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Discord in the Communication of Forensic Science: Can the Science of Language Help Foster Shared Understanding?

Loene M. Howes[1] and Nenagh Kemp[1]

Abstract

The criminal justice system is one arena in which nonscientists use scientific findings and expert opinions to aid decision making. Forensic science is a standard feature of criminal investigations, out-of-court settlements, and trials. Yet forensic science may be poorly understood by those who use it as a decision aid, with a consequent risk of contributing to miscarriages of justice. In this article, we discuss some of the contentious aspects of communicating expert opinion, and consider how research suggests that scientists might balance the competing concerns of scientific correctness and comprehensibility for nonscientists. Highlighting both research and theory, we argue that modifying language is a necessary component of ensuring understanding. However, the aim of transferring knowledge from a forensic scientist to a nonscientist is a complex task. Language modification alone is not sufficient; the practices and processes of communication require consideration. We argue that the dialogue and participation models of communication have much to offer to foster understanding of forensic science and enhance its value in the criminal justice system. We acknowledge some practical challenges to dialogue and participation approaches, and provide an example of how innovative organisational practices can help to facilitate effective interprofessional communication.

Keywords

inter-professional communication, forensic science, police, court

[1]University of Tasmania, Hobart, Tasmania, Australia

Corresponding Author:

Loene M. Howes, School of Social Sciences, University of Tasmania, Private Bag 22, Hobart, Tasmania 7001, Australia.
Email: loene.howes@utas.edu.au

Forensic science, or the application of science to problems of law, contributes to justice, serving the wider community, victims of crime, and wrongfully accused individuals. Forensic science is a rapidly developing area of enquiry (Peterson, 2015) and has been used increasingly as a decision-making tool in the criminal justice system (Smith, Bull, & Holliday, 2011). In policing, there exists an increased impetus to use forensic intelligence effectively not only for investigations of particular instances of crime but also to target, disrupt, and prevent patterns of crime (Ribaux et al., 2003). In court, experts including forensic scientists, unlike other types of witnesses, are permitted to give opinions that are based wholly or substantially on knowledge from their training, study, or experience (Odgers, 2012). In short, forensic science is firmly entrenched in the criminal justice system, and forensic scientists are afforded the status and responsibility of providing their expert opinions to assist in decision making within the system.

For forensic science to be used most appropriately within a given criminal justice system, effective communication must be a specific goal (Aarli, 2013). Internationally, forensic scientists face the challenge of reporting their findings and expert opinions so that they balance scientific correctness with comprehensibility for nonscientists in the context of the particular case (Howes, 2015a). The communication of forensic science is a complex endeavour, and a wide range of approaches are used to report findings and expert opinions (Siegel, King, & Reed, 2013). The 2009 National Academy of Sciences (NAS) Report, *Strengthening Forensic Science in the United States: A Path Forward*, recommended improvements to communication through the development of standard terms and templates for written reports. This U.S.-based report has implications for forensic science service provision internationally, and reporting guidelines and standards have since been developed in Europe and Australia (European Network of Forensic Science Institutes [ENFSI], 2015; Standards Australia, 2013).

The purpose of this article is to consider how the science of language, or more broadly, the social science of communication, can help overcome the difficulties inherent in the communication of forensic science in the criminal justice system. We contribute the perspective that while language is a tool for communication, shared meaning cannot be assumed because of differing professional discourse communities in forensic science, policing, and law. This cultural divide cannot be overcome by attention to language in isolation from the broader communication context. We draw from research and theory in psychology, sociolinguistics, and the sociology of science communication to discuss recent research and practice from crime scene to court. We argue that barriers to effective communication can be overcome through more nuanced organisational policies and practice guidelines. This can help facilitate communication to ensure that police investigators and legal practitioners understand forensic science in the context of their cases.

The Problem

In many Western countries, mandatory school education in science concludes fairly early. For example, in Australia, mandatory science concludes at Grade 10 (or approximately age 16), although students may elect to continue their study of science for the remaining 2 years of high school. Past studies indicated relatively low rates of scientific literacy in the Australian community (Thomson & De Bortoli, 2008; Wyatt & Stolper, 2013). There is no prerequisite for entry into policing or law to have studied mathematics or science. Poor forensic awareness has been identified as an issue in policing (Julian, Kelty, & Robertson, 2012). In court, forensic scientific evidence can be very persuasive (Dartnall & Goodman-Delahunty, 2006) and nonscientists, including judges, may tend to idealise science, or to treat it as fact (Mnookin, 2007; Shelton, 2010).

Yet science is a human endeavour and is subject to limitations and assumptions. Forensic science is an interdisciplinary field of applied sciences, encompassing a range of techniques from traditional pattern-matching techniques (e.g., handwriting analysis and fingerprinting) to complex forensic chemistry and biology (e.g., materials analysis and DNA profiling) and newer technology-related techniques (e.g., recovery of information from mobile phones and computer hard drives; Fraser, 2010). While DNA profiling has been held up as an example of a discipline with high scientific rigour (NAS, 2009)—a gold standard (Lieberman, Carrell, Miethe, & Krauss, 2008)—it too involves human decisions about collection, sampling, testing, and reporting. Like other sciences, DNA profiling has a number of inherent limitations and proceeds based on a number of assumptions (Jasanoff, 2006). For example, a DNA profile gives no indication of how and when DNA was deposited.

Misuse, miscommunication, and misunderstanding of forensic science can result in serious consequences for justice (Cordner, 2012). As recently as 2015, a report by the U.S. Federal Bureau of Investigation acknowledged failings in the administration of justice due to flawed microscopic hair comparison, which had been used in cases over many years (Brennan, 2015). Wrongful convictions on the basis of such evidence resulted in people spending many years in prison for crimes they did not commit (Pilkington, 2015). The issue of clear communication of forensic science cannot be entirely disentangled from the issue of scientific validity: Clear communication cannot fix flawed science, but unclear communication about valid forensic science can nevertheless contribute to miscarriages of justice (see, e.g., Garrett & Neufeld, 2009). To best assist in the administration of justice, it is imperative that forensic science be both conducted and communicated with the utmost rigour and integrity.

Communicating the Weight of Evidence

A great deal of contention about language in reporting forensic science arises because of the need to communicate expert opinion in a way that is both scientifically accurate and also comprehensible to nonscientists. Police investigators may use expert opinion to decide the next steps in an investigation; finders of fact (e.g., juries) in a court need to be able to weigh up all pieces of evidence to form their understanding of the facts of the case and decide a verdict. A range of different approaches to communicating the strength of evidence has been used.

In some disciplines such as analytical chemistry, the strength of evidence may be expressed somewhat vaguely. For example, to communicate that microscopic fragments of glass found on the clothing of a suspect and broken glass obtained from a crime scene were indistinguishable in all class characteristics, forensic scientists may state that the glass from the crime scene and from the suspect "could have originated from the same source" (Aitken, 2012; Howes, Kirkbride, Kelty, Julian, & Kemp, 2014). The use of the expression "could have" does not seem to run the risk of overstating the evidence. Additionally, the expression is used in lay language and thus is readily comprehensible to nonscientists. However, the use of this expression has been criticised for giving an impression of a 50/50 chance, rather than a clear communication of the significance of the evidence or a degree of likelihood of a particular scenario (Aitken, 2012). As such, the communication of expert opinion may be of limited assistance to finders of fact.

In some pattern-matching disciplines, such as fingerprinting, shoe marks, and tool marks, the strength of opinion has typically been given by stating that an association between a mark from a crime scene and the print taken from the suspect (or item said to belong to a suspect) is an "identification; exclusion; or inconclusive" (Lennard, 2013). While an "exclusion" of a person as a suspect is relatively uncontroversial, the term "identification" causes contention as it implies 100% certainty, which cannot be justified because it lacks room for human error (NAS, 2009) and has not been compared with all other reference marks in existence (Fraser, 2010). Furthermore, whilst it is possible to assume the uniqueness of fingerprints, based on biological principles, this does not apply to tool marks and shoeprints. The use of the term "inconclusive" is also somewhat contentious. It may be used, for example, when the crime scene mark is low in quality (NAS, 2009) because it is smudged or partial. Contention arises because the term "inconclusive" does not allow the analyst to communicate nuance, such as weak or moderate support for the proposition that the prints were made by the same person, even if there is evidence to that effect. Debate has centred on whether statistical analyses should be used to give an indication of the weight of such evidence, so that useful information may be retained from lower quality prints and marks, rather than simply discarded (Lennard, 2013).

In DNA profiling, the strength of an association is often given as a statistical expression, whether an expected frequency within a given population, a random match probability, or a likelihood ratio. Frequencies are preferred by some legal practitioners as they may be more easily understood by nonscientists, given that such expressions are relatively common in daily life (Ligertwood & Edmond, 2012). One New South Wales case was appealed (unsuccessfully) on the basis that some numerical expressions were prejudicial. For example, stating that a profile is "expected in 1 in 1680 people in the general population" allows people to imagine other possible perpetrators, whereas an exclusion rate of 99.9% makes it hard to imagine that many others share the profile (Goodman-Delahunty, Gumbert-Jourjon, & Hale, 2014). The appeal was dismissed by the New South Wales Court of Criminal Appeal and subsequently by the High Court. The High Court ruled that the evidence given in the original trial had been explained and presented in more than one statistical format, and although adverse to the accused, was not prejudicial (Goodman-Delahunty et al., 2014; *Yusuf Aytugrul v. The Queen* [2012] HCA 15).

Random match probabilities indicate the chance of selecting another person, unrelated to the suspect or defendant, drawn from the population at random, who would have the same DNA profile as that of the evidence sample. Often random match probabilities are given in the form: 1 in 1,000,000. This form of reporting is contentious, in part because nonscientists may be expected to find the concept of random match probabilities difficult to comprehend, and instead interpret such a result as the likelihood of guilt (Goodman-Delahunty & Hewson, 2010). This is known as the prosecutor's fallacy, which reflects errors in statistical reasoning that favour the prosecution case (and contrast with the defence lawyer's fallacy that favours the corresponding case).

Likelihood ratios refer to the likelihood of the evidence if one proposition is true as opposed to an alternative proposition. For example, it may be reported that the evidence is at least 1 billion times more likely if the suspect is the source of the major DNA component obtained (in the DNA profile) than if the source is another unknown and unrelated person selected at random from the (e.g., Australian Caucasian) subpopulation. Likelihood ratios are currently used in some Australian jurisdictions for reporting DNA evidence when mixed DNA profiles are obtained (i.e., DNA from two or more contributors), while other Australian jurisdictions use it for single-source DNA profiles (DNA from one person) as well (Howes, Julian, Kelty, Kemp, & Kirkbride, 2014). The use of the likelihood ratio has been strongly advocated by some forensic scientists (e.g., Berger, 2010) because it is seen to be the scientifically correct way to respond to reasoning under uncertainty, as is done in forensic science. It allows forensic scientists to take into account various factors in their calculations, assigning them weights based on research and professional experience (ENFSI, 2015).

However, the use of likelihood ratios is not a simple solution. Likelihood ratios refer to the likelihood of the *evidence*, but can be easily mistaken for the likelihood of a suspect's or defendant's guilt or innocence in the aforementioned prosecutor's and defence lawyer's fallacies (de Keijser & Elffers, 2012). Researchers found that when presented with likelihood ratios, judges, defence lawyers, and even forensic scientists were not only susceptible to such fallacies but also overrated their ability to understand the expressions correctly (de Keijser & Elffers, 2012). Despite such complexities, the likelihood ratio approach to reporting has recently been recommended in Europe for participating countries and in *all* forensic scientific disciplines (ENFSI, 2015). This blanket approach has been criticised because the criminal justice systems of some countries and some scientific disciplines may be better placed to adopt changes than are others (Simmross, 2014).

Given the difficulty of understanding the likelihood ratio, the use of a verbal scale has been proposed to enhance the effectiveness of communication to nonscientists. Verbal scales provide terms (e.g., limited, moderate, moderately strong, strong, very strong, and extremely strong) to indicate the degree of support associated with likelihood ratios (e.g., of ≥10; 100; 1,000; 10,000; 100,000; 1,000,000) to be used with, or in place of, numerical likelihood ratios. However, because the numerical scale is logarithmic, the values are condensed at the upper end. Recent research (Martire & Watkins, 2015; Mullen, Spence, Moxey, & Jamieson, 2014) has demonstrated that such scales are not intuitive to lay people, who tend to undervalue evidence in the middle of the scale. Work is ongoing to further develop and improve such scales (Martire & Watkins, 2015), as a way to enhance the communication of the weight of evidence—essentially the crux or the "bottom line" of the expert's opinion.

Communicating for Coherence

We contend that not only the conclusion or bottom line but also the forensic scientist's entire explanation is potentially important to the nonscientist's understanding. To communicate effectively about forensic science, it is helpful to think more broadly about the communication. Increasingly, communication about forensic science occurs within a social context in which transparency is required (Roberts, 2015) as indicated by newly developed guidelines and standards (e.g., ENFSI, 2015; Standards Australia, 2013). Increased transparency reflects a trend away from simple deference to expert opinion, to more informed consideration of such opinion. Indeed, as past cases have suggested, to avoid miscarriages of justice, critical thinking is required by practitioners at all stages of the criminal justice process (Vincent, 2010).

However, according to sociolinguist Halliday (1993), understanding the language of science is synonymous with understanding science. This issue arises because during their specialised training, scientists enter a scientific discourse community, which includes ways of thinking and communicating (Magnifico, 2010) that differ from those in the broader community. Scientific language can be differentiated from lay language by the use of certain grammatical features (Halliday, 1993). For example, it contains high information density, characterised by a higher proportion of words containing content (as opposed to those fulfilling a grammatical function) than in lay language. It features abstraction, which is associated with the use of strings of nouns as the subjects of verbs, the use of nouns in instances where verbs would be used in ordinary English, and the use of the passive voice. It features technicality, which is achieved through the use of specialist terms (and familiar terms with specialist meanings), as well as complex interrelationships between such terms. The impact of technicality is that a definition of one specialist term would likely use a number of other related terms. Finally, scientific language tends to convey authoritativeness, through the characteristic use of specialist terms and the passive voice (Halliday, 1993; Roland, 2009).

Following Halliday and Martin (1993), using a broad and inclusive approach to examining the language of expert reports, we considered whether such reports would be readable to police investigators and lawyers (Howes, Julian, et al., 2014; Howes, Kirkbride, et al., 2014). In these studies, we examined reports of DNA analysis and forensic comparison of glass from Australian jurisdictions. In addition to the features outlined by Halliday (1993), such as using additional technical terms in definitions, we found that a number of other features of scientific writing were present. Some reports lacked definitions of specialist terms; many reports contained multipage tables; and explanations about procedures were often located in an appendix (Howes, Julian, et al., 2014; Howes, Kirkbride, et al., 2014). The reports would also pose difficulties for nonscientists because they contained implicit assumptions about science. For example, the practice of numbering an item that had been examined (e.g., 126752-3) was not explained. While a scientist would recognise that the “-3” referred to “a sample taken from Item Number 126752,” a nonscientist would not necessarily know about sampling practices, yet would still be interested to know that a number of red–brown stains were located on the pair of jeans and each tested for DNA. In short, the reports were written in ways that would be suitable for fellow experts (Howes, 2015a).

Kintsch and van Dijk (1978) discussed the differences in an expert writing for another expert versus writing for a novice in the field. Although brevity is valued in scientific writing, when writing for nonscientist readers, an alternative approach is needed. Nonexperts do not have the background knowledge required to make inferences from the text, and so it is important to make links for the reader (Britton & Gülgöz, 1991). The very reason for using expert evidence in the criminal justice system is specifically to make available information that nonscientist decision makers could not be expected to know otherwise (Odgers, 2012). But the need to elaborate creates conflict for scientists, because it contravenes the ways in which they have been taught to communicate in their discourse community.

It can be difficult for experts in a scientific discourse community to identify the specific aspects of their expertise that are not likely to be understood by nonexperts, if they interact primarily with others in their community. Practical guides now exist to assist forensic scientists in determining the type of content that should be contained within expert reports, a logical sequence for the information (Found & Edmond, 2012; Howes, 2015a), and the types of features and language that would be helpful for nonscientists. Aspects of language that can be modified include the following: using descriptive rather than numerical terms to identify items tested, defining specialist terms, keeping sentence length in check, and avoiding loading tables with content and making them too complex (Howes, 2015a). Additionally, it is important to consider the content and sequence. For example, providing a comprehensive summary and some information about the report itself; including all relevant steps in the process so that the reader can follow the scientist’s logic; and including information about key limitations and assumptions (Howes, 2015a). Finally, formatting considerations could assist in making the expert report reader friendly. These included choosing an easy-to-read font type and size, retaining word shape (i.e., not justifying text to the right margin; avoiding overuse of capital letters and italics), using headings and subheadings to facilitate navigation through the document, including white space to avoid overwhelming the reader with text, and providing visual information (e.g., photographs or diagrams) where relevant (Howes, 2015a).

Reports that are written to meet these criteria are likely to be more easily readable for nonscientists. However, we acknowledge that a well-written report is not a magic bullet. Reports are often read by multiple readers whose background knowledge of science differs and whose purpose for using the report may also differ. Additionally, the answer to the scientific question does not necessarily directly address the investigative or legal questions asked and scientists may not have been provided with information that enables them to explain the meaning of findings in the context of the case (Howes, 2015b, 2015d).

Communicating for Deeper Understanding

In jury trials (in countries with an adversarial system such as the United Kingdom, the United States, Australia, Canada, and New Zealand), jurors cannot ask questions of forensic scientists but must later formulate a question to ask the judge. This constrains the communication by making it formal, asynchronous, and indirect. During the course of police investigations and in the lead-up to trial (and in judge-only trials as well as trials in countries with an inquisitorial system, such as those in continental Europe), these particular constraints on the communication of forensic science do not apply.

Three models of communication of science with the public (deficit, dialogue, and participation; Bucchi, 2008) are relevant to the communication of forensic science. The *deficit* approach views the scientist as a repository of knowledge who transmits his or her knowledge to police, lawyers, judges, and jurors in a one-way flow of information. This model assumes that a transfer of knowledge is possible between the expert and nonexpert (Bucchi, 2008; see also Krieger & Gallois, this issue). Given the use of written reports to communicate findings and expert opinions to police and lawyers, and the constrained communication in the courtroom based on expert reports, the communication of forensic science in the criminal justice system is best described by the deficit model (Howes, 2015c).

In contrast to the deficit approach, dialogue and participatory approaches to communication do not assume a linear transfer of knowledge. Rather, they reflect a more contemporary understanding of communication, which acknowledges that meaning is negotiated by parties to the communication (Campos, 2007). Psychological research suggests that intragroup communication is better understood by recipients than intergroup communication (see, e.g., Greenaway, Wright, Willingham, Reynolds, & Haslam, 2015). Understanding may be further enhanced if a shared group identity is developed and if communication is accommodative (see Gallois, Ashworth, Leach, & Moffat, 2017). In investigative and pretrial contexts, dialogue, and participation approaches to communication of forensic science feature more centrally.

A *dialogue* approach focuses on social responsibility and suggests two-way negotiation of meaning between forensic scientists and nonscientists. Such an approach may be used in communication in investigative and pretrial contexts, when police investigators or legal practitioners discuss with forensic scientists the meaning of the scientific findings and expert opinions for a particular case (Howes, 2015b). Interviews with police investigators revealed that not only did they encounter a wide variety of evidence types in their work but also that the main forum for learning about such techniques was on the job. Consequently, investigators reportedly found it helpful to discuss the findings, particularly when the case or the science were complex, when the officer had been seconded, transferred, or promoted to a new area, or when the officer had otherwise not encountered the particular science before (Howes, 2015b). Additionally, forensic scientists reported increased confidence that their findings were understood once they had the opportunity to discuss them with police investigators. Dialogue also offered forensic scientists a valuable opportunity to practice explaining their findings to a nonscientist (Howes, 2015b).

Similarly, research and commentary has emphasised the importance of discussion between legal practitioners and forensic scientists (see, e.g., Roberts, 2015). Legal practitioners and forensic scientists agreed about the importance of meeting prior to the trial (Howes, 2015d). Both groups were concerned about coherence for the judge and jury: Without adequate preparation, presentation could be poor. For lawyers, pretrial communication helped clarify the content of the expert report, to decide how best to copresent that information in court, and to ensure that scientists' explanations would comprehensible for the jury. For forensic scientists, it helped ensure that the questions asked by the lawyer made sense and allowed evidence to be elicited (Howes, 2015d).

A *participatory* approach involves input into decision making about forensic science. This approach allows for knowledge coproduction, without prioritising scientific knowledge over investigative or legal knowledge. It is often used in major cases (e.g., homicide) when forensic scientists join with police investigators, crime scene examiners, and Crown prosecutors (in some jurisdictions) to prioritise the items to be examined scientifically (Howes, 2015b; Kelty, Julian, & Ross, 2013). Police investigators, crime scene examiners, forensic scientists, and Crown prosecutors who participated in such case conferences (e.g., for homicide) were unanimous in acknowledging their value, reporting that they gained insights into the broader criminal justice process and their role within it, as well as a deeper understanding of the particular case (Howes, 2015b, 2015d; Kelty et al., 2013).

Despite the benefits of two-way communication to practitioners, the use of dialogue and participation approaches is somewhat contentious. Barriers to the use of dialogue and participation approaches include practitioners' concerns about contextual bias. Contextual bias is the issue that forensic scientists' opinions may be influenced, outside their awareness, by the case context provided by investigators (see, e.g., Dror, Charlton, & Peron, 2006; Dror & Hampikian, 2011). Legal practitioners were concerned about unwittingly influencing an expert witness or the contents of the expert report through their requests for such a report, or for additions to it, because this could potentially compromise the fairness of a trial (Blake & Gray, 2012-2013). Defence lawyers in particular were concerned about the perceived lack of impartiality of state experts called as witnesses by the prosecution, particularly if they did not have access to an independent consultation about the contents of an expert report (Chapman, 2015). It is therefore important to foster understanding and encourage discussion in ways that enhance comprehension without compromising scientific, investigative, or legal integrity.

Organisational Priorities and Communication

Either hindering necessary communication or fostering too much communication may risk negative impacts on justice. In policing, the approach to managing contextual bias and the associated communication differs in each jurisdiction according to the organisational philosophy adopted (Howes, 2015b). Thompson (2011) outlined three theoretical approaches to laboratory management: *CSI* (crime scene investigator); case manager; and blind service models, which are described below. Having reviewed the data (from interviews with forensic scientists who specialised in forensic biology [DNA] or forensic chemistry [trace evidence examination] reported in Howes, 2015b) by jurisdiction, it is possible to discuss findings about the nature of organisational approaches to bias and communication in Australian jurisdictions in light of the distinct approaches. We note that while practical approaches to laboratory management are unlikely to be fully consistent with their theoretical outlines, the following observations in Australian approaches reflect some of the diversity in practice internationally.

In all Australian jurisdictions, forensic scientists from a range of disciplines are sometimes invited to participate in serious case conferences. High involvement of forensic scientists in key decision making about forensic scientific evidence reflects, to some extent, a *CSI* (crime scene investigator) approach (Thompson, 2011). In practice, this may take form on a continuum of greater or lesser decision-making involvement or advisory capacity about what to prioritise for scientific testing. This approach maximises both the case information shared with forensic scientists and the value of forensic science, by offering expert interpretation of evidence to guide intelligence-led policing efforts (Ribaux, Crispino, & Roux, 2015). It allows interpretations of findings to be explained in case context, but may risk bias due to the influence of such context (Thompson, 2011). Influence of case context can be mitigated against using the either the case manager or the blind service approach, discussed below, in which the forensic scientist who advises police is not the scientist who tests items related to the case.

In some jurisdictions, for a range of case types, discussing which items to test as well as the results and interpretations of testing is a relatively common practice. Discussions take place between police investigators and liaison officers who are based at laboratories, or directly with forensic scientists. Often policing and forensic science are sister organisations, possibly sharing an organisational umbrella. A variation of a *case manager* model of laboratory management (Thompson, 2011) is typically in place. The case manager is provided with some case context, but another scientist undertakes testing, receiving only that case information that is crucial to interpretation and only once testing has been completed. The benefit of this approach is that scientists can assist investigators and legal practitioners with interpretation of the results in the context of the case, without the biasing effect of exposure to such information prior to testing (Thompson, 2011). This approach offers a sound compromise; after all, interpretation of the results in the case context is often regarded as the essence of expert opinion.

Conversely, in other jurisdictions, investigators are asked not to waste scientists' time by contacting them. This may be due to organisational policies designed to maximise efficiency by keeping scientists at laboratory benches and assigning less specialised work to other staff (Howes, 2015b). These laboratories are more likely to be viewed by policing organisations as service providers, under separate organisational banners, and to have a *blind service model* in place (Thompson, 2011). Under this approach, decisions about what to test are made primarily within the policing organisation. Forensic scientists receive little if any case contextual information to assist with interpretation, simply stating whether two samples corresponded with each other.

In some of the jurisdictions using a blind service model, police investigators reported having few opportunities to discuss the content of expert reports (Howes, 2015b). Forensic scientists expressed concern about this because they wanted their findings to be understood. Forensic scientists also noted that without sufficient relevant case detail, their opinion may not address the questions asked as effectively as it otherwise could, diminishing the value of forensic science in the criminal justice system (Howes, 2015b).

However, in other jurisdictions under a blind service model, investigators were directed to contact a liaison officer or intermediary in the first instance for any clarification (Howes, 2015b). In other contexts, such intermediaries have been described as "knowledge brokers" (see Strekalova et al., 2017) and "interpretivists" (see Wray, 2017). These liaison officers were typically based within policing organisations, but could liaise with forensic scientists on behalf of investigators, or make referrals for complex enquiries. When such liaison officers were provided, police investigators had the opportunity to discuss their questions with someone who understood both forensic science and policing (Howes, 2015b). A potential pitfall of the approach arises if police investigators are not aware of the existence of liaison officers, or if liaison officers and forensic scientists do not maintain open lines of communication. Overall, however, the provision of liaison officers as intermediaries is one innovative way to ensure that necessary dialogue about forensic science can occur, while meeting organisational objectives of avoiding context bias and allowing scientists to focus on their laboratory work (Howes, 2015b).

In the criminal justice arena, scientific accuracy must be balanced with lay understanding. Further research is needed to establish whether particular models of laboratory management and the concomitant approaches to communication of science are more or less effective in contributing to justice. For instance, how much information is lost in blind service models and how is such information loss mitigated? To what extent is greater involvement of forensic scientists associated with enhanced case outcomes? Such studies would contribute to developing protocols concerning the nature and extent of information exchange between forensic scientists, police investigators, and legal practitioners throughout the life of a case.

Implications

The issues raised above have some more general implications for the communication of science. Forensic science is science applied to law, so that nonscientist decision makers have access to expertise to assist in their decision making. Although some unique communication challenges arise in the context of the criminal justice system, some of the research findings from this area may transfer to other contexts, such as science communication that informs governmental policy and organisational practice. Transferable implications include the principles used to guide written communication and the need for science communication to be explicitly taught and enacted with appropriate guidelines, so that professional integrity is not compromised.

The principles of the written guidelines that have been developed to assist forensic scientists to write readable reports were drawn from theory and research (Howes, 2015a). Such principles have been used in other fields such as medical patients' health literacy (e.g., Clerehan, Buchbinder, & Moodie, 2005; Feufel, Schneider, & Berkel, 2010) and may also be applied to writing for nonscientists about other fields of scientific endeavour. In written communication, to facilitate understanding by nonscientists, it is essential to sequence the text logically to walk the reader through the scientist's reasoning process, outline key limitations and assumptions of the scientific techniques used, and explain the basis for the opinion in lay terms, defining all necessary specialist terms. When verbal communication is also possible, it allows a chance for mutually beneficial exchanges, for nonscientists to deepen their understanding of science, and for both parties to negotiate meaning of the scientific findings and expert opinion in the specific context (about which the nonscientist has valuable knowledge).

It is evident that science communication is an important aspect of many science-related careers: Science communicators help foster scientific literacy in the communities with which they work. There is a need for a science communication component to be included in science degrees and professional development workshops. A number of universities offer science communication courses as part of science or journalism degrees (Longnecker, 2009). Such courses encourage students to break away from disciplinary norms and develop flexibility in their writing (and speaking) about science. Some universities also offer cross-disciplinary courses, which foster interaction between prospective forensic scientists and law students (Biedermann et al., 2014). Similar cross-disciplinary courses could be offered, for example, for students of climate and political sciences. In such courses, consideration should be given to how audiences can be involved in negotiating meaning for greater understanding through dialogue- and participation-based approaches to science communication.

In this article, as part of the special issue on using the science of language to help translate the language of science, we have highlighted some of the contentious aspects of communicating effectively about forensic science in the criminal justice system. We have argued that in light of past failings, forensic science is in an era of increased accountability and transparency. It is incumbent on actors in the criminal justice process to communicate clearly and understand adequately the forensic scientific evidence presented in the criminal justice process. We argued that the science of language can assist in translating the language of science in the criminal justice system. However, we contended that the attempts to improve language must be part of an overall approach that considers the practices and processes of communication more broadly. Discussion and participation models of communication facilitate understanding through negotiation of meaning. In the criminal justice system, we acknowledged that various initiatives offering the opportunity for discussion and participation are already in place, and we have offered here a theoretical basis to explain their value. We hope that this illustration may be of interest to others who aim to communicate scientific findings from diverse scientific disciplines to nonscientists.

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References

Aarli, R. (2013). The status and meaning of criminal procedure: An exploration of the reception of DNA evidence in criminal process. *Bergen Journal of Criminal Law & Criminal Justice*, *1*, 63-74.

Aitken, C. (2012). An introduction to a debate. *Law, Probability & Risk*, *11*, 255-258.

Berger, C. (2010). Criminalistics is reasoning backwards: Logically correct reasoning in forensic science and in the courtroom. *Nederlands Juristenblad*, *13*, 784-789.

Biedermann, A., Voisard, R., Scoundrianos, A., Furrer, J., Taroni, F., & Champod, C. (2014). Supporting interdisciplinary case studies: Development and implementation of a joint learning environment for students in forensic science and criminal law. *Australian Journal of Forensic Sciences*, *46*, 317-329.

Blake, G., & Gray, P. D. (2012-2013). Can counsel settle expert reports? *Bar News, 2012-2013*, 56-66.

Brennan, B. (2015, April 21). FBI admits decades of forensic hair analysis evidence was wrong, hundreds of criminal trials to be reviewed. *ABC News*. Retrieved from http://www.abc.net.au/news/2015-04-21/fbi-admits-decades-of-forensic-hair-analysis-evidence-wrong/6410448

Britton, B. K., & Gülgöz, S. (1991). Using Kintsch's computational model to improve instructional text: Effects of repairing inference calls on recall and cognitive structures. *Journal of Educational Psychology*, *83*, 329-345.

Bucchi, M. (2008). Of deficits, deviations and dialogues: Theories of public communication of science. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology* (pp. 57-76). New York, NY: Routledge.

Campos, M. N. (2007). Ecology of meanings: A critical constructivist communication model. *Communication Theory*, *17*, 386-410.

Chapman, L. (2015). Playing forensic science monopoly. *Australian Journal of Forensic Sciences*, *47*, 402-410.

Clerehan, R., Buchbinder, R., & Moodie, J. (2005). A linguistic framework for assessing the quality of written patient information: Its use in assessing methotrexate information for rheumatoid arthritis. *Health Education Research*, *20*, 334-344.

Cordner, S. (2012). *R v Klamo*: An example of miscommunication and misunderstanding of expert evidence where the conviction was overturned. *Australian Journal of Forensic Sciences*, *44*, 323-331.

Dartnall, S., & Goodman-Delahunty, J. (2006). Enhancing juror understanding of probabilistic DNA evidence. *Australian Journal of Forensic Sciences*, *38*, 85-96.

de Keijser, J., & Elffers, H. (2012). Understanding of forensic expert reports by judges, defense lawyers and forensic professionals. *Psychology, Crime & Law*, *18*, 191-207.

Dror, I. E., Charlton, D., & Peron, A. E. (2006). Contextual information renders experts vulnerable to making erroneous identifications. *Forensic Science International*, *156*, 74-78.

Dror, I. E., & Hampikian, G. (2011). Subjectivity and bias in forensic DNA mixture interpretation. *Science & Justice*, *51*, 204-208.

European Network of Forensic Science Institutes. (2015). *ENFSI guideline for evaluative reporting in forensic science: Strengthening the evaluation of forensic results across Europe (STEOFRAE)*. Retrieved from http://enfsi.eu/sites/default/files/documents/external_publications/m1_guideline.pdf

Feufel, M. A., Schneider, T. R., & Berkel, H. J. (2010). A field test of the effects of instruction design on colorectal cancer self-screening accuracy. *Health Education Research*, *25*, 709-723.

Found, B., & Edmond, G. (2012). Reporting on the comparison and interpretation of pattern evidence: Recommendations for forensic specialists. *Australian Journal of Forensic Sciences*, *44*, 193-196.

Fraser, J. (2010). *Forensic science: A very short introduction*. New York, NY: Oxford University Press.

Gallois, C., Ashworth, P., Leach, J., & Moffat, K. (2017). The Language of Science and Social Licence to Operate. *Journal of Language and Social Psychology*, *36*, 45-60.

Garrett, B. L., & Neufeld, P. J. (2009). Invalid forensic science testimony and wrongful convictions. *Virginia Law Review*, *95*, 1-97.

Goodman-Delahunty, J., Gumbert-Jourjon, T., & Hale, S. (2014). The biasing influence of linguistic variations in DNA profiling evidence. *Australian Journal of Forensic Sciences*, *46*, 348-360.

Goodman-Delahunty, J., & Hewson, L. (2010). *Enhancing fairness in DNA jury trials: Trends & issues in crime and criminal justice* (Report No. 392). Retrieved from http://www.aic.gov.au/publications/current%20series/tandi/381-400/tandi392.html

Greenaway, K. H., Wright, R. G., Willingham, J., Reynolds, K. J., & Haslam, S. A. (2015). Shared identity is key to effective communication. *Personality and Social Psychology Bulletin*, *41*, 171-182.

Halliday, M. A. K. (1993). Some grammatical problems in scientific English. In M. A. K. Halliday & J. R. Martin (Eds.), *Writing science: Literacy and discursive power* (pp. 69-85). London, England: Falmer Press.

Halliday, M. A. K., & Martin, J. R. (1993). The model. In M. A. K. Halliday & J. R. Martin (Eds.), *Writing science: Literacy and discursive power* (pp. 22-50). London, England: Falmer Press.

Howes, L. M. (2015a). A step towards increased understanding by non-scientists of expert reports: Recommendations for readability. *Australian Journal of Forensic Sciences*, *47*, 456-468.

Howes, L. M. (2015b). "Sometimes I give up on the report and ring the scientist": Bridging the gap between what forensic scientists write and what police investigators read. *Policing & Society*. Advance online publication. doi:10.1080/10439463.2015.1089870

Howes, L. M. (2015c). The communication of forensic science in the criminal justice system: A review of theory and proposed directions for research. *Science & Justice*, *55*, 145-154.
Howes, L. M. (2015d). Towards coherent co-presentation of expert evidence in criminal trials: Experiences of communication between forensic scientists and legal practitioners. *Criminal Law Journal*, *39*, 252-271.
Howes, L. M., Julian, R., Kelty, S., Kemp, N., & Kirkbride, K. P. (2014). The readability of expert reports for non-scientist report-users: Reports of DNA analysis. *Forensic Science International*, *237*, 7-18.
Howes, L. M., Kirkbride, K. P., Kelty, S., Julian, R., & Kemp, N. (2014). The readability of expert reports for non-scientist report-users: Reports of forensic comparison of glass. *Forensic Science International*, *236*, 54-66.
Jasanoff, S. (2006). Just evidence: The limits of science in the legal process. *Journal of Law, Medicine & Ethics*, *34*, 328-341.
Julian, R., Kelty, S., & Robertson, J. (2012). “Get it right the first time”: Critical issues at the crime scene. *Current Issues in Criminal Justice*, *24*, 25-37.
Kelty, S. F., Julian, R., & Ross, A. (2013). Dismantling the justice silos: Avoiding the pitfalls and reaping the benefits of information-sharing between forensic science, medicine and law. *Forensic Science International*, *230*, 8-15.
Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review*, *85*, 363-394.
Lennard, C. (2013). Fingerprint identification: How far have we come? *Australian Journal of Forensic Sciences*, *45*, 356-367.
Lieberman, J. D., Carrell, C. A., Miethe, T. D., & Krauss, D. A. (2008). Gold versus platinum: Do jurors recognise the superiority and limitations of DNA evidence compared to other types of forensic evidence? *Psychology, Public Policy, and Law*, *14*, 27-62.
Ligertwood, A., & Edmond, G. (2012). Discussion paper: A just measure of probability. *Law, Probability & Risk*, *11*, 365-369.
Longnecker, N. (2009). Sharing science with better science communication. *Issues*, *87*, 37-40.
Magnifico, A. M. (2010). Writing for whom? Cognition, motivation, and a writer’s audience. *Educational Psychologist*, *45*, 167-184.
Martire, K. A., & Watkins, I. (2015). Perception problems of the verbal scale: A reanalysis and application of a membership function approach. *Science & Justice*, *55*, 264-273.
Mnookin, J. L. (2007). Idealizing science and demonizing experts: An intellectual history of expert evidence. *Villanova Law Review*, *52*, 763-801.
Mullen, C., Spence, D., Moxey, L., & Jamieson, A. (2014). Perception problems of the verbal scale. *Science & Justice*, *54*, 154-158.
National Academy of Sciences. (2009). *Strengthening forensic science in the United States: A path forward*. Washington, DC: National Academies Press.
Odgers, S. (2012). *Uniform evidence law* (10th ed.). Sydney, New South Wales, Australia: Thompson Reuters.
Peterson, J. L. (2015). A historical review of the demand for forensic evidence. In K. J. Strom & M. J. Hickman (Eds.), *Forensic science and the administration of justice: Critical issues and directions* (pp. 3-19). Thousand Oaks, CA: Sage.
Pilkington, E. (2015, April 22). Thirty years in jail for a single hair: The FBI’s “mass disaster” of false conviction: A “dirty bomb” of pseudo-science wrapped up nearly 268 cases–perhaps hundreds more. Now begins the “herculean effort to right the wrongs.” *The Guardian*. Retrieved from http://www.theguardian.com/us-news/2015/apr/21/fbi-jail-hair-mass-disaster-false-conviction

Ribaux, O., Crispino, F., & Roux, C. (2015). Forensic intelligence: Deregulation or return to the roots of forensic science? *Australian Journal of Forensic Sciences*, *47*, 61-71.

Ribaux, O., Girod, A., Walsh, S. J., Margot, P., Mizrahi, S., & Clivaz, V. (2003). Forensic intelligence and crime analysis. *Law, Probability & Risk*, *2*, 47-60.

Roberts, P. (2015). Paradigms of forensic science and legal process: A critical diagnosis. *Philosophical Transactions B*, *370*, 1-11.

Roland, M.-C. (2009). Quality and integrity in scientific writing: Prerequisites for quality in science communication. *Journal of Science Communication, 8*. Retrieved from http://jcom.sissa.it/sites/default/files/documents/Jcom0802%282009%29A04.pdf

Shelton, D. E. (2010). Forensic science evidence and judicial bias in criminal cases. *Judges' Journal*, *49*, 18-24.

Siegel, J. A., King, M., & Reed, W. (2013). The laboratory report project. *Forensic Science Policy & Management: An International Journal*, *4*, 68-78.

Simmross, U. (2014). Appraisal of scientific evidence in criminal justice systems: On winds of change and coexisting formats. *Law, Probability & Risk*, *13*, 105-115.

Smith, L. L., Bull, R., & Holliday, R. (2011). Understanding juror perceptions of forensic evidence: Investigating the impact of case context on perceptions of forensic evidence strength. *Journal of Forensic Sciences*, *56*, 409-414.

Standards Australia. (2013). *Forensic analysis-Part 4: Reporting*. Sydney, New South Wales, Australia: SAI Global.

Strekalova, Y. A., Krieger, J. L., Neil, J., Caughlin, J. P., Kleinheksel, A. J. & Kotranza, A. (2017). I Understand How You Feel: The Language of Empathy in Virtual Clinical Training. *Journal of Language and Social Psychology*, *36*, 61-79.

Thompson, W. C. (2011). What role should investigative facts play in the evaluation of scientific evidence? *Australian Journal of Forensic Sciences*, *43*, 123-134.

Thomson, S., & De Bortoli, L. (2008). *Exploring scientific literacy: How Australia measures up* (The PISA 2006 survey of students' scientific, reading and mathematical literacy skills). Camberwell, Victoria, Australia: ACER.

Vincent, F. (2010). *Report: Inquiry into the circumstances that led to the conviction of Mr Farah Abdulkadir Jama*. Melbourne, Victoria, Australia: State Government of Victoria.

Wray, A. (2017). The Language of Dementia Science and the Science of Dementia Language: Linguistic Interpretations of an Interdisciplinary Research Field. *Journal of Language and Social Psychology*, *36*, 80-95.

Wyatt, N., & Stolper, D. (2013). *Science literacy in Australia*. Canberra, ACT, Australia: Australian Academy of Science.

Yusuf Aytugrul v. The Queen (2012). HCA, 15.

Author Biographies

Loene M. Howes is a lecturer in criminology and a researcher at the Tasmanian Institute of Law Enforcement Studies at the University of Tasmania. Her research focuses on interprofessional communication in the criminal justice system.

Nenagh Kemp is a senior lecturer in psychology at the University of Tasmania. She studies the acquisition and use of spoken and written language, with a particular interest in digital communication.