enter terrain where the validation described in publications may no longer apply.

Validation is vitally important because superficially persuasive abilities might not in reality exist or might be less impressive than they seem to analysts and lay observers.[24] Recent studies have revealed that forensic odontologists, for example, have very limited abilities when it comes to comparing bite marks in order to identify a biter. They generally cannot identify people, although in some instances they might be able to exclude a person from the pool of potential biters.[25] Another example concerns the ability of anatomists and physical anthropologists to identify strangers in images. It does not follow that a person trained in anthropology or anatomy will be better (or significantly better) than a lay person when it comes to interpreting features and persons in images (even if they possess a more

21 In terms of the Uniform Evidence Law (UEL), validation studies should be considered part of 'specialised knowledge' required by s 79. 'Training, study or experience' do not overcome the need for 'specialised knowledge' and they do not constitute 'specialised knowledge' otherwise s 79 does not make sense. See Edmond, above n 7.

22 When considering the admissibility of expert opinion evidence, according to ss 79(1), 135 and 137, in the vast majority of cases the evidence should stand on its own. That is, there should be independent evidence (ie, not case related) that supports the validity and reliability of both the technique and the analyst's ability. It does not matter if the case is otherwise strong or even compelling. This does not tell us whether the technique works or whether the analyst has actual expertise. Indeed, in many cases the analyst(s) will have been exposed to the other 'compelling' evidence when undertaking their analysis. This, as Sections 2.G 'Contextual bias and contextual effects' and 2.H 'Cross-contamination of evidence' explain, tends to be highly undesirable and threatens the value of incriminating opinion evidence.

23 The fact that one or more analysts agree, especially where a technique has not been validated, may not be particularly meaningful. What does agreement using a technique that may not work or may have a high (or unknown) level of error, mean? Moreover, on many occasions agreement is reached in conditions where the other analysts knew the original conclusion. Again, such circumstances are conducive to neither accuracy nor independence. See Sections 2.G and 2.H.

24 It is not only lay persons who may be impressed, but the analysts themselves may well believe they possess special abilities even when they do not.

25 See, eg, E Beecher-Monas, 'Reality Bites: The Illusion of Science in Bite-mark Evidence' (2008) 30 *Cardozo L Rev* 1369.

extensive anatomical vocabulary).[26] Similarly, it does not follow that people who have spent a great deal of time (or have a great deal of experience or training) looking at images will necessarily be better than those who have spent less time and have less experience.[27] This raises difficulties for legal recognition of 'ad hoc experts' — see Section 4. The value of techniques (and abilities) should be demonstrated rather than asserted.

Do not assume that those with qualifications (in apparently related fields) and/or experience (including extensive experience doing precisely the same thing that they have done in the instant case) will perform better than judges and jurors. Do not assume that longstanding forensic science techniques will have been validated or embody orthodox scientific approaches to the analysis of evidence and the expression of results.[28]

C Limitations and errors

Validation studies provide information about the circumstances in which a technique is known to work, how well it works as well as its limitations. Limitations and information about potential sources of error should be included in reports and testimony.[29] Limitations may extend beyond the technique to include the process, such as where the analyst is exposed to potentially biasing *domain irrelevant information* or where the quality of the trace is low (eg, a fragmentary latent fingerprint or a poor quality voice recording).[30] Limitations ought to be disclosed in expert reports and the form of conclusion or expression ought to explicitly incorporate limitations.

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26 See eg, *Honeysett v R* [2014] HCA 29; BC201406345 at [45]. Preliminary studies suggest that anatomical training does not make a significant difference to the ability to interpret images for identification/comparison purposes. See, eg, A Towler, *Evaluating training for facial image comparison*, PhD research, UNSW, 2014.

27 Studies suggest that experience and training may have limited value in improving abilities. For example, White et al report that the ability of passport officers to determine whether two portrait photographs are of the same unfamiliar person is unrelated to the duration of employment, with some passport officers who have been in the post for less than a year outperforming others who have held the position for more than 20 years. See D White, R Kemp, R Jenkins, M Matheson and M Burton, 'Passport Officers' errors in face matching' (2014) 9 *PLoS ONE* e103510.

28 Latent fingerprint comparison, for example, was only validated in recent years: J M Tangen, M B Thompson and D J McCarthy, 'Identifying fingerprint expertise' (2011) 22 *Psychological Science* 995; B T Ulery, R A Hicklin, J Buscaglia and M A Roberts, 'Accuracy and reliability of forensic latent fingerprint decisions' (2011) 108 *Proceedings of the National Academy of Sciences of the United States of America* 7733. There have, however, been many criticisms of the assumptions and practices maintained by examiners in the United States, Scotland and, by implication, Australia. See NAS Report, above n 4, pp 136–45; Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach*, US Department of Commerce, National Institute of Standards and Technology, National Institute of Justice, 2012 (NIST/NIJ Report); A Campbell, *The Fingerprint Inquiry Report*, APS Group Scotland, 2011 (FI Report).

29 NAS Report, above n 4, p 184:

> All results for every forensic science method should indicate the uncertainty in the measurements that are made, and studies must be conducted that enable the estimation of those values. . . . the accuracy of forensic methods . . . needs to be evaluated in well-designed and rigorously conducted studies. The level of accuracy of an analysis is likely to be a key determinant of its ultimate probative value.

30 'Domain irrelevant information' is information that is not relevant to the analyst's task. For

Could you explain the limitations of this technique?

Can you tell us about the error rate or potential sources of error associated with this technique?

Can you point to specific studies that provide an error rate or an estimation of an error rate for your technique?

How did you select what to examine?

Were there any differences observed when making your comparison . . . [eg, between two fingerprints], but which you ultimately discounted? On what basis were these discounted?

Could there be differences between the samples that you are unable to observe?

Might someone using the same technique come to a different conclusion?

Might someone using a different technique come to a different conclusion?

Did any of your colleagues disagree with you? Did any express concerns about the quality of the sample, the results, or your interpretation?

Would some analysts be unwilling to analyse this sample (or produce such a confident opinion)?

All techniques have limitations and all techniques and processes involving humans are error prone.[31] Limitations and risks, and their reality, should be disclosed. Also, institutional strategies for managing and reducing the ubiquitous threat of error should be publicly available.

D Personal proficiency

Formal evaluation (eg, validation) of techniques provides empirical evidence that they are valid — that is, they produce stable and consistent results on different occasions and between analysts.[32] In any given case, however, the

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example, telling a latent fingerprint examiner that the main suspect has previously been convicted for a similar offence is not necessary for the examiner to compare two fingerprints. Generally, analysts should not be exposed to domain irrelevant information about the case, investigation or the suspect because it has a demonstrated potential to mislead. See Sections 2.G and 2.H.

31 See, eg, National Academy of Sciences, Institute of Medicine, Committee on Quality of Health Care in America, *To Err Is Human: Building A Safer Health System*, McGraw-Hill Companies, Washington DC, 1999.

32 There may be utility in ascertaining whether the same analyst will produce the same interpretation on different occasions. Studies of fingerprint examiners found that they tend to identify different points of similarity when comparing the same prints on different occasions. See I Dror, C Champod, G Langenburg, D Charlton, H Hunt and R Rosenthal, 'Cognitive issues in fingerprint analysis: Inter-and intra-expert consistency and the effect of a "target" comparison' (2011) 208 *Forensic Science International* 10.

analyst may not be proficient with the use of the technique, may not have used the technique appropriately, or the validity of the technique may be compromised by factors such as the unnecessary exposure of the analyst to domain irrelevant information (see Sections 2.G 'Cognitive and contextual bias' and 2.H 'Cross-contamination of evidence'). Where techniques have not been validated, claims to personal proficiency are questionable. Apparent proficiency in the use of a technique that has not been formally evaluated does not enable the court to assess the probative value of the evidence.[33] For, it does not address the primary issue of whether the technique does what it is purported to do, whether it does so consistently, nor how consistently it does so. Failure to validate a technique means that there are few appropriate measures with which to evaluate the derivative opinion evidence.[34]

Have you ever had your own ability... [doing the specific task/using the technique] tested in conditions where the correct answer was known?

If not, how can we be confident that you are proficient?

If so, can you provide independent empirical evidence of your performance?

Internal (or in-house) proficiency tests and many commercial proficiency tests available to forensic scientists and their institutions are reported to be notoriously easy.[35] In most cases, the proficiency tests are only used to compare results between forensic practitioners, and since they are not given to lay persons, the validity of the tests themselves (like the expertise of the analysts) cannot be evaluated.[36] There has, in addition, been a tendency to design proficiency tests in ways that may reflect casework processes but are incapable of assessing actual expertise. This can lead to flaws in the way results are understood and represented — see App A.[37]

Once again, appeals to formal study and training, like long experience using a technique, do not address the question of whether the technique works, in what conditions, how well, and how often. Where the analyst cannot show that they are proficient with a technique, where the proficiency instrument is flawed, or there is no independent evidence of proficiency, serious challenge might be made to both admissibility (around relevance and expertise) as well as the probative value of the analyst's opinion.

E Expressions of opinion

The expression of results, really the expression of the analyst's interpretation or opinion (based on the trace, data or results), should be developed using a

33 See, eg, J J Koehler, 'Fingerprint error rates and proficiency tests: What they are and why they matter' (2008) 59 *Hastings LJ* 1077; J J Koehler, 'Proficiency tests to estimate error rates in the forensic sciences' (2012) 12 *Law, Probability & Risk* 89.

34 Failure to validate tends to shift the focus to heuristics with more limited value, such as the longevity of the 'field', the analyst's qualifications and experience, what other courts have done and so on.

35 See Koehler, above n 33; D M Risinger, 'Cases Involving the Reliability of Handwriting Identification Expertise Since the Decision in *Daubert*' (2007) 43 *Tulsa L Rev* 477.

36 See, eg, Tangen, Thompson and McCarthy, above n 14.

37 Problems seem to be pervasive in both in-house and commercially provided proficiency testing for forensic analysts.

validated technique. The expression should be consistent with the limits of the technique. Where a particular form of words is used (eg, 'match' or 'one and the same') whether free-standing or drawn from a scale (eg, involving a range of evidence strengths such as 'probable', 'very probable', 'strong support' etc), the reason for the selection of the specific expression should be explained.[38]

Can you explain how you selected the terminology used to express your opinion?

Is it based on a scale or some calculation? If so, how was the expression selected?

Would others analyzing the same material produce similar conclusions, and a similar strength of opinion? How do you know?

Is the use of this terminology derived from validation studies?

Did you report all of your results?

You would accept that forensic science results should generally be expressed in non-absolute terms?

Be wary of allowing the witness to simply claim they are expressing a considered opinion. Most analysts using comparison techniques should only be able to express the kind of result that validation studies of the specific technique allow.[39] The opinion is usually an interpretation incorporated into the process or technique. Be very careful about allowing a second more general impression/opinion about, for example, identity. Such opinions may not be based on 'specialised knowledge': UEL s 79. Be cautious where the analyst uses terms that do not incorporate any uncertainty such as, 'match', 'positive identification', 'individualization', and 'to the exclusion of all others' and so on. Also, be cautious where claims about levels of uncertainty are speculative or the analyst dismisses limits, risks of error and uncertainty in the absence of formal evaluation of the technique and their own proficiency.

Logically, forensic scientists cannot positively identify (i.e. individualise) a person or thing based on a trace or sample. DNA analysts, for example, do not positively identify persons, and authoritative scientific organisations have advised latent fingerprint examiners against equating a 'match' with positive

38 D McQuiston-Surrett and M J Saks, 'The Testimony of Forensic Identification Science: What Expert Witnesses Say and What Factfinders Hear' (2009) 33 *Law and Human Behavior* 436; K Martire et al, 'The psychology of interpreting expert evaluative opinions' (2013) 45 *Aust Jnl of Forensic Sciences* 305.

39 DNA evidence is a good example, the techniques do not facilitate positive identification but rather probabilistic evidence about the significance of a match or the relative likelihood of two opposing propositions.

identification.[40] The best scientific advice recommends against positive identification and expressing results in absolute (or categorical) terms or something similar (eg, 'practical certainty').[41] Moreover, most attentive scientists recommend reporting results in terms that respond to prosecution and defence theories in order to minimise bias in expression. For every hypothesis an analyst tests (eg, that two items share a common origin) there will be one or more alternative hypotheses (eg, that the two items do not share a common origin). A transparent opinion will explicitly state one or more of these alternative hypotheses in the conclusion.[42]

F Verification

Investigative processes often include some kind of review that is designed to confirm or bolster the value of the result and conclusion. Importantly, where techniques are not validated, the value of verification (such as peer review by a colleague) is uncertain (and possibly trivial). Similarly, verification where the reviewer knows the original result tends to be a very poor form of review. It does not constitute independent support or independent corroboration.[43]

Can you explain your peer review (or verification) process?

Is the review process documented and are the results included in the report?

Is the person undertaking the review of the result blinded to the original decision?

How often does a reviewer... [in your institution] disagree with the original conclusion? What happens when there are disagreements or inconsistencies? Are these reported? Are these errors or limitations?

G Cognitive bias and contextual effects

The perception and interpretation of evidence is a subjective process that can be influenced by a range of cognitive, contextual and experiential factors. This is particularly so where the evidence to be evaluated is of low quality or

40 Discussed in G Edmond, M B Thompson and J M Tangen, 'A Guide to Interpreting Forensic Testimony: Scientific Approaches to Fingerprint Evidence' (2014) 13 *Law, Probability and Risk* 1. See also Section 3.

41 NAS Report, above n 4, p 184. See, eg, *R v Dastagir* (2013) 224 A Crim R 570; [2013] SASC 26; BC201309040 at [29]. The introduction of 'practical', for example, makes no practical difference.

42 See, eg, C Aitken, P Roberts and G Jackson, *Fundamentals of Probability and Statistical Evidence in Criminal Proceedings: Guidance for Judges, Lawyers, Forensic Scientists and Expert Witnesses*, Royal Statistical Society, London, 2010, and the special edition 'Papers on the *R v T* debate' in (2012) 11(4) *Law, Probability & Risk*. Significantly, the defence is under no obligation to provide an hypothesis and there may be numerous alternative hypotheses.

43 Most of recent high profile problems with mistaken fingerprint matches — eg, those in the Madrid bombing and the *McKie* case in Scotland — withstood institutional verification processes. In these and other misattribution cases, multiple examiners agreed with the mistaken interpretation. See the FI reports and S Cole, 'More Than Zero: Accounting for Error in Latent Fingerprint Identification' (2005) 95 *Jnl of Criminal Law & Criminology* 985.

ambiguous. In such circumstances a common response is for the decision-maker to bring any and all information to bear on the task in the hope of reaching an informed decision. While this is a useful strategy in many day-to-day situations, it has the potential to introduce undesirable forms of bias into the work of forensic analysts. That is, where an analyst is exposed to extraneous (ie, domain irrelevant) information about the investigation, such as the suspect's prior criminal history, they may be more likely to perceive or interpret evidence in ways that are consistent with this domain irrelevant information. Such contextual and confirmation biases undermine the independence of the analyst's opinion and threaten the validity of their conclusions.[44] Analysts in the comparison domains should be aware of these threats and take steps to reduce them.[45]

Are you familiar with cognitive bias and contextual effects?

Could you tell us about them?

You accept that cognitive bias and other contextual effects represent a threat to forensic science evidence?

You accept that context effects can operate unconsciously?

You accept that even a sincere analyst may be influenced by cognitive and contextual effects and not know it?

Can you explain the processes employed to avoid exposure to information that is not relevant to your analysis? Can you tell us about them?

Can you tell us what you knew about the accused and circumstances of this case before you were asked to analyse the evidence, and before you produced your conclusion?

Were you told anything about the suspect when asked to undertake your analysis?

Did your letter of instruction indicate . . . [implicitly or explicitly] what it was expected you would find (eg, confirm the suspect is the perpetrator)? Can you indicate where you documented that in your report? Or, were the instructions open ended (eg,, assess whether or not any of these people feature in the crime scene images)?

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44 NIST/NIJ Report, above n 28.

45 Analysts should keep a documentary record of the information that they were given (and other forms of exposure), but preventing exposure to gratuitous (particularly suggestive information and processes) is the most important goal. One of the problems with relying on attempts to document exposure is that influences can be subtle, and analysts may not be aware of exposure or influence. Moreover, in many cases exposure will take place years before a case arrives at trial and so it may be unrealistic to attempt to try to unpack subtle exposures or conversations about what an analyst was told or saw about one of many cases (or analyses) quite a long time ago.

Can you explain why medical researchers use double blind clinical trials when attempting to evaluate the efficacy and safety of pharmaceuticals?

Recent research has demonstrated that exposure to information about the case or the accused, has the potential to influence, and sometimes reverse, an analyst's conclusion. Exposure to gratuitous information can influence interpretations and produce mistaken decisions even where the underlying techniques are otherwise valid and reliable. Studies have shown that experienced latent fingerprint examiners can change their minds about whether two fingerprints 'match'.[46] Similarly, exposure to information about the suspect or the case that is not required for their interpretation can influence decisions about whether the profile of a suspect appears in a mixed DNA sample.[47] Influences can operate unconsciously. Importantly, once the analyst has been exposed to domain irrelevant information (or contexts that encourage particular types of approaches and orientations) there is usually no way of decontaminating the resulting opinion.[48] The appropriate response is for another analyst to undertake an independent analysis using a validated technique in conditions where they are not exposed (ie, remain 'blind') to domain irrelevant information or suggestive processes.

H Cross-contamination of evidence

Very often prosecutors (and judges) present forensic science evidence as independent corroboration of other evidence (or the case) against the accused. In many proceedings, this is not appropriate because the analyst was unnecessarily exposed to suggestive information or may have revealed their opinions (or had them revealed by investigators) to other witnesses — whether forensic scientists or lay witnesses. In consequence, many opinions do not constitute genuinely independent corroboration.[49] They are not independent of other inculpatory (or suggestive) evidence.

Were other witnesses, whether forensic scientists or lay witnesses (eg, those proffering eyewitness identification evidence), told about the results of your analysis?[50]

Were you told about other evidence or the opinions of other investigators or forensic analysts?

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46 I Dror, D Charlton and A Péron, 'Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications' (2006) 156 *Forensic Science International* 74.

47 I Dror and G Hampikian, 'Subjectivity and Bias in Forensic DNA Mixture Interpretation' (2011) 51 *Science & Justice* 204.

48 A good example from Ontario involves encouraging social workers, pediatricians and forensic pathologists to 'think dirty' in response to allegations of childhood abuse. Such assumptions were staunchly criticised by Justice Stephen Goudge in his *Inquiry into Pediatric Forensic Pathology*, Queens Printer, Toronto, 2008 (Goudge Report) Vol 1: pp 111–3, 268–9 and Vol 2: pp 373–8.

49 G Edmond, R Searston, J Tangen and I Dror, 'Contextual bias and cross-contamination in the forensic sciences: The corrosive implications for investigations, plea bargains, trials and appeals' (2015) 14 *Law, Probability & Risk* (forthcoming).

50 This question might also be, or better, directed to investigating police. It is useful to have a clear idea about who knew what and when, because there can be widespread cross-contamination of information from both the spoken and written domains occurring over time and even feeding off one another.

These questions (and others from Section 2.G 'Cognitive bias and contextual effects') are relevant where, for example, eyewitnesses are told that a fingerprint analyst *confirmed* their tentative identification. Studies suggest that such witnesses are likely to be more confident in future versions of their identification evidence if they have reason to believe they are correct.[51] Similarly, forensic scientists (eg, a forensic odontologist reporting on bite marks or an anatomist interpreting an image) is vulnerable to suggestion and confirmation bias where, for example, they are told about a DNA result or the suspect's criminal record. Another common example is where the analyst was asked to confirm a police hypothesis (eg, that the police suspect is the perpetrator from the crime scene images) rather than determine whether the perpetrator is one of the persons in a 'lineup' of potential suspects.[52]

I Codes of conduct and rules about the content of reports

Almost all expert witnesses are now required to agree to be bound by court-imposed codes of conduct, and to formally acknowledge that commitment when preparing reports and testifying.[53] A remarkably small proportion of the reports produced by forensic scientists are compliant with the terms of these formal codes.[54] While non-compliance will not necessarily lead to exclusion, flagrant non-compliance by forensic science institutions ought to generate judicial opprobrium.[55] Regardless, formal rules should be invoked to secure compliance in order to obtain information that enables the lawyer (and others) to determine whether techniques have been validated.

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51 See, eg, C Semmler, N Brewer and G L Wells, 'Effects of postidentification feedback on eyewitness identification and nonidentification confidence' (2004) 89 *Journal of Applied Psychology* 334.

52 That is, assess whether any of a small group of people (the 'lineup') appeared in the crime scene images. The use of the word 'lineup' in this context is intentional. Just as an eyewitness to a crime is asked to select from an array of faces that usually includes the suspect, known innocent foils, and an instruction that the suspect may or may not be present — thereby reducing the likelihood of a chance or suggested identification of the suspect — so too could the opinion of the expert be elicited in similar ways with safeguards in place. See, eg, G L Wells, M Small, S Penrod, R S Malpass, S M Fulero and C E Brimacombe, 'Eyewitness identification procedures: Recommendations for lineups and photospreads' (1998) 22 *Law and Human Behavior* 603.

53 See, eg, *Expert witnesses in proceedings in the Federal Court of Australia*, Practice Note CM 7 at <http://www.fedcourt.gov.au/law-and-practice/practice-documents/practice-notes/cm7> (accessed 11 September 2014) and *Practice Note: Expert Evidence in Criminal Trials (Victoria)*, at <http://www.countycourt.vic.gov.au/sites/default/files/forms/Practice%20Note%20-%20Expert%20Evidence%20in%20Criminal%20Trials_FINAL%20(June%202014).pdf> (accessed 11 September 2014). For examples of what should be included in a report, see NIST/NIJ Report, above n 28, pp 100–1; FI Report, above n 28, pp 432, 702, 734; Goudge Report, above n 48, pp 429–30; B Found and G Edmond, 'Reporting on the comparison and interpretation of pattern evidence' (2012) 44 *Aust Jnl of Forensic Sciences* 193 and App B.

54 This is, in part, based on Edmond's observation of reports from criminal proceedings. Some of the standard templates used in Australia do not comply with the formal rules. Those used by latent fingerprint examiners in all Australian jurisdictions, for example, do not comply with the strict terms of the rules of court or codes of conduct. It is, in addition, interesting to contrast the reports produced by forensic analysts with the reports and the reception of reports produced for civil proceedings. See Edmond, above n 7.

55 See, eg, *Wood v R* (2012) 84 NSWLR 581; [2012] NSWCCA 21; BC201200775 at [728]–[730].

Adherence to the formal rules will help lawyers (and others) to understand and rationally evaluate the evidence.[56] Significantly, failure to comply with formal codes frequently reflects an inability to comply. In many cases there is no empirically derived information about limitations, uncertainties and error because the underlying research has not been done. It may, in consequence, be useful to go through the requirements in the codes step by step in order to elicit what the analyst has done in relation to each section and to generate a record that will facilitate more meaningful engagement with the opinion.

You are conversant with the code of conduct?

Could you tell us about the content of the code?

Now, could you show me where in your report you have appropriately addressed . . . [each of the elements specified in the code]?

Could you indicate where you made reference to alternative approaches and assumptions, or criticisms of your techniques and expressions?

Forensic scientists have obligations to be impartial and to present their evidence fairly. Their reports and testimony should not mislead or omit relevant information — even if they are not asked about an issue. Where the expert witness has not presented their evidence fairly, and this includes failure to draw attention to authoritative criticism, their apparent partiality might be reasonably impugned.

3 Authoritative reports: The US National Academy of Science report, for example

Several recent reports by pre-eminent scientific organisations have been critical of techniques and reporting practices employed by forensic analysts in the United States and Scotland. Many of the same techniques and practices are in routine use in Australia. Authoritative international reports provide useful resources for approaching the cross-examination of forensic analysts. Many of the criticisms and recommendations bear directly on prevalent assumptions, techniques and practices. Many of the criticisms and recommendations provide means of determining whether analysts, including those from longstanding 'fields', actually possess genuine expertise. And, as we have seen, several practice directions and codes of conduct for expert witnesses insist on the analyst disclosing the existence of uncertainty and controversy. The Victorian Practice Note requires that attention be drawn to 'any significant and recognised disagreement or controversy . . . directly relevant to the expert's ability, technique or opinion'.[57]

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56 See *HG v R* (1999) 197 CLR 414; 160 ALR 554; [1999] HCA 2; BC9900188; *Ocean Marine Mutual Insurance Association (Europe) OV v Jetopay Pty Ltd* (2000) 120 FCR 146; [2000] FCA 1463; BC200007242; *Dasreef v Hawchar* (2011) 243 CLR 588; 277 ALR 611; [2011] HCA 21; BC201104304.

57 *Practice Note: Expert Evidence in Criminal Trials (Victoria)*, para 4.2.

Have there been any recent criticisms of this kind of evidence . . . [eg, latent fingerprints, ballistics, image comparison and so on]?

You are no doubt familiar with the National Academy of Sciences report?

Could you tell the court what the report says about . . . [eg, latent fingerprint evidence]?

Let me read to you from the National Academy of Sciences report:

> ACE-V provides a broadly stated framework for conducting friction ridge analyses.[58] However, this framework is not specific enough to qualify as a validated method for this type of analysis. ACE-V does not guard against bias; is too broad to ensure repeatability and transparency; and does not guarantee that two analysts following it will obtain the same results. For these reasons, merely following the steps of ACE-V does not imply that one is proceeding in a scientific manner or producing reliable results.[59]

Now you use the same ACE-V technique, don't you?

These limitations, described by the National Academy of Sciences, were not included in your report/testimony, were they?

Also, I note that you reported a 'match' and equated that with the identification of my client. Is that correct?

I would like to refer you to the following recommendations and invite you to comment. First, Recommendation 3.7 from the US National Institute of Standards and Technology's review of latent fingerprint evidence in 2012. The National Institue concluded:

> Because empirical evidence and statistical reasoning do not support a source attribution to the exclusion of all other individuals in the world, latent print examiners should not report or testify, directly or by implication, to a source attribution to the exclusion of all others in the world'.[60]

Secondly, I'd like to refer you to Recommendation 3 from the 2011 report of the Fingerprint Inquiry in Scotland, conducted by Lord Campbell in 2011. Lord Campbell recommended that:

> Examiners should discontinue reporting conclusions on identification or exclusion with a claim to 100% certainty or on any other basis suggesting that fingerprint evidence is infallible.[61]

You did not qualify your interpretation or conclusion on the basis of this very authoritative criticism and advice, did you?

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58 ACE-V is the dominant 'method' of latent print comparison. The acronym stands for Analysis, Comparison, Evaluation, and Verification.

59 NAS Report, above n 4, pp 142–5. See also NIST/NIJ Report, above n 28, pp 9, 39, 123–4.

60 See also NIST/NIJ Report, above n 28, p 77: 'examiners should qualify their conclusions instead of stating an exclusion of identification in absolute terms.'

61 FI Report, above n 28, p 740.

You knew about these reports, didn't you?

But you have not referred to them in your report, have you?

What have you got to say in response to the recommendations in these Reports?

Have you changed your practices in response to any of the criticisms or recommendations made by the National Academy of Sciences, the National Institute of Standards or Lord Campbell? How? or Why not?

Most forensic analysts are aware of the NAS and other recent reports. Not all have credible responses to the numerous criticisms and recommendations. Many forensic analysts do not have training in statistics, research methods or cognitive science and so are not well positioned to respond to the wide range of criticisms and recommendations. Some forensic analysts are curiously hostile. These reports provide useful resources to identify some of the persistent problems with different types of forensic science evidence. Questions derived from the NAS Report, particularly if it is clear the report is being invoked, might be quite confronting for many forensic analysts. See Section 6 'Further Reading'.

4 Ad hoc experts

Most *ad hoc experts* are police officers or interpreters who have listened to covert voice recordings, or police officers and anatomists who have repeatedly watched images relevant to criminal acts. Because they have repeatedly listened to a voice, or watched a video, courts sometimes allow them to express their impressions about the identity of the speaker or persons in images, including persons speaking different languages and those wearing disguises.[62] 'Ad hoc experts' rarely write reports and are not always challenged about the limits of their abilities and the character of their 'expertise'.

Have you read any of the scientific literature . . . [eg, on voice comparison or image comparison]?

You are not familiar with any of the studies of voice comparison of strangers, of cross-lingual comparisons, of the effects of comparing voices speaking on phones as opposed to live speech, and so on?

Are you aware of how common it is for those comparing voices to make mistakes? Would you like to make a guess about the frequency of such mistakes in favourable conditions? How do you think the quality of the recording, accents, foreign languages, etc influence the accuracy of voice comparison?

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62 See, eg, *R v Leung and Wong* (1999) 47 NSWLR 405; [1999] NSWCCA 287; BC9905924 and *R v Riscutta & Niga* [2003] NSWCCA 170; BC200303629. Contrast G Edmond and M San Roque, '*Honeysett v The Queen*: Forensic science, "specialised knowledge" and the Uniform Evidence Law' (2014) 36 *Syd LR* 323.

If I was to suggest to you that published scientific studies suggest that even experienced individuals make mistakes identifying a voice speaking in a familiar language, in favourable conditions, about one third of the time, what would you say?[63]

If I was to suggest to you that professional associations of linguists recommend that their members do not engage in cross-lingual voice comparison, how would you respond to that?[64]

You have not produced a report in relation to your impression . . . [of the voices], have you?

You do not have scientific training in voice comparison or identification, do you?

You have not written or published any papers on voice identification, have you?

You accept that there are experts in voice analysis and comparison? And, you accept that you are not a voice comparison expert? Do you know why a witness with voice comparison expertise was not called in this case?

Even though you are confident, you accept that you cannot be certain? And, you accept that the scientific evidence — with which you are not familiar — suggests that voice comparison is an error-prone task?

You accept that you could be mistaken?

Were you aware of who the police believed the voice [or gait or image] belonged to when you undertook your comparison?

Were you involved in the investigation (and was the accused a suspect when you made your comparison)? If not, how did you come to 'identify' the accused?

For police officers and interpreters, if they are allowed to testify it may be useful to make clear that they are not relevant experts and that their impressions might well be mistaken. Most 'ad hoc experts' are not conversant with relevant methods, literatures or limitations, and do not comply with codes of conduct and practice directions. Significantly, there is no evidence that experience as a police officer and police training improves the interpretive abilities of police relative to others.[65] For 'ad hoc experts' with formal qualifications it will usually be useful to refer to the need for validation and

63 Relevant research is discussed in G Edmond, K Martire and M San Roque, 'Unsound law: Issues with ("expert") voice comparison evidence' (2011) 35 *MULR* 52 at 84–91.

64 See, eg, International Association for Forensic Phonetics and Acoustics, Code of Practice, at <http://www.iafpa.net/code.htm> (accessed 15 September 2014).

65 See, eg, S Smart, M Berry and D Rodriguez, 'Skilled observation and change blindness: A comparison of Law enforcement and student samples' (2014) 28 *Applied Cognitive*

the importance of scientific studies over training, experience and impressions — see Section 2.B 'Validation'.[66] Moreover, as discussed previously, the opinions of these *experts* could be elicited under safer 'lineup' conditions to minimise suggestion and confirmation bias.

'Ad hoc experts' are not really experts at all.[67] The admissibility of their opinions should usually be challenged. We do not know if their impressions are relevant — see Section 2.A 'Relevance'. In many cases they will not possess 'specialised knowledge' and their incriminating opinions — often the opinions of those who participated in the investigation — are almost never based on 'specialised knowledge' that is relevant to the specific analysis or interpretation. Their testimony seems to be inconsistent with the exclusionary opinion rule (s 76 of the UEL) and not redeemed by the limited exception afforded to opinions based on 'specialised knowledge' (s 79).

5 Conclusion

The cross-examination of forensic analysts on the substance of their evidence is difficult. It requires careful and protracted preparation and meticulous execution. In many, perhaps most, cases it will require research and expert assistance or advice.

There are many ways to cross-examine forensic scientists. It may be that highly creative and surprising questions will be informative, perhaps revelatory. It may be that the witness has overcharged, expressed inconsistent opinions in previous trials, not used appropriate methods and protocols, not cleaned equipment and so on. On occasion, serious problems or conflicts might be conceded or exposed, perhaps unwittingly. That said, in order to explore the probative value of forensic science evidence at the trial, in most cases it would seem paramount to expose and convey problems with methods, the lack of validation, other significant limitations, as well as the speculative nature of many opinions. This can only be done through carefully planned questioning.

Notwithstanding its great potential as a trial safeguard, surprisingly few of the problems with the forensic sciences are explored in detail through cross-examination.[68] Most of the problems with the forensic sciences are yet to be ventilated in Australian courts. There have, for example, been few attempts to challenge the way latent fingerprint examiners equate a 'match' with identification even though the three most recent reviews (by the National Academy of Sciences (US), the National Institute of Standards and Technology (US) and the Scottish *Fingerprint Inquiry*) all recommend against this practice. Such reports provide fertile grounds for contesting the historical

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Psychology 590; A Burton, S Wilson, M Cowan and V Bruce, 'Face Recognition in Poor-Quality Video: Evidence From Security Surveillance' (1999) 10 *Psychological Science* 243.

66 See *Morgan v R* (2011) 215 A Crim R 33; [2011] NSWCCA 257; BC201109698. Cf *R v Tang* (2006) 65 NSWLR 681; 161 A Crim R 377; [2006] NSWCCA 167; BC200603593.

67 G Edmond and M San Roque, 'Quasi-Justice: Ad Hoc Expertise and Identification Evidence' (2009) 33 *Crim LJ* 8.

68 On the limits of trial safeguards, see G Edmond and M San Roque, 'The Cool Crucible: Forensic Science and the Frailty of the Criminal Trial' (2012) 24 *Current Issues in Criminal Justice* 51.

status and claims made by forensic analysts, including those predicated upon longstanding and legally accepted techniques. The now notorious problems with many forensic sciences means that there may be little need to adopt highly rhetorical strategies or spend time endeavouring to impugn the credibility of individual witnesses. Carefully exploring limitations and oversights might be much more confronting for analysts than crude attempts to challenge credibility or vague insinuations about interests or partisan bias.[69]

There is no universally correct position on whether to challenge evidence on the voir dire and/or during the trial. Where courts maintain liberal admissibility standards it may be advantageous to leave the most serious questions and criticisms to the trial — to prevent analysts adjusting their testimony or preparing in advance. We would caution that trial safeguards do not seem to have been particularly effective at identifying, exposing and conveying problems.[70] On this note, we would caution defence lawyers to think very carefully about calling rebuttal witnesses, especially if the witness uses the same problematic (ie, non-validated) technique as the prosecution witness or will reinforce the existence of a disputed 'field' (eg, face mapping or forensic gait comparison). Calling such a 'critic' might inadvertently legitimate an enterprise that is entirely without empirical foundations.[71]

Unfortunately, the lack of judicial interest in excluding the unreliable, speculative and weak opinions of those characterised by prosecutors as experts means that decisions about responding to these forms of 'evidence' become tactical. Defence counsel should think very carefully about the best stage to challenge, the best means of challenging, and how best to expose the limitations, frailties and weaknesses in the forensic science evidence called by the prosecutor. Defence counsel need to think about ways of contesting and, where necessary, discrediting forensic science and medicine evidence that are appropriate to the audience — whether a judge on the voir dire or a judge or jury at trial. In doing so, they may need to attend to the significance of the evidence to the overall case.[72] Also, concerns about the relevance of the evidence and the mandatory and discretionary exclusions (ss 135 and 137) should not be too readily abandoned. Defence counsel should direct attention to the possibility of admissibility and sufficiency challenges on appeal.[73]

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69 See eg, *Fitzgerald v R* [2014] HCA 28; BC201406344.

70 The limit of trial safeguards can usually be observed in convictions that have come to be understood as miscarriages of justice or wrongful convictions. See *Morgan v R* (2011) 215 A Crim R 33; [2011] NSWCCA 257; BC201109698; *Gilham v R* (2012) 224 A Crim R 22; [2012] NSWCCA 131; BC201204527; *Wood v R* (2012) 84 NSWLR 581; [2012] NSWCCA 21; BC201200775.

71 Use of rebuttal 'experts' in facial mapping cases is a good example of the difficulty. See the way that trial and appellate judges suggest that rebuttal experts support the case for admissibility because they reinforce the existence of a 'field' or make the proceedings 'fair' by providing both parties with an *expert*. See *Murdoch v R* (2007) 167 A Crim R 329; [2007] NTCCA 1; BC200700008; *R v Dastagir* [2012] SASC 26; BC201201449; *R v Dastagir* (2013) 118 SASR 83; [2013] SASCFC 109; BC201313897; *Morgan v R* (2011) 215 A Crim R 33; [2011] NSWCCA 257; BC201109698 and *Honeysett v R* [2013] NSWCCA 135; BC201302922.

72 Often expert evidence is marginal and adds considerable cost, complexity and the risk of confusion to proceedings. Where the evidence is not demonstrably reliable, there may be scope for challenging its admission using s 135 of the UEL.

73 The more incisive any cross-examination, the more likely it is to alarm appellate judges.

Perhaps the most important thing for lawyers and judges to know is that a good deal of forensic science and medicine evidence seems to lack scientific foundations. A surprisingly large proportion of techniques, standards, protocols and expressions have never been independently evaluated. We do not know if they work. In consequence, it is not necessarily helpful to approach plea and charge negotiations, admissibility challenges or cross-examination before a jury on the assumption that the analyst proffering an opinion possesses actual expertise. For far too long fact-finders and judges have been deprived of this information and its serious and destabilising implications for legal practice. The worthy goal of doing justice in the pursuit of truth is threatened by weak, speculative and unreliable opinions, especially where the opinions are presented by prosecutors as 'expert' and that imprimatur is reinforced by admission.

6 Further reading

This guide draws on many scientific and technical works. We recommend that lawyers working around the forensic sciences, particularly those contemplating cross-examining them, should be conversant with the following:

National Research Council (of the National Academy of Sciences), *Strengthening the forensic sciences in the United States: A path forward*, Academy Press, Washington, DC, 2009, at <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf>.

Lord Campbell, *The fingerprint inquiry report*, APS Group Scotland, Edinburgh, Scotland, 2011, at <http://www.thefingerprintinquiryscotland.org.uk/inquiry/files/TheFingerprintInquiryReport_Low_res.pdf>.

Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach*, US Department of Commerce, National Institute of Standards and Technology, 2012, at <http://www.nist.gov/oles/upload/latent.pdf>.

Appendix A — Validation, reliability and proficiency

Validity

Is the forensic analyst able to do what they claim they can do?

There are many kinds of validity, but in the context of the forensic sciences we are most often thinking about the validity of the conclusions derived from an analyst's method (or technique); whether they result from a method for visually comparing two fibres, a method for comparing two substances chemically, or anything in between. The validity of the conclusions reached is

determined by the extent to which the analyst is actually able to offer the *best approximation of the truth* in their conclusion.[74]

For example, if it can be shown that an analyst is able to compare two fibres and reach an accurate determination regarding whether they came from the same source or a different source, their conclusion can be deemed valid because it provides the best available approximation of the truth regarding the origin of the fibres. If it is shown that the analyst is not able to accurately attribute the fibre sources, the conclusions derived from their method must be considered invalid as they do not, to the best of our knowledge, truthfully speak to the origins of the fibres.

Importantly, in order to establish the validity of the analyst's conclusions, we must also know about the accuracy of their methods where the objective truth of the situation is *known*. That is, we need to establish whether they can correctly differentiate between fibres originating from different sources and fibres originating from the same source where the correct answer is derived independently from the analyst's evaluation. Without this information the validity of the conclusions derived from the method cannot be estimated or assessed.

Reliability

Does the method used by the forensic analyst consistently or repeatedly produce the same results when applied to the same materials?

The reliability of a method is a measure of its *consistency* or *repeatability*. A method is reliable if it produces the same results on multiple occasions. For example, the method for comparing fibres would be considered reliable if the repeated analysis of the same two fibres always resulted in the same determination regarding their source (ie, whether likely the same or likely different). If the repeated analysis of the same two fibres resulted in varied determinations regarding the likely similarity or dissimilarity of their origins, the method would be considered unreliable.

Like validity, reliability can be conceptualised in a number of different ways. For example, we can assess the reliability of a technique across machines (ie, do two immunochromatographic strips produce the same result given the same samples), across analysts (do two analysts applying the same technique to the same samples reach the same conclusion) or across laboratories (do two laboratories produce the same result when analysing the same sample). These different forms of reliability may have differing relevance and weight depending on the situation at hand.

It is also important to note that very few things are 100% reliable. Indeed, some degree of unreliability may be acceptable depending on the specific application of the methodology being considered. For example, a method that produces an accurate conclusion only 70% of the time may be acceptable where the consequences of making a wrong decision based on that information are not serious.

If the comparison of fibres leads to inaccurate conclusions regarding their

74 At <http://www.socialresearchmethods.net/kb/introval.php> (accessed 10 September 2014).

origins 30% of the time, and the worst that will happens is that you will accidentally buy the wrong curtains for your living room, you might still be prepared to consult the fibre analyst before trying to match the fabric for your curtains to the cushions on your couch. But if you are trying to establish whether the fibres from the crime scene and the fibres from the jumper of the accused share a common origin, and the comparison leads to inaccurate conclusions 30% of the time, you might not wish to lead the evidence of the fibre analyst because the likelihood of an error and the consequences of making a mistake (either exculpatory or inculpatory) are too high given the context.

Ultimately, irrespective of the specific level of reliability, the determination regarding whether something is sufficiently reliable for the purpose at hand can only be made in light of evidence regarding reliability and after considering the consequences of possible errors. It cannot be assumed or inferred in the absence of data. What is critical is that the person applying the technique knows the reliability of their procedure. For example, a pathologist may choose to use a test to detect cancer even though it is not 100% reliable. Yet it may still be safe to do so because they know what the reliability of the test is, and in particular how often it will result in sick people being misclassified as well, and vice versa. In light of this knowledge the doctor can interpret the result of the test appropriately and decide on a proper course of action.

Proficiency

Does this forensic analyst/laboratory perform the method and/or draw conclusions to an acceptable standard of performance?

Proficiency testing examines the performance of individuals or laboratories in applying the relevant methods and drawing the appropriate conclusions. For example, does the fibre examiner follow the proscribed procedures and protocols associated with the method of analysis? If they do, they may be considered proficient in the execution of the method.

Importantly, proficiency is distinct from validity and reliability but it can impact upon both. An analyst who is not proficient in drawing conclusions about fibres from an analysis may draw invalid conclusions and potentially undermine the reliability of the results when compared to the conclusions drawn by other analysts from the same test. Conversely, validity and reliability do not generally impact upon proficiency. It is possible to be highly proficient in a method that is neither valid nor reliable and vice versa. Accordingly, knowledge about the proficiency of an examiner or a laboratory does not guarantee the validity of that analyst's conclusions or the reliability of their method.

Appendix B — Found & Edmond's report template