

Australian Academies of Science and Law

joint meeting

scientific evidence in Australian courts

David Balding
Melbourne Integrative Genomics,
School of BioSciences and School of Maths & Stats



THE UNIVERSITY OF
MELBOURNE

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Where I'm coming from

- ▶ Degrees in Mathematics from Newcastle (NSW) and Oxford (UK)
- ▶ Research on evaluation of DNA profile evidence
- ▶ Expert witness work: 25+ years, 100s of cases
 - ▶ mostly UK, some USA, Australia and other countries
 - ▶ mostly criminal cases, some civil
 - ▶ criminal cases: roughly equal prosecution/defence
 - ▶ mostly DNA evidence, some drug valuation, crash injury epidemiology, intellectual property, financial fraud, construction negligence, shaken baby, serial offenders.
- ▶ Scientific adviser to the Board of the UK Forensic Science Service
- ▶ Member of DNA Specialist Group advising UK Forensic Regulator.

2009 US National Research Council report on forensic science

Serious deficiencies in:

- ▶ research to validate ...
- ▶ assessment of limitations, and
- ▶ sources and magnitude of error

With the exception of DNA analysis,

no forensic method has been rigorously shown to [be reliable]

- ▶ Many false convictions from expert testimony that “matches” hair/bullets/shoe prints from a crime scene.
- ▶ Hair analysis: FBI examiners gave scientifically invalid testimony in > 95% of 3,000 criminal convictions studied.
- ▶ “claims of accuracy ... cloaked in ... scientific respectability ... never ... subjected to meaningful scientific scrutiny”
- ▶ “miscarriages of justice ... are systemic and pervasive”

- ▶ examiners cannot consistently identify a human bitemark nor its source
- ▶ unlikely that the method could ever become scientifically valid.

Yet bitemark analysis has supported many prosecutions

- ▶ qualified forensic dentists, members of professional societies
- ▶ accepted by courts over decades
- ▶ eventually, many exonerations
 - ▶ one after 25 years in jail
 - ▶ one **the day before execution.**

Fingerprint evidence



- ▶ Galton provided solid support around 1890, match probability $\approx 10^{-36}$,
- ▶ ignored as the infallibility myth of fingerprint evidence took hold.
- ▶ Uniqueness of fingerprints is of little value – **quality of the mark**.
- ▶ Major errors in Madrid bombing and other cases.

Australian miscarriages of justice due to errors in forensic science

- ▶ Chamberlain (dingo baby) case (NT 1982)
- ▶ Jama (Melbourne, 2008) – wrongful conviction due to DNA contamination.
- ▶ Eastman case (ACT)
 - ▶ 1995 trial: convicted of murdering AFP assistant commissioner
 - ▶ gunshot residue from car boot a “precise match”
 - ▶ Judge: “... one of the most skilled ... forensic investigations in Australia”
 - ▶ 2014 appeal: conviction quashed; flaws in the gunshot residue evidence
 - ▶ 2018 retrial: not guilty, gunshot residue evidence not used

Why haven't the courts demanded good science?

- ▶ Lack of awareness; impressed by positive image of science
- ▶ Fear of getting "out of depth" in technical discussions
- ▶ A tradition of respect for the authority of an expert, especially medical expertise.

Why didn't forensic science self-correct?

- ▶ Exploratory use of new techniques useful for investigations
- ▶ Initial caution abandoned after some "success"
- ▶ Police/governments want cost-reduction and results
 - ▶ don't prioritise good scientific culture.

A more critical scientific culture has evolved

- ▶ DNA evidence attracted scrutiny from scientists outside forensic arena
- ▶ then similar questions asked of other forensic disciplines.

Are we making progress? UK and US experience

UK:

- ▶ Forensic Science Regulator (since 2008)
 - ▶ big improvements in standards and testing.
- ▶ Lord Chief Justice 2014 Practice Direction on Expert Evidence
 - ▶ prompted by concern about the use of unreliable expert evidence
 - ▶ first criterion: extent and quality of [validation] data.

USA:

- ▶ *Daubert* replacing *Frye* admissibility hearings
- ▶ 2013 – 17: National Commission on Forensic Science
- ▶ 2017: federal appeal court found error in admitting fingerprint evidence
- ▶ 2019: federal judge restricted the use of ballistics evidence
 - ▶ citing lack of error rate information and standards.

What about Australia?

Australian judges have little “gatekeeper” role.

- ▶ Challenges to scientific evidence must be made in front of jurors.
- ▶ Courts have limited access to scientific knowledge and advice.
- ▶ No court asked a fingerprint expert to show the method works until 2015.

Victoria: Forensic Evidence Working Group

- ▶ 2014 Practice Note “Expert Evidence in Criminal Trials”

National Institute of Forensic Science (Aust + NZ)

- ▶ Co-ordination, innovation, education, certification.
- ▶ Complex history, limited independence from police, limited budget.

Can courts assess reliability?

Are pre-trial hearings effective?

- ▶ Reliability is difficult to assess.
- ▶ Defences can sow obfuscation – easy to cast doubt.

What really matters is:

evidence evaluation that is fair and comprehensible to courts

Fairness requires:

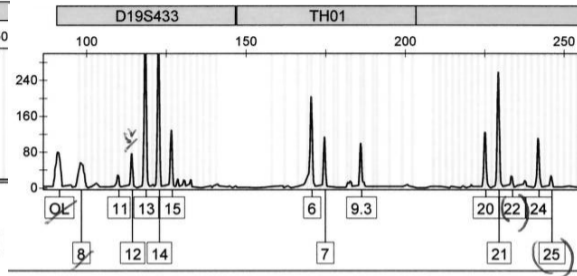
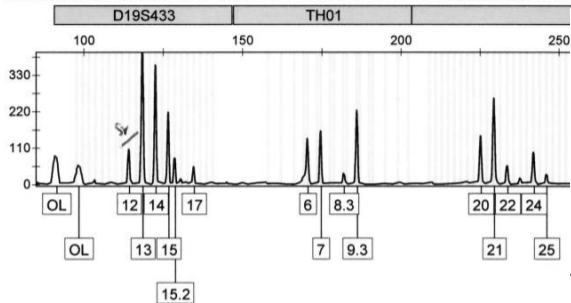
- ▶ Assessments of sources of uncertainty
- ▶ Openness to scrutiny by a wide public.

The identification of the skeleton of King Richard III

Type of evidence	Likelihood ratio
Radiocarbon dating	1.8
Age at death and sex	5.3
Scoliosis	210
Head wounds	40
Y chromosome (paternal lineage) DNA	0.16
mitochondrial (maternal lineage) DNA	480
isotope analysis	1
hair and eye colour genetics	1
Product	6.7 million



Complex DNA profiles from mixed, degraded, minuscule samples



Replicate (part-)profiles of swab from magazine of a gun

- ▶ noisy, hard to replicate, contaminated by environmental DNA, but much more informative than e.g. blood group or eyewitness evidence, given
- ▶ computation of weight-of-evidence accounting for sources of error.

Insights from quantifying the value of evidence

Crime-scene DNA is alleged to come from Mr Q

DNA evidence leads to likelihood ratio = 1 million

Insights from quantifying the value of evidence

Crime-scene DNA is alleged to come from Mr Q

DNA evidence leads to likelihood ratio = 1 million

- ▶ 10 million possible sources of the DNA:

1 in 10 million \Rightarrow 10% probability it's Q

- ▶ 1,000 possible sources of the DNA:

1 in 1,000 \Rightarrow 99.9% it's Q.

NB relatives of Q ignored here.

Insights from quantifying the value of evidence

Consider

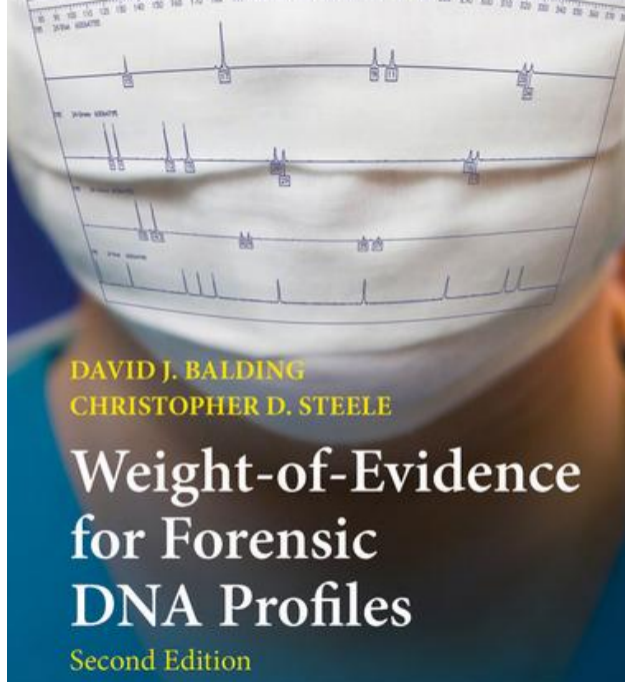
- ▶ LR = **200 million** comparing accused Q with unrelated man U.
- ▶ the CSP is **150 thousand** comparing Q's brother B with U.

Question: Can a court safely convict Q given strong evidence implicating B?

Answer:

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DAVID J. BALDING
CHRISTOPHER D. STEELE

Weight-of-Evidence for Forensic DNA Profiles

Second Edition