"Source" or "activity" What is the level of issue in a criminal trial?

By **Graham Jackson** and **Alex Biedermann**

Imagine the police knocking on your front door early one morning and arresting you on suspicion of a serious crime. They suspect you of assaulting a woman whom you know. She alleges that, during an argument, you grabbed a heavy necklace that was around her neck and pulled it tightly, causing her to pass out momentarily. You willingly provide a sample for DNA profiling.

The necklace and reference samples from the complainant and suspect are submitted to the forensic science provider with a request that DNA profiling be carried out on the items. Weeks later, when the results from the forensic laboratory become available, the police reveal that a DNA profile matching yours was found on the necklace. They say that the forensic scientist's report quotes a match probability of 1 in a billion and they charge you with the offence.

In the face of what appears to be very powerful DNA evidence, it might be tempting for you to plead guilty. Indeed, you may well be advised by your lawyer to do so to gain credit for an early guilty plea. However, all may not be as it appears.

While the statistics underpinning the match probability quoted by the scientist may be well founded and robust, they may not be the most relevant and reliable statistics for this case. In some situations, match probabilities can be highly misleading because were other, more relevant, probabilities to be used, they could indicate that the DNA evidence is of much lower, if any, probative value. Thus, so-called match probabilities are potentially misleading if they are used to answer questions that they are not designed to answer. We will return to this case later in this article and will see what happens as the case approaches trial.

The figure of a billion, and other figures regularly advanced in legal proceedings, are both pressing and hard to comprehend, even for many experts. As many reporting scientists can confirm, given a statistic of this kind obtained in a case, they almost inevitably face the question "And is it good evidence?" – a question they may feel pushed to answer "yes", an answer they may even feel intuitively comfortable with. However, as we will try to show, "yes" should not be the scientist's first answer because, in the absence of context, no suitable answer can be given. The scientist should rather ask "evidence for what?" Are we interested in who is the source of the detected DNA, or are we interested in whether a particular alleged activity occurred? We will tease out these intricacies in what follows, as they can have a crucial bearing on the meaning of DNA evidence in a case.

What happens in court with DNA evidence?

Generally, DNA evidence adduced in court will consist of DNA profiles that match each other – whether they be questioned profiles that match the known, reference profile of the defendant (if the alleged DNA transfer is believed to be from the defendant to a scene or complainant) or questioned profiles that match the reference profile of the complainant/victim (if the alleged transfer is from the complainant/victim to the defendant). The forensic scientist presenting the DNA evidence will usually describe the nature of the matching profiles and, in the UK, the Republic of Ireland and some European jurisdictions, will quote a match probability or a likelihood ratio (LR) to help the fact-finder evaluate the DNA evidence. In other jurisdictions, different statistics, such as the combined probability of exclusion or combined probability of inclusion, may be quoted instead of match probabilities or likelihood ratios, though the meaning and usefulness of such figures are controversial, mainly because they are spuriously suggesting a conclusion as to whether the compared items have a common source.

A match probability, in its simplest form, is the probability of obtaining matching DNA profiles if the DNA had come from someone other than, and unrelated to, the defendant (or complainant/victim, as appropriate). The statistics from which match probabilities are assigned have been well researched, tested and documented and, with the possible exception of statistics derived from some complex mixtures of DNA, are now generally accepted by the courts.

The likelihood ratio is the ratio of two probabilities: the first is the probability of obtaining matching DNA profiles if the DNA had come from the defendant (or complainant/victim, as appropriate), and the second is the match probability just described, i.e. the probability of obtaining matching DNA profiles if the DNA had come from someone other than, and unrelated to, the defendant (or complainant/victim, as appropriate). Both these

probabilities are conditioned on task-relevant circumstances and background information. As we will see later, this information may have crucial effects on probability assignments.

Typical match probabilities and LRs quoted for complete DNA profiles are very impressive, and seemingly very persuasive, but therein lies the danger for defendants, lawyers, judges and jurors unaware of the potential pitfalls in uncritical acceptance of the figures. Even some experts themselves may inadvertently present potentially misleading figures. At their simplest, these figures take account only of the rarity of genetic features in the population and do not take into account other factors such as, for example, the probability of an error occurring at some point in the process (e.g., handling or labelling error, clerical errors, etc.). Expert activity is known not to be error-free; hence omitting this factor raises issues of lack of transparency. There is ongoing discussion on whether the potential of error should be incorporated in likelihood ratios, or perhaps discussed separately. Moreover, since case-specific probabilities of error presumably are several orders of magnitude *greater* than – and hence nowhere near – the tiny match probabilities, their impact on probative value should deserve more attention than they currently receive in scholarship and practice.[1]

Lawyers representing the defendant (or appellant) can adopt various strategies with DNA evidence depending on, among other considerations, what the defendant tells them, the facts at issue in the case, the strength of the other evidence, the availability of a second, defence-commissioned, expert opinion and, in the absence of such a second opinion, the lawyer's own understanding and appreciation of the subtleties of DNA evidence. On this basis, they may:

1. decide not to contest the DNA evidence and advise their client to offer a guilty plea;
2. accept the match but offer alternative explanations, such as legitimate, prior contact; or
3. contest the evidence and suggest there has been an inadvertent transfer either before the items arrive at the forensic science laboratory or within the laboratory itself (i.e., a technical failure in the process of collecting, extracting and analysing DNA).

In the experience of the authors, the more common strategy in cases of first instance, and on appeal in England and Wales, is the second of these strategies – that of exploring alternative explanations for the finding of matching profiles. Experts are asked about the possibilities, as well as sometimes the probabilities, of DNA being obtained through a variety of ways, including those that can be termed "primary", "secondary" and "tertiary" transfers. The expert is drawn into giving opinions about specific activities, such as helping an injured victim, engaging in social activities (e.g., shaking hands or hugging) or handling an intermediary object, that may give rise to innocent transfer.

It is worth stressing here that forensic scientists presenting DNA evidence in the UK have been trained not to give an opinion, for sound legal and logical reasons, on the probable source of the matching DNA profile. The probability that the defendant was the source of the DNA, given that a match has been obtained, would be a form of posterior probability. The Court of Appeal in England and Wales cautioned against experts providing this form of opinion because the decision on the origin of the matching DNA profile is entirely within the remit of the fact-finder who has the benefit of hearing all of the evidence in the case.[2] In logical terms, a posterior probability could be a manifestation of the fallacy of the transposed conditional[3] or it could be the product of an inadvertent, but biased, prior probability. In the USA, federal experts have been cautioned[4] against advising that there is reasonable scientific certainty that, for example, the DNA originated from the accused – such opinions would also be examples of posterior probabilities.

While it is to be hoped that experts do not give opinions in the form of posterior probability for the source of the DNA, in contrast they regularly give opinions on the probability that a particular suggested activity, that could give rise to DNA transfer, actually took place. But this, too, represents a transgression of the scientist's domain of competence: by opining directly on alleged events of "transfer", they opine on alleged activities, rather than on the DNA findings *given* alleged activities, as demanded by the likelihood ratio. By focusing on providing a likelihood ratio, the expert leaves it to the court, in its rightful role, to distinguish between the alleged activities given all the evidence brought before it.

Why may cases go wrong?

Cases can be said to "go wrong" in two broad situations where matching DNA profiles have been found.

A person who is truly the perpetrator may have no proceedings brought against him, or is found not guilty, when the probative value of the DNA evidence has been undervalued by the expert. We believe this to be a rare occurrence and we do not intend to discuss this type of case further.

On the other hand, there is potential for miscarriage of justice in those situations where a person who is truly not the perpetrator is charged and tried, and the matching DNA profiles have been overvalued at some point in the

justice process. This overvaluing has its root cause in the presentation, without qualification, of match probabilities, or LRs, for matching profiles in the context of what have been called issues of "source". However, if the fact at issue is more appropriately at the level of "activity", then the probative value of the evidence may be much lower.[5, 6]

Match probabilities at source level for complete, or "full", DNA profiles are reported, in the UK, of the order of 1 in 1 billion, with corresponding LRs for such profiles being of the order 1 billion. These mind-boggling figures, taken together with the portrayal of DNA evidence in the media, must appear to be very persuasive to lay fact-finders and many lawyers. However, if the fact at issue were to be placed in the context of a more appropriate level, that of activity, the probabilities in the numerator and denominator of an LR could well be determined primarily by the factors of transfer, persistence and detection of DNA rather than that of match probability. Depending on the precise specification of the prosecution and defence propositions, the LR may well then approach a value close to 1, meaning there would be practically no probative force in the DNA evidence; it would provide no assistance to anyone asked to judge which proposition is true.

Based on judgments from the Court of Appeal of England and Wales in DNA cases, there seems to be poor appreciation by lawyers of the risks of misleading evidence being presented when there is a lack of clarity about the level of the fact at issue that they think is being addressed through the DNA evidence. And this lack of clarity does not necessarily lie solely with lawyers; experts themselves can be the source of confusion when they fail to identify, or are not in a position to identify, the fact at issue in the case. Difficulties also arise where there is confusion about the differences between propositions and explanations. In forensic science contexts, unlike formal propositions, 'explanations' are *ad hoc* and intermediate considerations that are generated after the forensic findings have been obtained. Explanations have the potential to account for particular observations, but may disregard relevant case context and circumstantial information, and hence be speculative or fanciful. For example, a suspect may argue that the DNA match can be *explained* because his twin brother is the source. This is fanciful if there is nothing in the background information to suggest that the suspect could have a twin brother. Confusion also arises when people use the terms "likelihood ratios", "match probabilities" and "posterior probabilities" almost interchangeably.

What should happen?

The first important factor to help avoid misinterpretation of DNA evidence is the early identification of the facts at issue. If the expert is made aware at the outset of the relevant case circumstances and, crucially, what the person of interest will assert in his defence, then she will be able to specify the relevant propositions for which DNA, and possibly other forms of examination, would provide help in addressing.

The second factor is the adoption of standard definitions and terminology to encourage clear communication and reasoning. Standard definitions and terminology would help the recipients of expert information to appreciate the kinds of questions forensic experts can and cannot address, providing univocal understanding of these standards across scientific and legal disciplines.

Let us return to our case example of the necklace and the alleged assault to see how these may impact our case.

When the case was submitted to the forensic science provider, the request was for a DNA examination of the items. There was limited explanation of the relevant case circumstances. The scientist did not ask for clarification of the facts at issue and assumed that a source-level evaluation would meet the needs. The expert found a clear, "major" profile matching the defendant, mixed with, as would be expected from an item that had been worn, a background profile corresponding with that of the wearer (the complainant). The profile corresponding with the complainant was at a low level and was regarded as a "minor" profile. The expert provided an evaluation of an LR at source level for the major profile – the LR was of the order of 1 billion – and reported this as extremely strong support for the view that the DNA originated from the defendant rather than from another, unknown person unrelated to the defendant (technically, this would be classed as an evaluation at "sub-source" because there has been no attribution of the DNA profile to a particular body fluid or type of tissue).

In court, the defence team explore with the expert the possibility that the matching DNA was transferred via an intermediary agent, so-called secondary transfer. The expert hears from the defence lawyer, for the first time, that the defendant is the cohabiting partner of the complainant. She is asked, "Could the defendant's DNA have been transferred via the complainant's hands after she had touched his skin ... or after handling his underwear ... or through using the same towel, etc.?" The expert would have to concede that any of these transfers would somehow be possible – but how likely would they be? The probabilities of secondary transfer under a specific set of circumstances, as in this case, would be impossible to assign without extensive knowledge of the couple's home and habits, and without thorough testing of items in the home for the presence of DNA. The expert may be tempted to give a posterior probability for a particular transfer, but that opinion – as we have already mentioned – may be poorly based, biased and misleading, and go beyond the expert's area of competence.

So, at the end of the expert's evidence, the fact-finder is left with, on the one hand, an impressive big number (the LR) but

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also, on the other hand, a list of possible explanations for the transfer (as a result of specific activities). How do they decide what the DNA evidence means, and how does the evidence impact their decision?

For a more efficient way to have dealt with this case, we need to go back to the start. If the guidance of the case assessment and interpretation model[5] had been followed, the forensic science provider should firstly have contacted the police client to explore the relevant case circumstances and identify the key issue. In this case, it is of crucial significance that the complainant and defendant are cohabiting. The defendant admits to handling the necklace recently but denies pulling it tightly around his partner's neck. With this knowledge, the issue becomes clear – did the defendant pull the necklace tightly around his partner's neck? The competing propositions, based on the prosecution and defence assertions, can be set out in the case notes:

- Prosecution proposition – the defendant pulled the necklace tightly around his partner's neck;
- Defence alternative – the defendant simply handled the necklace.

The expert now needs to consider what type of examination strategy will help address effectively the issue of whether the defendant pulled the necklace tightly around his partner's neck. Simply swabbing the whole necklace and seeing if matching DNA profiles are obtained will not provide the fact-finder with any help in resolving the fact at issue. The probability of obtaining matching profiles from the swab if the defendant pulled the necklace tightly would seem to be of a similar value to the probability of obtaining matching profiles if he had simply handled the necklace recently. The LR would be approximately 1.

Depending on what the complainant would say about how she wears the necklace and which areas the defendant allegedly grabbed and pulled tight, the expert may decide to swab different areas of the necklace. These swabs could then be analysed for the presence and quantity of matching DNA profiles in the different areas. The quality of interpretation of the outcomes of the analysis depends upon the expert's knowledge and expertise in assigning robust probabilities for the transfer and persistence of DNA in such circumstances. Of course, this depends on the quality and quantity of relevant data to inform those probabilities. Assuming the expert has such data, knowledge and expertise, it could be the case that she assesses the findings as far more probable if the prosecution proposition rather than the defence proposition were true. The findings would therefore support the prosecution proposition over the defence proposition.

The problem that has been highlighted by this hypothetical case example should not be taken, however, as a suggestion that DNA has become a valueless type of evidence. The important point is that the assessment of probative value is intimately related to the case circumstances, to the allegations made by the parties, and to task-relevant case circumstances. This evaluative task requires case-specific thinking. DNA and other so-called transfer evidence does not have an intrinsic or default value that could be assigned without regard to the context of the case, nor does it reduce to a single predefined statistic. Before any statistics can be introduced, it is essential to clarify first the relevant issue and circumstances. Indeed, the probative value in our case example might turn out to be quite different if, for example, the defendant and the victim do *not* know each other. In such a case, the scientist will need to assess the probability of finding the DNA given that an unknown person assaulted the victim, and that there was no previous manipulation of the necklace by the defendant. The probability assigned under the condition of this proposition might turn out to be much lower than one assigned under a condition in which the defendant is a cohabitee of the complainant. In which case, the LR would have more probative force than in the 'cohabitee' situation and would provide stronger evidence against a defendant.

Conclusion

The "source-to-activity" problem is not one that crops up solely in DNA cases; it can occur in any type of scientific evidence, especially with transferable materials such as fibres, traces of drugs, explosives and gunshot residues. Experts, investigators, lawyers, judges and jurors all need to understand the problem and apply mitigating procedures, as do experts themselves.

However, one of the pending challenges is to foster this understanding in an operating legal system where time, monetary constraints and caseload pose obstacles to continuing education, review, reflection and interdisciplinary exchange. The Royal Statistical Society has supported and continues to support works to help overcome the gap between, on the one hand, academic research, knowledge and expertise (bit.ly/2TiWHsa) and, on the other hand, the need for resources readily accessible for practitioners (bit.ly/2H6unD8). ■

Acknowledgement

Alex Biedermann gratefully acknowledges the support of the Swiss National Science Foundation through grant No. BSSGI0_155809.

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