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Of earprints, fingerprints, scent dogs, cot deaths and cognitive contamination—a brief look at the present state of play in the forensic arena

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Abstract

Over the last decades, the importance of technical and scientific evidence for the criminal justice system has been steadily increasing. Unfortunately, the weight of forensic evidence is not always easy for the trier of fact to assess, as appears from a brief discussion of some recent cases in which the weight of expert evidence was either grossly over- or understated. Also, in recent years, questions surrounding the value of forensic evidence have played a major role in the appeal and revision stages of a number of highly publicized criminal cases in several countries, including the UK and the Netherlands. Some of the present confusion is caused by the different ways in which conclusions are formulated by experts working within the traditional approach to forensic identification, as exemplified by (1) dactyloscopy and (2) the other traditional forensic identification disciplines like handwriting analysis, firearms analysis and fibre analysis, as opposed to those working within the modern scientific approach used in forensic DNA analysis. Though most clearly expressed in the way conclusions are formulated within the diverse fields, these differences essentially reflect the scientific paradigms underlying the various identification disciplines. The types of conclusions typically formulated by practitioners of the traditional identification disciplines are seen to be directly related to the two major principles underpinning traditional identification science, i.e. the uniqueness assumption and the individualization principle. The latter of these is shown to be particularly problematic, especially when carried to its extreme, as embodied in the positivity doctrine, which is almost universally embraced by the dactyloscopy profession and allows categorical identification only. Apart from issues arising out of the interpretation of otherwise valid expert evidence there is growing concern over the validity and reliability of the expert evidence submitted to courts. While in various countries including the USA, Canada and the Netherlands criteria have been introduced which may be used as a form of input or output control on expert evidence, in England and Wales expert evidence is much less likely to be subject to forms of admissibility or reliability testing. Finally, a number of measures are proposed which may go some way to address some of the present concerns over the evaluation of technical and scientific evidence.

Keywords: Forensic identification; Individualization; Dactyloscopy; DNA analysis; Interpretation of expert evidence

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1. Problems in assessing the weight of forensic evidence: some examples

1.1. Mitochondrial DNA: 'incontrovertible evidence'

In a recent, highly publicized criminal case in which a revision was granted by the Dutch Supreme Court, a prosecutor insisted that a DNA profile obtained from a pubic hair found on the victim's jersey which matched the profile of one of the two male suspects constituted damning evidence against this suspect.[1] However, the profile obtained was a mitochondrial profile. Mitochondrial DNA is passed on unchanged from mother to child.[2] While this is in itself a remarkable genetic fact which has led to the claim that all Caucasians are descended from only a handful of women,[3] its relevance here is that an unknown number of relatives of the suspect on the suspect's mother's side, as well as an unknown number of unrelated individuals,[4] could have the same profile. The assessment of the evidential weight of the DNA-match was therefore clearly erroneous.

1.2. Semen in a rape case: 'non-perpetrator trace'

In the same case, a full nuclear DNA-profile that was obtained from semen found on the thigh of the strangled rape victim was declared a non-perpetrator trace by the prosecution when it turned out not to match the profiles of the two main suspects. The two men eventually confessed to raping and killing the girl, a 23-year-old flight attendant, who was found dead in her grandmother's house, but only after they had undergone what later turned out to have been prolonged and somewhat unorthodox questioning by the police. When the suspects later retracted their confessions both in front of the district court as well as the appeal court, police and prosecution were singularly unimpressed. They explained the non-match by arguing that the semen found on the victim's thigh originated from an earlier consensual sexual contact, and had been dragged from the victim's vagina to its position on her thigh as a result of the subsequent involuntary sexual intercourse. Largely because it was backed by an expert opinion proffered by a highly qualified but non-professional ad hoc forensic expert, an emeritus professor of gynaecology, this argument, which came to be known as the 'drag theory', was accepted by both the district court and the appeal court. The two men were convicted and sent to prison. Several years later, when the case came up for review, the professor retracted his theory, on the grounds that he had not given due consideration to the fact that there was no 'drag trail' on the woman's leg to mark the route the semen had travelled. The two men were released in 2002, after serving 7 years in prison.

1.3. Fingerprints: 'absolute identification'

About 5 years ago, Detective Constable Shirley McKie was charged with perjury when she denied entering a crime scene where a fingerprint was found which the Scottish Criminal Records Office claimed was hers. Two years later some of the world's leading dactyloscopists pointed out that the latent print did not match the policewoman's reference fingerprint and could not be hers.[5] Today Ms. McKie is still fighting for rehabilitation.[6]

A similar example involving the FBI occurred in May 2004, when—following the Madrid train bombings on 11 March 2004—37-year-old US born attorney and Muslim convert Brandon Mayfield was arrested as a 'material witness' and spent 2 weeks in solitary confinement in a federal jail. Three FBI dactyloscopists categorically—but wrongly—identified a fingermark on a plastic bag containing detonators found in a van parked near the station from which three of the four affected trains had departed as his.[7] An independent expert appointed by the judge reached the same conclusion. In spite of the fact that the Spanish authorities had advised the FBI that Mayfield's reference print did not match the finger mark even before Mayfield was arrested, it was only after Mayfield had been detained for 2 weeks and the Spanish authorities had informed the FBI that the mark in fact originated from an Algerian national that Mayfield was released.

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[1] Court of Appeal (Hof) Leeuwarden 24 April 2002, LJN-number AE1877.

[2] Mutations are thought to occur only once every 6500 years.

[3] Sykes, B. (2002) *Seven Daughters of Eve: The Science that Reveals our Genetic Ancestry*, W.W. Norton & Co: New York.

[4] The fragment at hand is a short hypervariable fragment of the D-loop and it has been shown that unrelated individuals can share identical fragments because of recurrent and fast mutation processes, leading to so-called homoplasy (Dr. Peter de Knijff: personal communication).

[5] *H.M. Advocate v. Detective Constable Shirley McKie* (visit: www.clpex.com/Articles/McKie).

[6] See also: Grieve, D.L. (1999) 'Built by Many Hands', *Journal of Forensic Identification* 49(5), 565–579; McKie, I.A.J. (2003) 'There's nane ever fear'd that the truth should be heard but they whom the truth would indite', *Science & Justice* 43(3), 161–165, and the recently opened internet site www.ShirleyMcKie.com.

[7] On the forensic implications see: Rudin, N. & Inman, K. (2004) 'Fingerprints in Print – the Apparent Misidentification of a Latent Print in the Madrid Bombing Case', *CACnews*, 4, 14–21. For a description of the case by the defence see: Wax, S.T. & Schatz C.J. (2004) 'A Multitude of Errors', *The Champion*, September/October, 6. An international committee of fingerprint experts asked by the FBI to examine the case concluded that: '*. . . the failure was in the application of the ACE-V methodology during this particular examination.*' (Robert B. Stacey (2004) 'Report on the Erroneous Fingerprint Individualization in the Madrid Train Bombing Case' *Journal of Forensic Identification* 54(6), 706–718). The problem with this analysis, which tries to save the method by blaming the expert is that the method and the expert cannot be separated because the expert plays an essential role as judge/measuring instrument in the fingerprint examination process.

On 23 January 2004, Stephan Cowans was released from prison in Boston, Massachusetts, after DNA analysis had demonstrated that biological trace material on the baseball hat and the sweatshirt of an unknown perpetrator and on a drinking glass used by this same perpetrator could not be Cowans. The three DNA-profiles obtained from the cell material on these objects were identical but they did not match Cowans' profile. It subsequently appeared that a thumb print on the glass which the Boston police had attributed to Cowans did not originate from him either. This fingerprint and an identification from a photo line-up by two eye witnesses, the victim and another witness, had been the only evidence against him at the time of his conviction. Cowans is the first case in which DNA-evidence has led to the release and subsequent exoneration of a suspect whose conviction was based on flawed fingerprint evidence. Cowans, who was convicted for the nonfatal shooting a policeman with his own gun, spent nearly 7 years in prison.[8]

1.4. Scent lineup: 'up in the air'

In a second Dutch case in which a revision was granted, the Deventer murder case, a canine scent identification test or scent line-up was used to link a knife to a murder suspect. The positive result that was obtained was apparently taken by both the prosecution and the appeal court to provide sufficient grounds to establish an association between the knife and the suspect, as well as to infer that the knife was the murder weapon.[9] At this stage no biological material had been found on the knife so that there was no independent confirmation for the association in the form of a DNA test. Not only was there no DNA evidence linking the knife to the suspect, stranger still, there was no DNA evidence linking the knife to the victim either, even though she had received several deep stab wounds and had been bleeding profusely. When the case came up for review before the Dutch Supreme Court, meticulous sampling of the knife did produce some cell material. However, as the—mixed—DNA profile obtained from this biological material failed to match that of the victim, the Supreme Court decided to grant revision of the appeal court's verdict and order a re-trial. At the re-trial in February 2004, the prosecution dropped the knife as evidence but maintained the murder charge. Contrary to expectation, the re-trial ended in a renewed conviction of the suspect on the basis of new scientific evidence when the suspect's DNA profile was obtained from a small blood stain and tiny fragments of cell material found on the female victim's blouse.[10]

1.5. Cot deaths and statistics

Three further examples are from England. The first is one of a series of questionable cot death convictions which may well herald a much larger miscarriage of justice. It took Sally Clark, a solicitor from Chester, 5 years to be cleared of the charge of killing her two baby sons. Forensic experts of various medical persuasions figured prominently both in the first trial and in the later appeal proceedings. What is particularly worrying is the fact that while expert opinion was clearly divided this did not stop the jury from finding her guilty, or the judge from administering two life sentences, of which Ms. Clark eventually served almost 3 years.[11] It is now clear that several women suffered a similar fate and that women at the centre of recent cases like Trupti Patel and Angela Cannings only narrowly escaped the same fate. Following the acquittal of Angela Cannings early in 2004, a large-scale review of hundreds of cot death convictions was announced.

1.6. Earprints versus DNA

In the UK, in July 2002, the Court of Appeal quashed the conviction of Mark Dallagher, who was sentenced to life imprisonment at Leeds Crown Court in 1998 for the murder of 94-year-old Dorothy Wood in Huddersfield.[12] A re-trial was ordered but in the course of the new investigation by the prosecution a non-matching partial low copy number DNA profile was obtained from an earprint found on a window at the crime scene which was originally categorically attributed to the suspect. Based on this finding, in January 2004, the prosecution decided to drop the charges against Dallagher, who was the first man to be convicted of murder on earprint evidence. Even though it is not clear whether the DNA material, or the earprint for that matter, bear any relation to the crime, it now looks as though several other convictions involving ear print evidence will be presented for review in the wake of this decision.

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8 Loftus, E.F. & Cole, S.A. (2004) 'Contaminated Evidence', *Science* 304(5673): 959.

9 On the basis of Schoon, G.A.A. (1998) 'A First Assessment of the Reliability of an Improved Scent Identification Line-up', *Journal of Forensic Sciences* 43(1), 70–75. The diagnostic value or likelihood ratio of a positive identification in a properly executed scent line-up must be estimated to lie somewhere between 6 and 14. If the a priori likelihood that the knife was held by the suspect is low, a positive result is unlikely but *if* it occurs it is more likely to be a false alarm (false positive) than a correct identification.

10 LJN-number AO03222 Court of Appeal 's-Hertogenbosch, 9 February 2004.

11 R. v. Sally Clark (2003) EWCA Crim 1020; Case No: 200203824 Y3. For a brief discussion of some of the forensic aspects of the case see Richardson, B.A. (2004). 'The Sally Clark Case and its Implications, *Interfaces* 38, 6–7. For a full account, see Batt, J. (2004) *Stolen Innocence – A Mother's Fight for Justice: The Authorised Story of Sally Clark*, Ebury Press, London.

12 R. v. Dallagher, UK Court of Appeal 2002, EWCA Crim 1903, July 25.

1.7. Profile mix-up

My final example involves DNA-evidence. On 14 February 2003, Peter Hamkin, a 23-year-old barman from Merseyside, was arrested and taken to London, where he spent 3 days in custody before narrowly escaping extradition to Italy. It appeared that his DNA-profile matched that of the man who shot 24-year-old Italian Annalisa Vincentini after a failed rape attempt in a pinewood in Tuscany. A second test showed that his profile differed from that of the cell material collected at the crime scene. His protestations of innocence—he claimed that he had never set foot in Italy, let alone Tuscany and that he had 20 witnesses who were prepared to swear he was stuck behind the beer pumps in his employer's bar at the time—apparently merited more credence than the British police were initially prepared to give them.

2. Forensic science under attack

Forensic science—more specifically, but not exclusively, forensic identification science—has come under fierce attack in recent years. Some of the graver miscarriages of justice which have come to light in several countries in the last decades were seen to be at least partly associated with inadequate standards of forensic expertise. Names of forensic scientists that spring to mind are those of serologist Fred Zain, odontologist Michael West, serologist Timothy Dixon, DNA-analyst Jacqueline Blake, footprint specialist dr. Louise Robbins (of Cinderella Evidence fame),[13] all from the United States, and to a lesser extent that of serologist dr. Alan Clift and the SCRO in the United Kingdom. Curiously—but not necessarily significantly—all of these seem to be associated with adversarial type criminal law systems, as are many of the better-known miscarriages of justice. In fact, recent British history provides numerous examples of what must now be believed to be erroneous convictions, many of them involving expert evidence, like the Birmingham Six, the Guildford Four or the case of Stefan Kiszko.[14] More generally, it appears that what were long held to be tried and trusted forensic identification procedures like dactyloscopy, questioned document examination or firearm examination are now said to lack a sound scientific basis, and the traditional claims of forensic identification science have come to be dismissed as logically untenable. Studies like those by Evett and Williams (1996) on fingerprint identification provide further evidence of the present crisis in the forensic arena.

3. Forensic DNA analysis as a model

At the same time, forensic science is rapidly expanding. DNA profiling in particular may fairly be said to have revolutionized forensic science. It not only constitutes a powerful investigative and evidential tool in its own right, it is, ironically perhaps, also largely as a result of the growing familiarity with the scientific paradigm associated with DNA evidence that traditional identification science is now lying so heavily under siege. Indeed, there can be little doubt that the most significant forensic development of the 20th century has been the introduction of DNA-typing for the purposes of personal individualization. In the two decades that have elapsed since DNA-analysis was first applied in a criminal case by Sir Alec Jeffreys in the UK, DNA evidence has not only revolutionized forensic identification science. It has also been instrumental in resolving countless old and cold cases by its power to exclude certain individuals as donors of biological crime scene material and thereby categorically eliminate them as suspects, and by its power to provide incriminating evidence against others. It has proved its investigative and evidential value in solving violent, high profile crimes as well as in tackling the rather more common type of transgression of the law that is nowadays collectively referred to as high volume crime. Over and above this, it has played an essential role in bringing to light grave miscarriages of justice in an ever widening range of countries including those which have long prided themselves on being among the nations with the best criminal justice systems in the world.

[13] See Gold, A.D. (2003) *Expert Evidence in Criminal Law: the Scientific Approach*, Irwin Law: Toronto, 5 ff. on Robbins and other examples of questionable forensic expertise including Lawrence Farwell's 'brain fingerprinting', a technique which he claims tells investigators whether certain information is or is not present in the suspect's brain.

[14] In 1976, Kiszko was sentenced to life imprisonment following a conviction based largely on his own confession of the murder of 11-year-old Lesley Molseed. Kiszko admitted having masturbated on the victim's underwear, a statement which seemed to be borne out by serological tests. Fourteen years later it appeared that the perpetrator's semen contained sperm heads, while Kiszko's reference sample that was taken at the time of the original investigation did not contain sperm heads. Although Kiszko, who suffered from hypogonadism (underdevelopment of the testes), was infertile and could not possibly be the donor of the questioned semen, the defence was not informed of this fact at the time of the trial. Kiszko was released in 1992 but died a year later at the age of 44 of a heart attack. The prosecutor who brought the case against Kiszko and secured Kiszko's conviction, was appointed Lord Chief Justice in 1992 (www.users.bigpond.com/burnside/kiszko.htm). In 1993, this case and similar cases led to the foundation of INNOCENT, an independent organization based in Manchester fighting for persons whose convictions are believed to amount to miscarriages of justice. The INNOCENT website, www.innocent.org.uk, features a Hall of Judicial Infamy with the names of scores of people whose innocence has since been established, albeit in some cases only after their death by hanging. A similar organization operating under the name of MOJUK (Miscarriages Of Justice UK; at www.mojuk.org.uk) is also committed to examining cases of people believed to be wrongly convicted.

DNA evidence is used not only to bring true perpetrators to book but also to exonerate innocent victims, through post-conviction DNA testing. In this sense, forensic DNA analysis can be said to be ideologically neutral. Perhaps the best example here is the Innocence Project, set up as a non-profit legal clinic by Barry C. Scheck and Peter J. Neufeld at Cardozo Law School in 1992.[15] The Project only handles cases where post-conviction DNA testing of evidence can yield conclusive proof of innocence. As a clinic, students handle the case work while supervised by a team of attorneys and clinic staff. To date, the project has produced 153 exonerations. Recent examples of post-conviction exonerations based on DNA evidence from the UK and the Netherlands include the exoneration of the Cardiff Three of the murder of Lynette White, a case which dates from 1988, and the resolution of the Fitting Room murder (Zaanse paskamermoord) in the Netherlands, which dates from 1984. In both these cases men who were previously released on other grounds were definitively exonerated as DNA evidence identified the true perpetrators. The first UK exoneration through DNA testing involving an imprisoned offender is reported in Johnson and Williams (2004).[16]

But DNA evidence was not immediately taken on board by the courts. After a spectacular start—the Pitchfork case in the UK, in which the first suspect of the murder of two young girls was excluded and the perpetrator initially avoided detection by asking a friend to take his place in the subsequent, first-ever mass forensic DNA screening—forensic DNA analysis met with considerable criticism (as it did in the O.J. Simpson case in the USA). The subsequent development of forensic DNA-analysis has taken place before a broad scientific forum composed of molecular biologists, population geneticists, methodologists and statisticians. As a result, it has acquired a firm theoretical basis. In this, it differs from virtually all other types of forensic identification evidence as well as many types of non-identification evidence, in which interest tended to focus on the potential for practical application of the method used (i.e., does it help us to catch criminals?) rather than on aspects like the reliability or validity of the method, or on a critical scrutiny of the theoretical principles underlying it.

Apart from being a very effective identification method, forensic DNA analysis has had an unparalleled effect in increasing our understanding of the potential and actual dangers of relying too heavily on the use of eyewitness testimony and various types of forensic or technical expertise in judicial fact-finding. Last but not least, the rise of forensic DNA analysis and the accompanying interest in the probabilistic model associated with it have sparked off a renewed critical interest in the interpretation and evaluation of other types of forensic identification evidence which was long overdue and whose full impact is as yet unclear.

[15] www.innocenceproject.org.

[16] Johnson, P & Williams, R. (2004) 'Post-conviction DNA testing; The UK's first 'exoneration' case', *Science & Justice* 44(2), 77–82.

Table 1
Different forensic processes

Identification	Determination of physical-chemical composition (e.g., illicit drugs)
Classification	Determination of class, type (e.g., hair, fibres, blood type, DNA[22])
Individualization	Determination of unique identity of source (e.g., fingerprints, handwriting)
Association	Determination of contact between two objects (e.g., through transfer of fibres, glass)
Reconstruction	Determination of facts of the case: nature and place of events in time and space (e.g., murder, explosion)

4. Does forensic science qualify as science?[17]

Almost inevitably, the brunt of the critical assault was initially borne by the tried and trusted traditional forensic identification disciplines like handwriting analysis, more commonly known as questioned document examination, firearm and tool mark examination, and morphological hair analysis. More recently however, the very icon of traditional forensic identification science, the fingerprint, has also come under attack, culminating in early 2002 in Philadelphia-based Judge Louis H. Pollak[18] ruling fingerprint evidence inadmissible only to—somewhat anticlimactically—reverse himself less than 2 months later.[19] Even more so than earlier admissibility decisions like US v Starzecpyzel,[20] in which Judge McKenna ruled handwriting analysis not to be a science but something in the nature of a craft or a technical skill ('such as piloting a vessel') and as such admissible after all, Judge Pollak's decision sent shock waves through the forensic science community which extended all the way to the serious press.

At this point, it may be good to pause for a moment to see what distinguishes forensic identification science from other forms of forensic science. Essentially, this difference can be described in terms of what Inman and Rudin[21] have termed the

[17] The same question was implicit in the title of Kennedy, D. (2003) 'Forensic Science: Oxymoron?', *Science* 203, 1625. An unequivocal answer can be found in Saks, M.J. & Koehler, J.J (2005) 'The Coming Paradigm Shift in Forensic Identification Science' *Science* 309, 892–895.

[18] U.S. v. Plaza 188 F.Supp 2d p. 576 (E.D. Pa. 13 March 2003).

[19] On recent criticism of fingerprint evidence see also Cole, S.A. (2001) *Suspect Identities: A History of Fingerprinting and Criminal Identification*, Harvard University Press: Cambridge MA; Epstein, R. (2002) 'Fingerprints Meet *Daubert*: the Myth of Fingerprint "Science" is Revealed', *Southern California Law Review* 75:605–658 and Steele, L.J. (2004). "The Defense Challenge to Fingerprints, *Criminal Law Bulletin* 40(3), 213–240.

[20] U.S. v. Starzecpyzel, 880 F. Supp. 1027; S.D.N.Y. 1995.

[21] Inman, K. & Rudin, R. (2002) 'The Origin of Evidence', *Forensic Science International* 126, 11–16.

[22] Although the purpose of forensic DNA analysis is individualization, the forensic process involved is technically one of classification, based as it is on the use of class characteristics, in the form of DNA markers or alleles.

Table 2
Identification (identity of source), more properly called individualization

Discipline	Type of conclusion	Example
Dactyloscopy	Categorical: yes or no	Finger trace does (not) originate from suspect
DNA	Probabilistic and quantitative	Probability of random match (RMP) of profile suspect with that of crime scene cell material
Other[a]	Probabilistic and verbal[24]	Crime scene material (very) probably does (not) originate from suspect

[a] Handwriting, hair, fibres, firearms, toolmarks, impression marks.

various forensic processes, i.e., identification, classification, individualization, association and reconstruction (Table 1).

It is the individualization process, the inference of identity of source, that is the ultimate aim of all forensic identification science.[23] Unfortunately, the various types of forensic identification science do not use the same scientific paradigm and—consequently—do not report their conclusions in the same format. The situation may be summed up as given in Table 2.

Largely as a result of the growing prominence of the scientific paradigm associated with DNA evidence, traditional identification science, as exemplified by dactyloscopy and the remaining identification disciplines, is now lying heavily under siege. What is at issue here is nothing less than the scientific status of forensic identification procedures. Critics point to the lack of scientific rigour in the methodology applied, to the presence of various types of examiner bias and to the prosecutorial orientation inherent in many traditional and well-accepted forensic procedures.[25] Elsewhere I have argued that the 'positivity doctrine'[26] subscribed to by the dactyloscopist community, whereby identifications are exclusively reported as absolute under penalty of excommunication from said community, may well have served to perpetuate fundamental misunderstandings about the nature of scientific evidence which—contrary to widespread belief—is essentially not of a categorical or deterministic but of a probabilistic nature.[27]

As Kwan[28] and others have since pointed out, any form of individualization is an essentially inductive process. While forensic identification procedures may lead to categorical elimination, as again the example of DNA profiling demonstrates, unless the number of potential sources is limited and known, no forensic identification procedure can lead to a categorical identification. It is again forensic DNA analysis that, through the implicit example it sets as a forensic identification procedure with a solid scientific basis, is increasingly being referred to as a standard for other forensic identification procedures, which so far are seen to be failing to reach the standard of proper scientific procedure set by DNA.

5. The traditional approach in forensic identification

This is not to say that the results reported by traditional forensic identification scientists are necessarily always or even frequently wrong. What it does mean is that the conclusions are not logically tenable, as in the case of categorical fingerprint identifications, and that they typically have a subjective element, which makes it difficult to assess their validity in an objective fashion. Traditional forensic identification science distinguishes itself from other types of scientific endeavor in that it is almost exclusively practiced in the context of the criminal law. In so far as it does not meet the requirements of the scientific method, it may be more aptly described as a 'Science Constructed in the Image of the Criminal Law', as one of its most vociferous critics, Michael Saks, put it.[29] Because the method used does not meet the scientific standard, there are no safeguards against the

[23] In 'The Ontogeny of Criminalistics', *Journal of Criminal Law, Criminology and Police Science* 54 (1963), P.L. Kirk defined criminalistics as 'the science of individualization' (p. 235).

[24] Increasingly, following the DNA model, these types of evidence may be reported using a likelihood ratio or a likelihood ratio-based scale, as proposed by Evett, I.W., Jackson, G., Lambert, J.A. & McCrossan, S. (2000). 'The impact of the principles of evidence interpretation on the structure and content of statements', *Science & Justice* 40(4), 233–239.

[25] Saks, M.J., Risinger, D.M., Rosenthal, R. & Thompson, W.C. (2003) 'Context effects in forensic science: A review and application of the science of science to crime laboratory practice in the United States', *Science & Justice* 43(2), 77–90. An almost identical version of this article appeared earlier as Risinger, D.M., Saks, M.J., Thompson, W.C. & Rosenthal, R. (2002). 'The Daubert/Kumho Implications of Observer Effects in Forensic Science: Hidden Problems of Expectation and Suggestion', *California Law Review* 90, 1–56.

[26] 'Friction ridge identifications are absolute identifications. Probable, possible, or likely identification are outside the acceptable limits of the science of friction ridge identification.' McRoberts, A.L. (2002) 'Scientific Working Group on Friction Ridge Analysis, Study and Technology', *Journal of Forensic Identification* 52, 263–348.

[27] Broeders, A.P.A. (2003) *Op zoek naar de bron: Over de grondslagen van de criminalistiek en de waardering van het forensisch bewijs*, Kluwer: Deventer.

[28] Kwan, Q.Y. (1977) *Inference of Identity of Source*, Ph.D. Thesis, University of California, Berkeley, CA.

[29] Saks, M.J. (1998) 'Merlin and Solomon: Lessons from the Law's Formative Encounters with Forensic Identification Science', *Hastings Law Journal* 49(4), 1069–1141.

potentially pernicious effects of observer bias and cognitive contamination due to domain-irrelevant information.[30] These are not only known to present powerful threats to human observation and judgment in general but have now also been demonstrated to provide some of the contributing factors to the conditions in which grave miscarriages of justice may occur.

There are two major principles underpinning classical forensic identification science. The first is the principle of uniqueness, summed up in the phrase 'Nature never repeats itself', which is almost invariably—but as far as I have been able to establish with little justification[31]—attributed to the Belgian astronomer and social statistician Quetelet, and is echoed in claims like 'All fingerprints/ears/voices are unique'. The second is the principle of individualization, which says that every trace can be related to a unique source.

The main problem here lies in the second of these assumptions. While the first principle, that every object is unique, is an unproved assumption which—in a philosophical but forensically trivial sense—is both necessarily logically true and impossible to prove, it is the second principle that is largely responsible for the methodological problems surrounding forensic identification science. The proper question to ask is not if all physical traces are unique and therefore theoretically capable of being uniquely identified with a particular source but whether they can always be so identified in the forensic context and using the methods and procedures employed by the forensic scientist. That is also, or rather should be, the central question in the currently raging fingerprint debate. What the traditional individualization procedure entails is formulated by Huber as follows:

'When any two items have characteristics in common of such number and significance as to preclude their simultaneous occurrence by chance, and there are no inexplicable differences, then it may be concluded that they are the same, or from the same source.'[32]

The problem here of course lies in the basis on which chance occurrence of shared features can be excluded and differences can be deemed to be explicable. This requires reference to an indefinitely large set of alternative potential sources whose size cannot normally be defined with any precision and whose feature composition is not really very well known. A more authoritative handbook of forensic science describes the process as follows, invoking the distinction between class characteristics and individual characteristics that is commonly made in the forensic identification context:

'Class characteristics are general characteristics that separate a group of objects from a universe of diverse objects. In a comparison process, class characteristics serve the very useful purpose of screening a large number of items by eliminating from consideration those items that do not share the characteristics common to all the members of that group. Class characteristics do not, and cannot establish uniqueness.
Individual characteristics, on the other hand, are those exceptional characteristics that may establish the uniqueness of an object. It should be recognized that an individual characteristic, taken in isolation, might not in itself be unique. The uniqueness of an object may be established by an ensemble of individual characteristics. A scratch on the surface of a bullet, for example, is not a unique event; it is the arrangement of the scratches on the bullet that mark it as unique.'[33]

While this sounds plausible, there is still a major logical problem. The definition of individual characteristics is essentially circular. Individual characteristics are defined as characteristics that are—frequently in combination—capable of establishing uniqueness. But uniqueness is defined by an ensemble of individual characteristics. Whether characteristics—either by themselves or collectively—are unique is an inductive question, which raises the classical induction problem: we can never be sure that all swans are white as long as we have not seen all swans. Similarly, we can never be sure that a feature or combination of features is unique, until we have observed all relevant objects.

What practitioners of traditional forensic identification sciences really do is perhaps best described by Stoney, who used the image of the 'leap of faith' as the mechanism whereby the forensic scientist actually establishes individualization:

'When more and more corresponding features are found between the two patterns scientist and lay person alike become subjectively certain that the patterns could not possibly be duplicated by chance. What has happened here is somewhat analogous to a **leap of faith**.[34] It is a jump, an extrapolation, based on the observation of highly variable traits among a few characteristics, and then considering the case of many characteristics. [] In fingerprint work, we become subjectively convinced of identity; we **do not prove it**.'

Dactyloscopists, and all other traditional forensic identification scientist are ultimately making a subjective decision in reaching a categorical decision about the identity of

[30] Saks et al. *op. cit*.

[31] I have been unable to find it, i.e., its French equivalent) in the source that is most frequently given, i.e., Quételet, Ad. (1870) *Anthropométrie ou Mesure des Différentes Facultés de l'Homme*, Muquardt: Bruxelles.

[32] Huber, R.A. (1959–1960) 'Expert Witnesses', *Criminal Law Quarterly* 2, 276–296.

[33] Thornton, J.I. & Peterson, J.L. (2002) 'The General Assumptions and Rationale of Forensic Identification' § 24–2.0–2.1, in D.L. Faigman, D.H. Kaye, M.J. Saks & J. Sanders (red.) *Modern Scientific Evidence: The Law and Science of Expert Testimony*, West Publishing Co.: St. Paul, MINN.

[34] Bold type APAB.

source of two traces. They become convinced that the unknown trace and the reference material have the same origin. But there is no logical basis for this type of conclusion, as Tuthill points out:

'At the present time, in most jurisdictions, an opinion of certainty is the only acceptable opinion when dealing with the individualization of a fingerprint impression. This is not a rule that has been laid down by the courts (who will deal with any opinion offered) but rather by the fingerprint examiners. There is no scientific basis for the rule. It is simply one of the aberrations that have developed within the discipline of fingerprint identification.'[35]

Quantification of the frequency of the characteristics involved is often difficult but even if it is possible—as again pre-eminently in the case of nuclear DNA typing—and no matter how infrequent we estimate the combined occurrence of the characteristics to be, it will not allow us to individualize, as Stoney so aptly expressed in the title of his 1991 paper, 'What made us ever think we could individualize using statistics?[36] The estimated frequency of the profile of the crime scene sample and that of the reference sample of the suspect may be vanishingly small, there is still no logical basis on which the forensic scientist could pronounce them to have the same origin. DNA characteristics are essentially class characteristics, which, as Thornton & Peterson put it '... do not, and cannot establish uniqueness'.[37]

6. Rules of expert evidence

Traditionally of course expert evidence in common law systems is subject to four exclusion rules: the common knowledge rule, the field of expertise rule, the ultimate issue rule and the basis rule. These rules can be seen to also play at least an implicit role in defining expert evidence in Continental systems. However, while expert evidence in the United States may be said to be subject to a form of entrance examination or input control, with the judge acting as gatekeeper for the jury, the Dutch legal system may be said to operate an exit check or use a form of output control. In general, Continental style judges are free to accept or reject evidence, and to assess and evaluate it as they see fit, as long as such decisions are duly motivated. As a result, the need to rely on guidelines by means of which the question of the admissibility of evidence can be resolved—of which the Frye test, the Federal Rules of Evidence and the Daubert ruling are examples in the US context—has clearly traditionally been less strongly felt in the continental European systems, especially those using professional judges rather than juries. However, in recent years, the Dutch Supreme Court has made several important decisions on the reliability of expert evidence of which the most important is the Shoemaker ('stick to thy last' opinion) decision.[38] The Supreme Court ruled that the expert testimony of an orthopedic shoemaker who identified footwear marks found at a crime scene as originating from the suspect's shoes should not have been used as evidence by the appellate court because the court had failed to motivate why it used the expert evidence even though its validity was questioned by the defence. The Supreme Court ruled that if expert evidence is challenged it can only be used by a court if the court indicates (Table 3):

Table 3
The shoemaker criteria

1. What is the profession, the education and experience of the expert?
2. Does the expertise relate to the subject on which the expert is giving an opinion?
3. What method did the expert use?
4. What is the reliability (validity) of the method used?
5. Was the expert able to apply the method in a competent fashion?

An important milestone in this context in the United States is the so-called Daubert decision from 1993. In this civil case, the presiding judge laid down a number of criteria for scientific evidence to meet if it is to be submitted to the jury (Table 4).

It appears that the position in the UK is vastly different form that in the United States or Canada. Ormerod (2002: 774) describes the situation as follows:

'English law admits novel scientific techniques as the basis of expert opinion without any special scrutiny. The attitude is that there are "no closed categories where evidence may be placed before a jury" and that "it would be entirely wrong to deny to the law of evidence the advantages to be gained from new techniques and new advances in science".[39] The lack of regulation governing admissibility in England and Wales is in stark contrast to the position in the USA where the much-discussed Daubert-criteria require judges to consider the reliability as well as the relevance of the expert evidence. In particular Federal courts are to have regard to [whether the method] has been subjected to peer review, to whether the technique is falsifiable and has published error rates as

[35] Tuthill, H. (1994) *Individualization: Principles and Procedures in Criminalistics*, Lightning Powder Company: Salem, Oregon, p. 61.

[36] Stoney, D.A. (1991a) 'What made us ever think we could individualize using statistics?', *Journal of the Forensic Science Society* 31(2), 197–199.

[37] Thornton, J.I. & Peterson, J.L. (2002) 'The General Assumptions and Rationale of Forensic Identification' § 24–2.0–2.1, in D.L. Faigman, D.H. Kaye, M.J. Saks & J. Sanders (red.) *Modern Scientific Evidence: The Law and Science of Expert Testimony*, West Publishing Co.: St. Paul, MINN.

[38] HR 27 January 1998, *NJ*, 404.

[39] Per Steyn L.J. in *Clarke* (1995) 2 Cr. App. R. 425, 430.

Table 4
The Daubert criteria

1. Is the underlying theory, technique, methodology or reasoning at issue empirically testable and has it been tested?
2. Has the theory been subjected to peer review and publication?
3. What is the known or potential error rate of the technique in question?
4. Are there standards controlling the technique's operation and are these being maintained?
5. Does the method or technique pass the general acceptance test of the relevant scientific community?[40]

regards its validity and reliability, and to whether the data are capable of replication.'[41]

According to Meintjes-van der Walt (2001: 156), in England/Wales, and in South Africa there are 'no reported cases where courts had to decide on the admissibility of novel forms of scientific expertise'.[42] Ormerod (2002: 774) observes that '... it is arguable that recent cases signal a growing judicial unease with the relaxed English approach ...' towards expert evidence, even though it is impossible to confirm a definite move towards any particular test. He even goes on to observe that recent cases '... demonstrate [] that the present position is prone to lead to miscarriages of justice'. Gold (2003: 36) strikes a similar chord: '... the UK law of expert evidence has demonstrated little movement towards modernization. [] Unlike in the United States and Canada, it appears that gatekeeping with regard to reliability is not an aspect of the British judicial role with regard to expert evidence'.[43] Finally, Grant (2002: 121) points out that '[i]n contrast to the American ''Daubert'' approach, the British laws on admissibility recognize the expert rather than the method and while there are obvious difficulties with this, it might sometimes allow the baby in with the bathwater'.[44] If this analysis is correct, it might in fact go some way towards explaining the enormous influence an expert like Sir Roy Meadow may have had[45] in a field where validation of expert evidence is notoriously difficult.

7. Remedies

Although the responsibility for judicial errors traditionally tends to be primarily associated with the police and the prosecution ('Another prosecution blunder in case X'), other players in the criminal justice field including forensic scientists also have a major part to play in improving the administration of criminal justice. Miscarriages of justice, whether they are real or imagined, reflect on the credibility of the entire criminal justice system and may ultimately undermine its very existence. A major question in this context is that of the lack of communication and understanding between the forensic expert on the one hand and the prosecution and the trier of fact, and to a lesser extent, the defence lawyer on the other. There is traditionally a wide gulf separating the natural sciences from the law. As the Dutch legal psychologist Crombag put it, with the increasing importance of expert evidence in criminal as well as civil cases, lawyers can no longer afford to hold empirical science as essentially a terra incognita, an unknown area that they are determined never to set foot on if they can avoid it.[46] Lawyers need experts because they do not possess the required expertise; at the same time it is the lawyer or the trier of fact who ultimately has to judge the competence of the expert and the weight of the expert evidence by actively seeking to establish its validity and reliability.

A prominent Dutch defense lawyer and professor of law in the university of Utrecht, Dr. Knoops, has argued that the criteria for granting revision of a judicial decision or a retrial should be brought in line, or synchronized as he put it, with the rapid advances made in forensic science.[47] Under current Dutch law, revision is only possible if, after the final verdict, a so called novum emerges, i.e., a new circumstance of a factual nature which gives rise to the grave presumption that, had this fact it had been known to the trier of fact at the time of the trial, this would have led to the acquittal of the suspect. Knoops adduces three arguments in support of his proposal. He first observes that in countries like the United States and Canada the truth of the maxim that 'a fair trial does not always guarantee a safe verdict' has been more than convincingly demonstrated by the scores of cases in which post-conviction DNA testing has exonerated innocent suspects. Knoops' second and third arguments, the possibility of forensic error and the danger of prosecutorial bias in forensic expertise are also of such grave concern that careful consideration of his proposal seems warranted.

At present, under Dutch law, a revised expert opinion does not qualify as a novum. This is somewhat difficult to

[40] Daubert v. Merrell Dow Pharmaceuticals Inc. (113 S. Ct. 2786 1993).

[41] Ormerod, D. (2002) 'Sounding Out Expert Voice Identification', *Criminal Law Review*, 771–790.

[42] She does mention two apparent exceptions, both in South Africa; the last of which dates from 1986 and relates to the admissabliltyof identification procedures involving scent dogs.

[43] Gold, A.D. (2003) *Expert Evidence in Criminal Law: the Scientific Approach*, Irwin Law: Toronto.

[44] Grant, T. (2002) 'Review of Donald Foster (2001) Author Unknown: On the Trail of Anonymous, 2nd edition, London: Macmillan', *Forensic Linguistics* 9(1), 119–121.

[45] As in the Sally Clark case referred to above.

[46] Crombag, H.F.M. (2000) 'Rechters en deskundigen', *Nederlands Juristenblad* 33, 1659–1665.

[47] Knoops, G.G.J. (2002) 'De Puttense moordzaak: herzieningsrechtelijke implicaties van de voortschrijdende forensische expertise', *Nederlands Juristenblad* 29, 1402–1407.

reconcile with the prevailing view today in which all scientific knowledge is conceived of as inherently non-final or provisional in nature: it is presumed to be valid only for as long as and inasmuch as it has not been proved otherwise. This means that the possibility that conclusions need to be revised in the light of advancing knowledge is always open. In the forensic context, this means that advances in forensic techniques may produce results which may modify or contradict earlier results and make it necessary to revise earlier conclusions in old cases. Knoops proposal in response to this dilemma, the institution of a special Revision Chamber, composed not only of experienced lawyers but also of experts from the forensic sciences, is certainly worthy of serious consideration. In a similar vein, Gold (2003: 231–237) proposes three changes to ensure the reliability and validity of expert evidence. They are: (1) the use of scientific methodology as a litmus test for expert evidence, (2) the use of science as a criterion for scientific evidence, and (3) the use of a court-appointed scientist in the role of devil's advocate to examine and critique expert evidence to be presented by parties.

8. Conclusion

Forensic science is going through a period of considerable turmoil. What were long held to be incontestable forensic disciplines like dactyloscopy and handwriting expertise are increasingly being required to meet the same standards of scientific procedure as DNA evidence, even though DNA profiling in its present forensic application essentially amounts to a classification not an individualization process. While judges in countries like the USA are becoming more critical of forensic identification expertise, they will frequently still tend to plump for what might be termed the 'split the baby approach', whereby rather than throwing out the expert evidence altogether, the judge allows the expert to discuss similarities and differences but not to pronounce upon the ultimate issue, i.e., the source of the trace material. The criticism is beginning to produce fresh research efforts aimed at improving forensic identification methods, which are frequently undertaken in an international context. Harmonization of methods and techniques, as well as quality control is high on the forensic agenda. A relatively new development is the growing awareness of the danger of cognitive contamination or observer effects in traditional forensic identification disciplines like dactyloscopy, handwriting comparison and firearm examination and the need for blind testing in these areas.[48]

To conclude on a positive note, the critical scrutiny of traditional forensic science procedure is likely to lead to an improved understanding of the nature of scientific evidence which can eventually only strengthen its position. Despite or better precisely because of the current critical climate forensic science is bound to play an increasingly important role in the various national criminal justice systems as well as in those associated with the diverse international courts and tribunals.

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[48] Saks, M.J., Risinger, D.M., Rosenthal, R. & Thompson, W.C. (2003) 'Context effects in forensic science: A review and application of the science of science to crime laboratory practice in the United States', *Science & Justice* 43(2), 77–90.