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Demonstrating reliability through transparency: a Scientific Validity Framework to assist scientists and lawyers in criminal proceedings

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Abstract:	<p>In recent decades, forensic science evidence has come to play an increasingly significant role in criminal proceedings. However, the ability of non-scientists (lay-persons, including lawyers and judges) within criminal justice systems to recognise and resolve issues of validity and reliability relating to expert opinion evidence has not maintained pace with the need to do so. Despite international scrutiny from scientists, statisticians, governments and those involved in law reform, the parameters of a) different forensic disciplines and b) some case specific interpretations, remain elusive to some legal practitioners and judges. It is therefore essential that within the context of national, and increasingly international and transnational criminal investigations, forensic science experts convey the evidential value of the scientific findings in a manner that is understandable to, and useable by all. To assist this paper first identifies the organisational structures necessary to scaffold and support the delivery of reliable expert opinion evidence. This is followed by a format for transparently reporting the reasoning and the scientific validity underpinning the expert's evidence within their report: a tripartite Scientific Validity Framework. This framework is comprised of (i) foundational validity, (ii) applied validity and (iii) the new concept of evaluative validity. While written from the perspective of England and Wales such a framework, because of its underlying scientific principles, is applicable to expert reports in any jurisdiction and would be complementary to different national approaches, such as the certification of general expert competency. That is because utilising this framework could ensure that experts can, and do, demonstrate that their case-specific opinion is reliable and alert the legal profession to the expert's reasoning process and any limitations in the scientific validity underpinning the opinion.</p>

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Demonstrating reliability through transparency: a Scientific Validity Framework to assist scientists and lawyers in criminal proceedings.

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Headlines

Case-specific expert evidence must be demonstrably reliable to all

Experts should convey the foundational, applied and evaluative validity of an opinion

An expert's report should transparently demonstrate their reasoning process

The strengths and weakness of expert evidence must be clear to all concerned

Supporting structures are necessary for critical trust in forensic science

Demonstrating reliability through transparency: a Scientific Validity Framework to assist scientists and lawyers in criminal proceedings.

Abstract

In recent decades, forensic science evidence has come to play an increasingly significant role in criminal proceedings. However, the ability of non-scientists (lay-persons, including lawyers and judges) within criminal justice systems to recognise and resolve issues of validity and reliability relating to expert opinion evidence has not maintained pace with the need to do so. Despite international scrutiny from scientists, statisticians, governments and those involved in law reform, the parameters of a) different forensic disciplines and b) some case specific interpretations, remain elusive to some legal practitioners and judges. It is therefore essential that within the context of national, and increasingly international and transnational criminal investigations, forensic science experts convey the evidential value of the scientific findings in a manner that is understandable to, and useable by all.

To assist, this paper first identifies the organisational structures necessary to scaffold and support the delivery of reliable expert opinion evidence. This is followed by a format for transparently reporting the reasoning and the scientific validity underpinning the expert's evidence within their report: a tripartite Scientific Validity Framework. This framework is comprised of (i) foundational validity, (ii) applied validity and (iii) the new concept of evaluative validity. Such a framework, because of its underlying scientific principles, is applicable to expert reports in any jurisdiction and is complementary to different national approaches. That is because utilising this framework could ensure that experts can, and do, demonstrate that their case-specific opinion is reliable and alert the legal profession to the expert's reasoning process and any limitations in the scientific validity underpinning the opinion.

Keywords: expert opinion evidence, scientific validity, critical trust, reliability

Introduction

Expert opinion evidence plays an increasingly significant and often pivotal role in systems of justice. Safeguards and scrutiny are required to ensure (both for case determination and to maintain public confidence in justice) that the evidence presented is demonstrated to be (and accepted as) reliable. This is particularly so in light of recent (relatively) multi-jurisdictional reviews of forensic science by a variety of bodies, remarkably critical of both procedures and derivative evidentiary claims and the legal responses to these [1, 2, 3]. They have, between them, questioned the scientific pretensions or accuracy of forensic science procedures, insisted on the need for more research, recommended procedural reform and, significantly here, advocated changes to the traditional reporting of results [4]

Yet criminal procedure, judges, advocates and others playing a key role in the admission of, or reliance upon, expert forensic science evidence appear to be unaware of these concerns or do not engage in further critical scrutiny of matters identified in these reports. The answer may lie a jurisdiction's confidence that their well-resourced state institution's forensic science provision is unaffected by the content within these reports [5] or that the actors within a criminal justice system are insufficiently resourced (in respect of time, finance and requisite knowledge) to make deeper enquiries. The relatively small number of appeals linked to flawed forensic science evidence may be symptomatic of this. However, the inability of a criminal procedure and process to consistently expose problems with forensic science does not signify that all is well. In addition, assumptions that traditional legal safeguards will identify any weaknesses and strengths in expert evidence misses the valuable opportunity to properly consider the evidence before an admission of guilt may have to be made and results in a limited opportunity to make further enquiries of the expert evidence, when necessary.

The Role of Expert Evidence

Whilst there are standardised (and in some jurisdictions accredited) internal and external laboratory, regulatory and jurisdictionally based processes, practices and expert certifications in place to direct that expert evidence is firmly rooted in defensible analysis and inference, historic failings have served to illustrate that gaps may remain. Those external to forensic science could view these systems as safeguards, acting as a marshal for quality and providing a level of confidence that an expert's evidence is likely to reflect the necessary individual and organisational levels of competence, accuracy and impartiality that should be expected. Once an expert has produced a report, the safeguards in place to identify any concerns with that expert evidence vary, dependent upon the criminal procedure processes of the specific criminal justice system and the knowledge and skill of the various actors, including whether opinion is sought from another expert witness. Scrutiny may range from judicial assessment of whether the evidence is admissible to court, through to no distinct consideration, due in part to overall confidence in the employment of an individual from a state laboratory or law enforcement agency. As such expert witnesses in either an adversarial system, or an inquisitorial process, may increasingly face less external scrutiny of their evidence for reasons such as a judiciary insufficiently trained to ask critical questions in the face of greater sophistication in scientific methodology, traditional practice of acceptance or the absence of a defence/independent expert to assist. Often the identification of an issue is dependent upon scrutiny by a defence expert, the appointment of which is subject to jurisdictional practices and ever-decreasing public funding [5, 6].

In a climate of restricted time and finance, the working principle of assumed reliability appears to be the default position, unless there is blatantly a concern with: a) the expert, b) their evidence or c) an issue is raised by the defendant or their representative. Credence is afforded to the expert, assuming they have understood and complied with their legal and professional obligations (and in some jurisdictions have the appropriate certification). Whilst legal procedural rules increasingly seek to "enhance the quality and reliability of expert evidence relied on by the prosecution and the accused..." [7] or more specifically ensure that the expert report "includes

such information as the tribunal may need to decide whether the expert's opinion is sufficiently reliable to be admissible as evidence" [8] the reality of practical application remains less definitive. The rather broad scope, of what could or should be incorporated, does little to direct the expert or any 'reviewer' to ensure that the expert's report contains both appropriate and sufficient information to transparently convey the strengths and weaknesses of that evidence.

In many criminal justice systems the assessment of expert evidence lies with legal practitioners or lay people, generally judges, magistrates or lay juries in adversarial systems, or examining judges (or similar) in inquisitorial systems. Often they have no scientific training, may be ill-equipped to deal effectively with scientific evidence and are at risk of making uninformed assumptions of reliability – which (in systems where admissibility criteria are applied) will ultimately impact upon the admissibility of, and weight afforded to, that expert evidence. Those assessing evidence within an inquisitorial process may well assume reliability of an expert's evidence, based on a level of confidence in the competence and impartiality of state employed experts or those with recognised certification or registration. It is therefore imperative that forensic science experts, participating as expert witnesses, are aware of the underlying risks. Exemplified through (i) generalised assumptions of reliability, and (ii) lack of external critique of the merit and reasoning underpinning an expert's opinion, that may ultimately result in misinterpretation (by the expert or the legal profession) of the relevance or strength of the evidence provided in an individual case.

Experts must be alert to the implications these underlying risks pose for the broader upholding of justice (and perceptions of forensic science), if presented (and readily accepted) opinions are not conveyed and communicated in a manner that promotes a full and proper assessment and understanding of the scientific evidence and the reasoning that has informed the opinion. This challenge has been recognised in specific jurisdictions for specific evidence types [9] and more broadly by the European Network of Forensic Science Institutes (ENFSI) which in response has provided guidance intended to standardise and improve evaluative reporting across all forensic science disciplines. [10]

Reliance on Trust

“Most of us have neither the time nor the expertise to examine every decision or explore all the evidence. We rely on judgments about the values and behaviours of those in charge. For the individual, ‘critical trust’ may be the best frame of mind: neither outright scepticism nor uncritical acceptance.” [11]

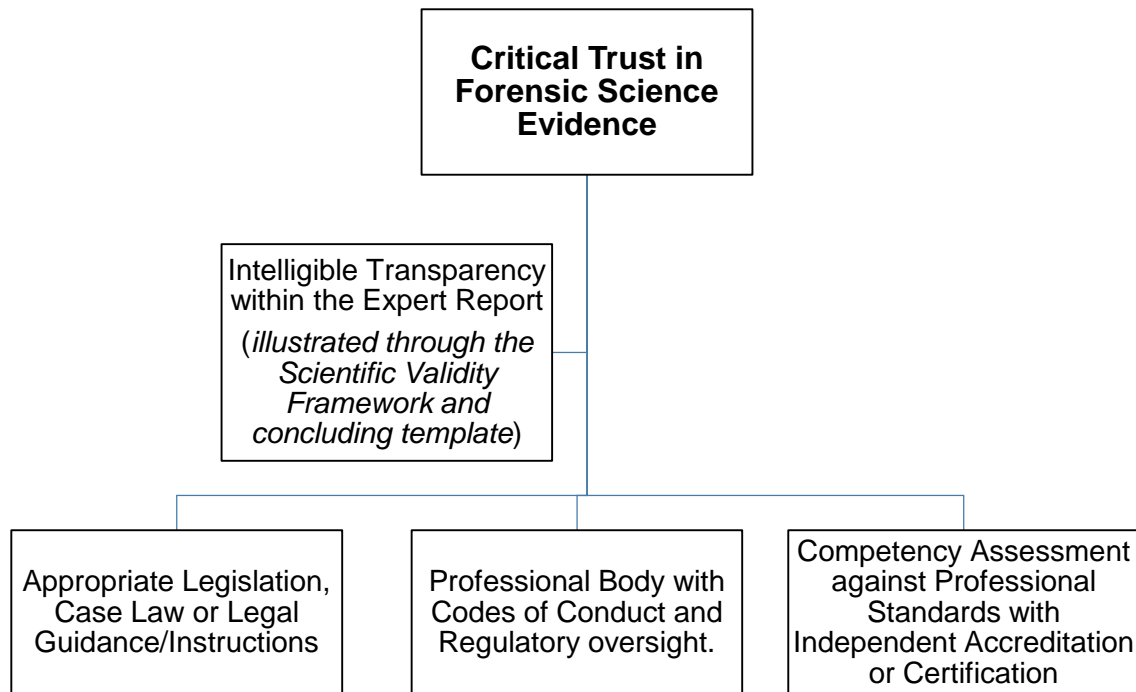
At some level, trust involves an assessment of a person, or agency’s, competence and commitment - to do the task or answer the question – and depends upon the reasonableness of deeming someone, or an agency, *trustworthy*. Simply put, trustworthiness can no longer be assumed because of one’s profession [12]. It is said [13] that evidence, expertise and professional competence all have a bearing on trustworthiness. Notably, these characteristics align to what can be reasonably expected of those providing *reliable* expert opinion to criminal justice systems - that their evidence is relevant and they are both competent and trustworthy. Whilst in general the areas of evidence, expertise and professionalism will be specific to a particular task (or situation), the inescapable behavioural traits that a trustworthy individual would portray are honesty, commitment and competence for the task at hand [14] and should be expected of all experts participating in criminal justice processes. These objectives must also be supported by any institution employing, regulating or certifying that individual and would be expected to form part of professional codes of conduct.

As trust cannot be assumed, it requires the provision of intelligible information to demonstrate that a person is *trustworthy* [13]. Thus for critical trust in expert evidence to steadfastly exist, the forensic science profession – at an organisational and individual level – must demonstrate trustworthiness in the way that it operates (including regulation) and the information and assistance that it provides.

This takes us to the requirement for a scaffolding structure to support critical trust in forensic science evidence. Whilst the arrangement of the component parts may differ across legal jurisdictions, such a structure is likely to include all or some of the following elements: appropriate legislation or case law; a professional body for the discipline; professional standards; regulation and ongoing expert competency assessment (ideally verified by independent

accreditation or certification). Sitting aside from 'organisational and professional' considerations, illustrative of trustworthiness of the processes and practices, there is also a necessity to exhibit individual trustworthiness, which is part displayed through transparency of information and clear communication within an expert's report (See Fig.1). Whilst the internal structures that map to these components may differ by jurisdiction, this objective is universal in demonstrating and supporting critical trust in expert opinion evidence. Any remaining risk, associated with the provision of critical trust, will differ on a case-by-case basis and, owing to the accepted subjective nature of expert evidence, will be dependent on the specific circumstances of the criminal case and the material(s) available and subjected to analysis. This leads us to the proposed Scientific Validity Framework, designed to clearly illustrate reliability – of the processes and practices associated with expert evidence and the individual expert's evaluation.

Fig.1. A Structure to Support Critical Trust in Expert Evidence



Determining Reliability of Expert Evidence

The soundness of judicial and quasi-judicial decisions relies on the use of experts to clearly communicate the intricacies of knowledge that is frequently bound to be outside of the decision maker's sphere of knowledge; but there must be some assessment of the opinions presented by an expert. Any system of justice must approach this challenge not with the aim of stifling the use of expert evidence, or contradicting the expert's authority in the area of expertise, but to ensure that there is a sufficiently reliable basis for its admittance as evidence and/or for attributing probative value to it [15].

Much of the general discussion on the reliability (or otherwise) of forensic science has focused on the merits of an individual subject area, such as DNA or fingerprints; questioning the scientific quality of the methodology [1]. Such debate remains relevant across all subject areas, and its

continuance is necessary to uphold the standards required to ensure robust inferential reasoning and maintain pace with scientific and technological developments and thinking. Yet these deliberations remain elusive to many within the legal profession charged with assessing expert evidence [5]. Expert opinion evidence is not infallible, often incorporating aspects that are uncertain, open to bias, contestable, or error-prone [16]. For example, as a working principle, the ability of fingerprint and DNA evidence to discriminate between individuals is readily accepted within criminal proceedings - but analytical precision declines with poor quality marks or complex mixed DNA profiles. Similarly, among frequently used technological expert evidence, cell site analysis is likely to yield much more precise locational data in an urban area than in the countryside [17]. These are just some of the factors that blur the boundaries between reliable and unreliable expert opinions. Such blurred boundaries are likely to exist across all evidence types, sometimes resulting from the search tools and methodology, other times influenced by the questions asked and the quality and quantity of material or data available.

The increasing capabilities of both science and technology have resulted in the need for additional scrutiny - of the very detail and information necessary for an individual expert to evaluate and infer the strength or significance of the scientific findings in a particular case. This inferential opinion is very often focused on the disputed issue on which non-expert decision makers require guidance. Whilst it is accepted (but unfortunate) that neither science nor law can deliver 100 per cent certainty, what criminal justice systems can reasonably expect from expert witnesses is complete transparency in acknowledging and evaluating areas of uncertainty [2]. There is a need for a transparent framework capable of illustrating the validity of the discipline and methodology as well as the validity of an expert's opinion, tailored to reduce the potential for a miscarriage of justice. As a general principle this framework maps to requirements across any scientifically or technologically derived opinion evidence, particularly when factors might make expert opinion much more susceptible to cognitive bias (e.g. in circumstances where countermeasures such as context management cannot be achieved) [18].

A Tripartite Framework for Scientific Validity

To assist with this issue, we present a tripartite framework that illustrates the strength and reliability of an expert's evidence. The first two components are *foundational validity* and *applied validity*, as identified by the President's Council of Advisors on Science and Technology (PCAST) which considered 'the fundamental scientific validity and reliability of many forensic methods used every day in courts' [1]. At a discipline level, foundational validity requires that a test or method of analysis is in the first instance scientifically sound: that it is repeatable, reproducible and accurate under specified conditions. Materials should be available to illustrate the scientific rigour of the testing and peer-review that has taken place to a level that the very foundation of that expert discipline has been demonstrated to be, and accepted as, valid. In some disciplines, where errors may be random or systematic, foundational validity is not necessarily a given, providing a reminder that experts must be clear on the capabilities and uncertainties of a method, technique or tool [19]. The second component, applied validity, considers the application, merits and limitations of a foundationally valid discipline, method or test, to a particular piece of evidence. In essence, has the test or method been used appropriately - for a sample type or question, and was it undertaken correctly and appropriately shielded from potential bias?

Regulation of forensic science requires ownership at the 'laboratory' level. To enable satisfaction of the component parts of this framework, and critical trust, requires improved policy and scientific research [20]. Regulatory compliance with discipline based standards, professional codes, organisational accreditation or individual competency certification can assist an expert to demonstrate how their analysis meets relevant part of the framework and provides an independent level of assurance to legal and law enforcement professionals. In contrast, a declared non-compliance with professional codes or non-accredited organisation or certified individual would direct attention for further questioning – as to whether a discipline has appropriate quality standards in place and whether the expert can provide other measures of assurance regarding the relevance and competence of their area and personal expertise. Therefore legislation, procedural or judicial rules that require an expert to demonstrate and

clearly document their level of compliance with both national and international regulatory standards and the certification structure or codes of their professional body would meet the needs of a structure that enables an attitude of critical trust in the provision of forensic science. This detail could be tabulated in an appendix to an expert's report.

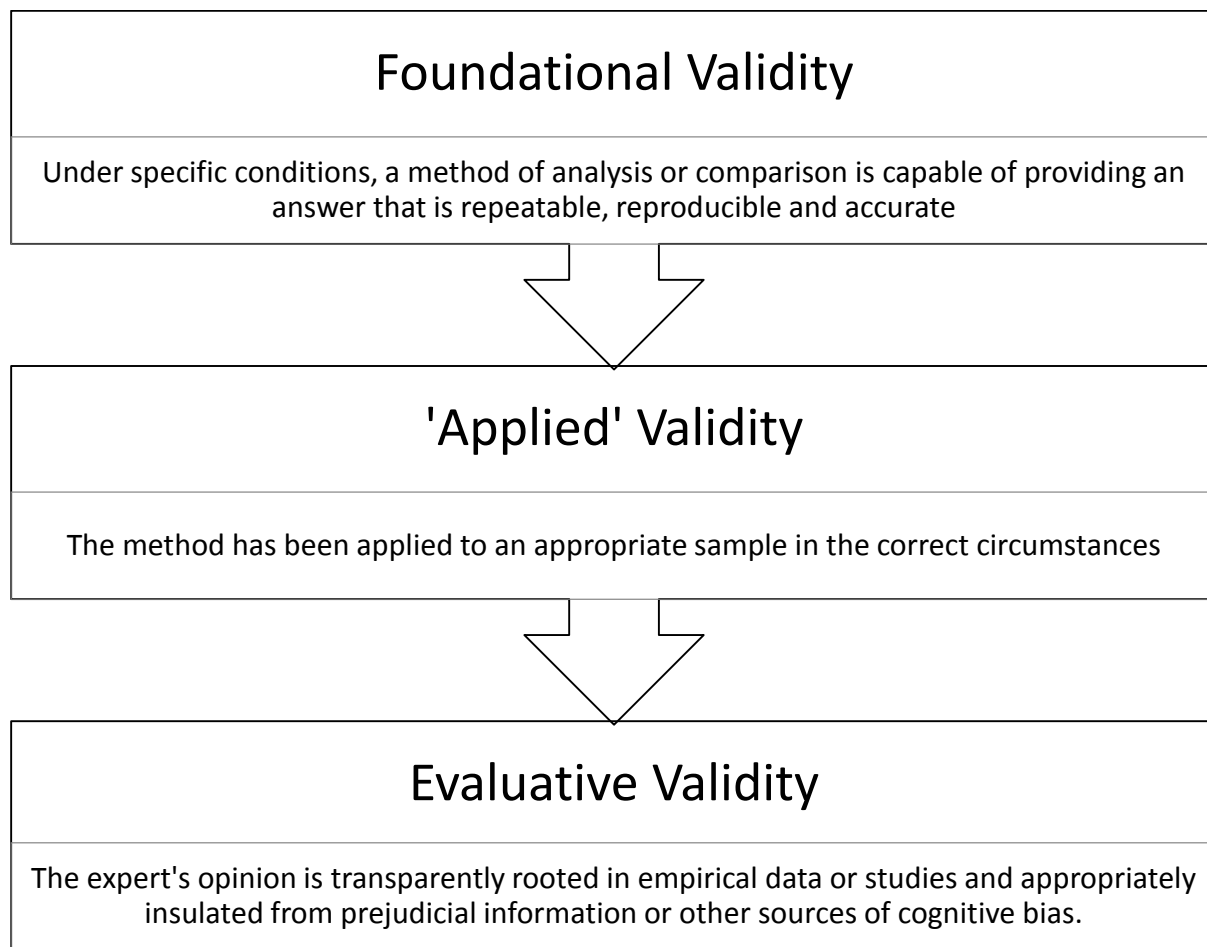
Returning to the Scientific Validity Framework, both foundational and applied validity components are appropriate for the application of an evidence type or method to a forensic aspect of a criminal investigation. However, they are limited and do not extend to the next stage of consideration – the case specific inference or conclusion, often commenting on specific matters relevant to disputed issues. For example: source/'identification'; how and when material was deposited or transferred; the existence or level of association between data/information. This requires greater consideration and scrutiny of a) the validity of such inferential conclusions, drawn from knowledge, findings and analyses outside of the individual test(s) performed and b) the manner in which this information is communicated.

Extending PCAST's dual requirements for scientific rigour, we propose a third criterion: *evaluative validity* [16]. See Fig.2. Focusing on concluding opinions, evaluative validity considers the underpinning disciplinary knowledge directly informing the expert's inferential reasoning and interpretation of evidential strength in the instant case. Evaluative validity requires that the expert's opinion or inference transparently and robustly displays balance and logic in the approach and underpinning material.

Experts have a professional duty to be clear on matters that may appear abstract to others such as, but not restricted to: the identification paradigm [21], the general commonness or rarity of particular sorts of traces; the natural levels of variations to patterns that may be observed; the completeness of a search and recovery algorithm; the accuracy of the recovered information and the limits to the generalisations or inferences that can be made from experiments or data capture, particularly as they are likely to have been undertaken under different conditions to those under consideration in a specific case or at the time the criminal offence was committed.

Clear communication, capable of satisfying the criteria within evaluative validity, is a fundamental part of doing the science [12], necessary if we are to avoid inadvertent misinterpretations. An expert's report must make clear where areas of ambiguity or uncertainty exist, and why.

Fig.2. A Tripartite Scientific Validity Framework for Expert Opinion Evidence



Evaluative Validity

To assist in application of this tripartite approach we extend the discussion to a practical example. Taking routine forensic DNA (STR) profiling, the methodology has been shown to be *foundationally valid* and if *applied appropriately*, to a suitable sample, the resulting DNA profile should satisfy all the requirements for a scientifically valid and reliable result. The next stage concerns the expert's evaluative opinion (or inference) relating to the hypothesis (proposition) posed. This very much depends upon the allegation or disputed issue and the two competing propositions, one of which should represent the narrative provided by the defendant. The simplest issue may be one of source (or sub-source); what is the probability of the findings if the sample (DNA profile) originated from the defendant as opposed to from some other, unrelated, individual. The more complex analysis is often one that questions how and when a sample was deposited – which may involve consideration of body fluid transfer and persistence, or that of unattributed cellular material or 'touch DNA'. Such questions move the scientific validity of an opinion beyond that of foundationally valid methods towards a requirement to demonstrate the *evaluative validity* of the scientific reasoning.

“It is the expert's ethical responsibility to demonstrate, by way of published research, databases, inferential reasoning or other valid heuristics, how he or she arrived at an expert opinion presented to the court. The opinion must be communicated without ambiguity and in a comprehensible manner.” [16]

Intelligible Transparency

To assist with assessments of this nature, the working principle in forensic science is to adopt a Bayesian approach, which provides a framework for considering uncertainty through the use of probability. We must be mindful that probability is an expression of uncertainty and is dependent upon an individual's knowledge at the time the probability judgement was made. Knowledge is in itself subjective and therefore an assigned probability of uncertainty must make clear the knowledge (including material relevant to the interpretation of scientific findings as well as any assumptions arising from the proposed proposition e.g. conclusion criteria) that informed the

assessment [22]. Given the very personal state of knowledge, real or assumed, we can expect to observe intra-discipline differences in levels of uncertainties expressed by experts. This is not negative; a range of opinion may be useful when the outcome reflects several unknowns. Within a criminal context, when considering two competing propositions, one can never know the true state of affairs i.e. whether or not the suspect is the true source of the bloodstain; a forensic scientist can only calculate and consider criteria for their concluding opinion [23]. The importance and focus should therefore be placed upon whether the evaluative validity of the opinion is transparently illustrated through a logical, balanced and robust reasoning on the underpinning assumptions and material.

To that extent, evaluative validity is circumscribed by what is known by and made available to the expert – which includes discipline-based knowledge, information pertinent to the criminal investigation and the exhibits themselves. The following considerations all have a bearing on the evaluative validity of an opinion:

- how well does the information, by way of scientific data, algorithms or experiments etc. supporting that opinion, reflect the reality or significance that it claims to represent;
- does it demonstrate a robust consideration and conclusion of the forensic findings in the context of the proposed competing hypotheses;
- are there any limitations, ambiguities or conditions attached to that opinion;
- are there any uncertainties or potential for inaccuracies and is the rationale clear;
- were there any institutional factors (e.g. procurement, company guidance/protocol, pre-testing by another provider laboratory) that affected the examination process and restrict the opinion provided?
- has there been any overall consideration of the scientific evidence when it has been produced by more than institution/provider working independently?
- is there an expectation that competent scientists/experts, knowledgeable in the field, would differ markedly in their opinions from that in the scientist's evidence?

The reliability (or otherwise) of the expert's evidential opinion is a reflection of the material available to independently support any inferences and under what conditions. The domains of science and digital technology could result at times themselves in circumstances where the ability to analyse exceeds the ability to interpret. Boundaries exist in relation to the relevance, reliability and extent of data used to inform inferences arising from a particular outcome or scientific result. Recent scientific and digital advancements, in conjunction with the complexity of considerations relevant to criminal investigations, result in *evidential reliability* – which is a matter for legal adjudication – approached as degrees on a continuum, rather than as a binary choice.

The Reasoning Process

Those tasked with considering expert opinion evidence need to appreciate, in a context specific sense, how an expert has utilised their individual knowledge and the theory of the discipline to assess and evaluate their scientific findings, ultimately leading to their opinion on the evidence in any given case. A great deal of the relevant knowledge required to identify and make judgements on these criteria is absent from the education and training experience of those in the legal profession and more broadly that of the general population who act as fact-finding jury members within an adversarial legal system. To address this knowledge gap, we believe that what is required is a workable template, incorporating suggested headings, to assist non-experts in critically reviewing the opinions of an expert witness when required to determine admissibility or assess evidential weight. As previously discussed, the effectiveness of any consideration by the legal profession and fact finders is dependent upon the content and clarity within the expert's report such that areas of potential dispute (and unreliability) are clear.

In arriving at their opinion, experts make assumptions and inferences from the facts and information they receive about a case. Should any of the facts or information change, so may the assumptions and inferences that have ultimately informed the expert's opinion as to the strength of the forensic evidence in that particular case. As such, the relevance and helpfulness of the evidence, in respect of any disputed issues, may not necessarily be what it initially appears to be if one or more of those facts have changed. If the expert's inferential reasoning is not

visible to the non-expert (judge, lawyers or jury), making clear the pivotal information pertinent to an opinion, the opportunity to identify the potential significance of any change to this information or its potential for cognitive bias may go unnoticed. In such circumstances, the risk of misunderstanding the cogency of the expert’s evidence increases.

There are various pre-trial stages at which expert evidence is influential. These include development of an investigative strategy, decisions to prosecute, advice and decisions on plea, and whether the defence wish to appoint their own expert. A robust template that assists consideration and scrutiny at each of these stages, as well as the trial stage, would reduce the risk that decisions are based upon unreliable expert evidence. The Summary of Evidence table provided below (Table.1.) offers a format of suggested headings to ensure all necessary information is presented to non-scientifically or technologically trained recipients.

Table 1. Summary of the Evidence

Summary of the Evidence
Statement of Limitations [24]
Suggested content to include/illustrate: <i>In this particular case, what the evidence is limited to addressing and why eg what questions it can’t demonstrate or consider, and why.</i>
Capabilities of the Evidence
Suggested content to include/illustrate: <i>In this particular case, what questions is the evidence capable of addressing and to what extent (eg sub-source, source, activity level, association and provenance). What are the possible explanations for this evidence?</i>
Propositions
Suggested content to include/illustrate: <i>What explanations have been considered in this case.</i>
Can it be determined which of the propositions is the more likely and, if so, why?
Suggested content to include/illustrate: <i>The ‘headline data’ from appropriate sources/literature, must be referenced to support this evaluation.</i>

If there is no appropriate source/literature that would suggest that there is no objective data to transparently inform the opinion then it, (the opinion) is therefore limited in its nature.

Caveats and uncertainties

Suggested content to include/illustrate:

Are there any assumptions, qualifications or unidentified risks associated with this opinion (e.g. where standard countermeasures such as context management to counter the risk of contextual bias could not be used)? Are there any areas left unaddressed or unknown, and why?

Structure

It is suggested here that these considerations, necessary to demonstrate evaluative validity, should be utilised and evidenced within an expert's report, so that the reasoning and strength of the opinion is clear as well as any areas of ambiguity or uncertainty that exist, and why. Provision of this information is essential to the understanding of an expert's inferential reasoning and the assumptions made – and if necessary, to flag if these are, for whatever reason, now incorrect, suggest cognitive bias or do not encompass the defendant's account of events. As a mathematics teacher would advise 'please show your working out.'

This approach ensures logic and balance within an expert's report and assists the reader in identifying whether or not the scientific findings are focused on the true disputed issues in the case. All testing is dependent on sufficient funds for analysis – were alternative scenarios sufficiently explored? As recommended by ENSFI [10], and by the Forensic Science Regulator [25] in England and Wales, the majority of forensic science expert reports are structured with two competing propositions; it is a standard format for evaluating the evidence. This approach, if it were mandatory for all forms of expert evidence, would go some way towards facilitating the understanding and scrutiny of expert evidence, regardless of evidence type or national jurisdiction, and at any stage of the investigation or legal proceedings.

Conclusion

In the not too distant past there have been vocal criticisms [1, 2, 26] of cumulative failures in the presentation of forensic science evidence, particularly matters that have resulted in very grave miscarriages of justice [27]. Whatever the jurisdictional requirements in relation to accreditation, certification and registration and the existence of otherwise of formal admissibility requirements, the presentation of expert evidence in line with this tripartite framework for scientific validity, transparently and intelligibly demonstrating the strength of the scientific findings to all concerned, would reduce the risks of: uninformed assumptions of reliability; unjustified and unqualified inferences; partisan or biased evidence and injustice. Clarity and quality in the presentation of expert evidence would provide substantial reassurance and scaffolding to justify critical trust in the future use of forensic science within criminal proceedings.

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Fig.2. A Tripartite Scientific Validity Framework for Expert Opinion Evidence

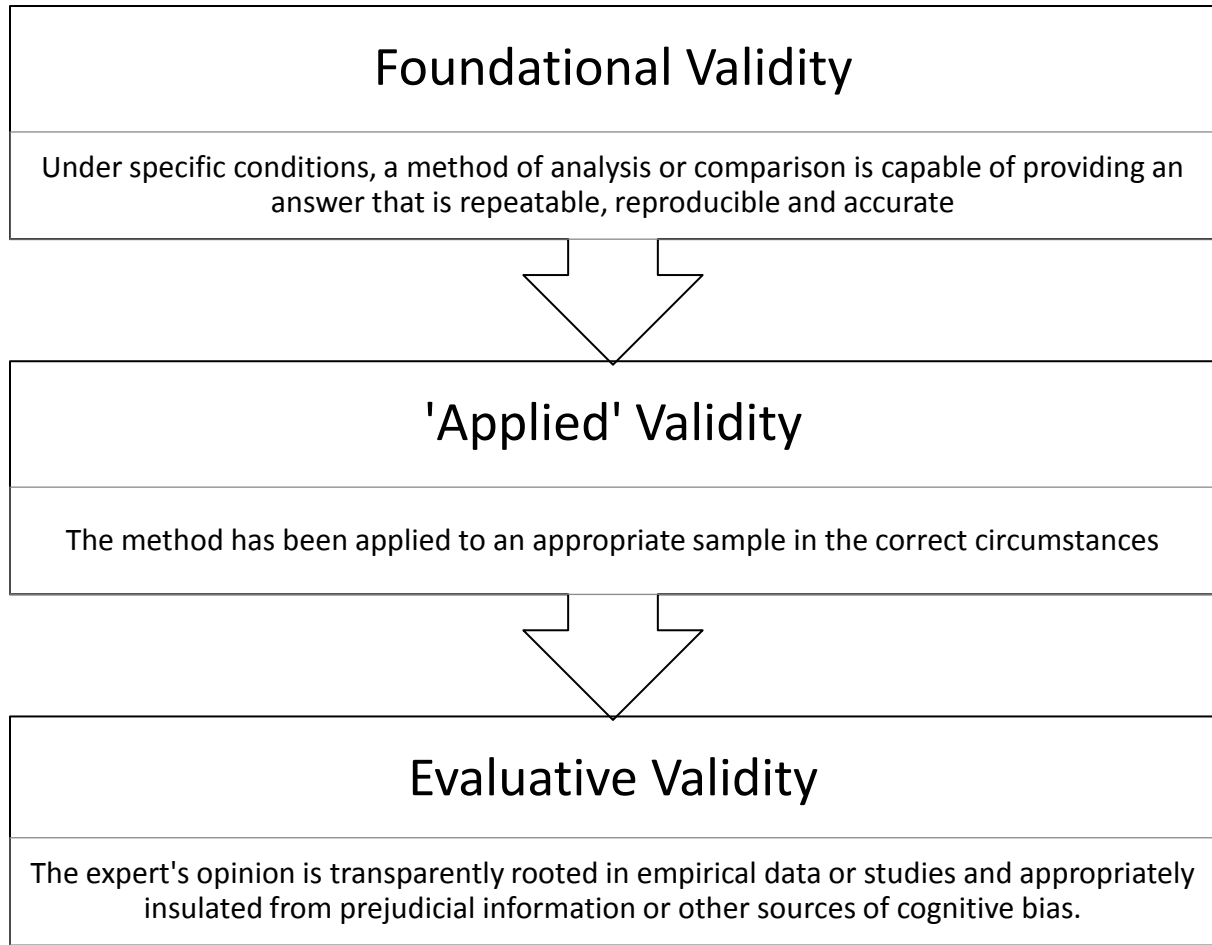


Fig.1. A Structure to Support Critical Trust in Expert Evidence

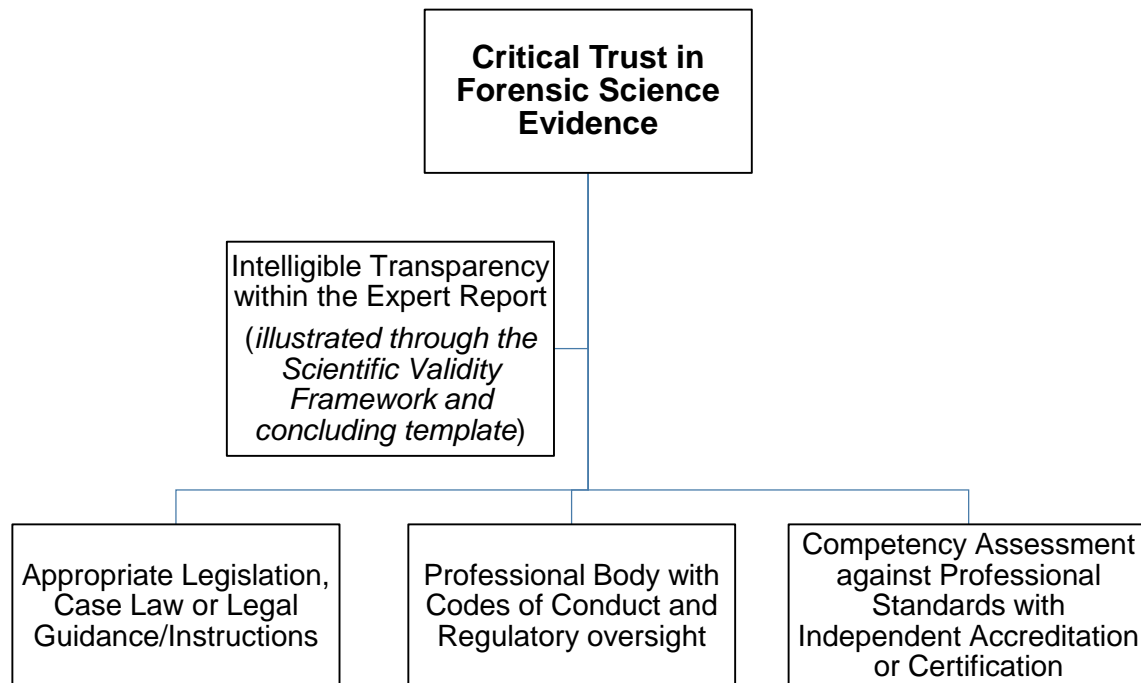


Table 1. Summary of the Evidence

Summary of the Evidence
Statement of Limitations [19]
Suggested content to include/illustrate: <i>In this particular case, what the evidence is limited to addressing and why eg what questions it can't demonstrate or consider, and why.</i>
Capabilities of the Evidence
Suggested content to include/illustrate: <i>In this particular case, what questions is the evidence capable of addressing and to what extent (eg sub-source, source, activity level, association and provenance). What are the possible explanations for this evidence?</i>
Propositions
Suggested content to include/illustrate: <i>What explanations have been considered in this case.</i>
Can it be determined which of the propositions is the more likely and, if so, why?
Suggested content to include/illustrate: <i>The 'headline data' from appropriate sources/literature, must be referenced to support this evaluation. If there is no appropriate source/literature that would suggest that there is no objective data to transparently inform the opinion then it, (the opinion) is therefore limited in its nature.</i>
Caveats and uncertainties
Suggested content to include/illustrate: <i>Are there any assumptions, qualifications or unidentified risks associated with this opinion (e.g. where standard countermeasures such as context management to counter the risk of contextual bias could not be used)? Are there any areas left unaddressed or unknown, and why?</i>

We are delighted that Reviewers #1 and #3 required no further amendments to the paper.

We are grateful to Reviewer #2 for the further comments and respond to them in the following way:

Reviewer #2: In the former version of the document, I made the following remark:

"It is regrettable that the article highly focuses on the UK situation (England and Wales) and hardly considers the practices in other countries. A broader view of different solutions and organisations is necessary e.g. certification of the experts can also serve as a proof of their competency. This would create a diversity in scaffolding structures to support critical trust in forensic science evidence. The current phrasing is too rigid and could be used to demonstrate the unreliability of the forensic service delivery in other countries."

The authors have replied by saying that "The article has been redrafted to acknowledge the important contribution made to the scaffolding structure by certification of competency to practice, but does indicate that this in itself is not necessary sufficient as a safeguard in individual cases. The references to legal requirements have been generalised so that the arguments are not dependent on English and Welsh (adversarial) law and procedure.)"

I regret to see that my remark, has not lead to a significant improvement of the document. A broader perspective is needed to increase the impact of this article. One of the missing references is e.g., the practice Note SC CR3 - Expert Evidence in Criminal Trials" of the Supreme Court of Victoria.

A broader perspective is incorporated into the paper – including with reference to the Practice Note of the Supreme Court of Victoria as suggested, which expands the point previously made with reference to England and Wales and further demonstrates the generality of the requirements of the legal safeguards.

There is no dispute that there is a diversity in appropriate scaffolding structures which is hopefully clear in the paper. Whatever the structures there remains a need for a transparent framework capable of illustrating and assisting in the assessment and communication of the validity of an expert's opinion - tailored to comply with individual legal jurisdictional rules and reducing the potential for miscarriages of justice.

There have been a number articles on the current state of provision and organisation of forensic science services in the Wales and England. For this reason, a broader context of this discussion would bring a substantial value to this publication

It is hopefully now clear that the paper is not a reflection on, or critique of, the current state of forensic science provision in England and Wales. The tripartite framework for scientific validity is applicable to the breadth of national, international and transnational criminal justice systems and investigations as a means of clearly communicating the strength and reliability of an expert's evidence. Where England and Wales features it is to provide an example of the practical application of the Framework in a jurisdiction with an established range of scaffolding structures.

To extend the discussion into a review of the range, merits and limitations of the differing organisational structures of forensic science provision at a global level would be of interest but to analyze the issues in full would extend beyond the remit of this paper and warrant a single article in itself.

Credit

Sophie Carr: Conceptualisation; Methodology; Writing

Emma Piasecki, Angela Gallop: Writing