The response to *R v T*.
Can forensic acoustics play a leading rôle in a new wave of adoption of the likelihood-ratio framework?

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Acknowledgment of Funding

- Research supported by the Australian Research Council, Australian Federal Police, New South Wales Police, Queensland Police, National Institute of Forensic Science, Australasian Speech Science and Technology Association, and the Guardia Civil through Linkage Project LP100200142. Unless otherwise explicitly attributed, the opinions expressed are those of the authors and do not necessarily represent the policies or opinions of any of the above mentioned organizations.

The appeal

- England and Wales Court of Appeal
  - *R v T* [2010] EWCA Crim 2439.
    http://www.bailii.org/ew/cases/EWCA/Crim/2010/2439.pdf

- Footwear-mark comparison

- Subjective estimation and expression of a likelihood ratio
  - sole pattern
  - size of shoe
  - wear
  - damage

- "'the Bayesian approach' of using likelihood ratios" had been applied but "this had not been explored in the course of the trial."

The appeal - The ruling

- The Court heard from a number of experts on the evaluation of forensic evidence including the UK Forensic Science Regulator

- **Experts:**
  - explained why the likelihood-ratio framework is the logically correct framework for the evaluation of evidence
  - "not logical to adopt the position that the Bayesian or likelihood ratio approach could be used in some areas, but not in others"

- **Court:**
  - "We do not agree with the observations of the Regulator that a similar approach is justified in all areas of forensic expertise. Each area requires a separate analysis because of the differences that there are in the nature of the underlying data."

The ruling

- **Court:**
  - "outside the field of DNA (and possibly other areas where there is a firm statistical base), this court has made it clear that Bayes theorem and likelihood ratios should not be used."
  - "If there were a sufficient database . . . an expert can give an opinion using a statistical database by simply using that database and expressing an opinion by reference to it, without recourse to the type of mathematical formula used in this case or to any form of Bayes theorem."
  - "the fact that there is no reliable statistical basis does not mean a court cannot admit an evaluative opinion. . . . However no likelihood ratios or other mathematical formula should be used in reaching that judgement"

The Court's misunderstandings

- The Court's ruling was based on a number of **misunderstandings** of
  - the likelihood-ratio framework
  - statistics

- The Court's arguments are based on the mistaken belief that objective measurements, databases, and statistical models are necessary to calculate likelihood ratios

- The likelihood-ratio framework is a **logical** framework and should be applied irrespective of the data type
  - objective measurements, databases, and statistical models
  - experience-based subjective opinions

The Court's misunderstandings

- The Court commits the ***prosecutor's fallacy***

  – $p(H_p|E)/p(H_d/E)$ substituted for $p(E|H_p)/p(E|H_d)$

  – "In the present case it was expressed as the probability that the Nike trainers owned by the appellant had made the marks discovered at the scene divided by the probability that the Nike trainers had not made the marks."

The Court's misunderstandings

- The Court implied that statistical models cannot be used to calculate likelihood ratios for continuously valued data with intrinsic variability

  – "the data on footwear distribution and use is quite unlike DNA. A person's DNA does not change and a solid statistical base has been developed which enable accurate figures to be produced. . . . the data for footwear sole patterns is a small proportion of what is in use and changes rapidly."

- The Court does not understand statistical sampling

- The Court does not understand the meaning of validity and reliability in statistics and science in general

The scope of the ruling

- The Court states that the ruling only applies to footwear-mark comparison
- The Crown Prosecution Service is of the same opinion
- This is based on the mistaken belief that it is logical to apply the likelihood-ratio framework in some areas of forensic science but not in others
- There is nothing to prevent lawyers from making the same arguments with respect to other branches of forensic science
- There is nothing to prevent lawyers from making the same arguments in other jurisdictions

The response

- 31 leading forensic scientists from around the world signed a statement affirming their belief that the likelihood-ratio framework is **the** logically correct framework for the evaluation of evidence

  – Evett I.W. et al. (2011). “Expressing evaluative opinions: A position statement,” *Science & Justice* 52, 1–2. doi:10.1016/j.scijus.2011.01.002

- Endorsed by the European Network of Forensic Science Institutes (ENFSI)
  – 58 laboratories in 33 countries

The response

- Refereed-journal publications (forensic science and law)

- Berger C.E.H., Buckleton J., Champod C., Evett I.W, Jackson G. (2011). “Evidence evaluation: A response to the Court of Appeal judgment in R v T,” *Science & Justice* 51, 43–49. doi:10.1016/j.scijus.2011.03.005

- Robertson B., Vignaux G.A., Berger C.E.H. (2011) “Extending the Confusion About Bayes,” *Modern Law Review* 74, 430–455.

- Redmayne M., Roberts P., Aitken C.G.G., Jackson G., (2011). “Forensic Science Evidence in Question,” *Criminal Law Review* 5, 347–356.

- Facey O.E., Davis R.J. (2011). “Re: Expressing Evaluative Opinions; A Position Statement,” *Science & Justice* 51, xxx–xxx. doi:10.1016/j.scijus.2011.06.001

- Fenton N. (2011). “Improving statistical estimates used in the courtroom,” *Nature*, 3 November.

- Morrison G S. (2012). “The likelihood-ratio framework and forensic evidence in court: A response to R v T,” *International Journal of Evidence and Proof* 16, xxx–xxx.

The response

- Popular press

- Saini A. (2011). “A formula for justice,” *The Guardian* 3 October, p 12.

The response

- Multidisciplinary Research Network
  - lawyers and forensic scientists
  - over 60 members from around the world
  - https://sites.google.com/site/bayeslegal/

The response

- Multidisciplinary Research Network

- aim is to ensure that within 10 years the following are common practice:

3. Expert witnesses and lawyers know the difference between the assumptions (which will generally be disputed) and the probability laws and calculations (which should be agreed) that determine the conclusions arising from the various assumptions. . . .

5. Likelihood ratios (or some suitable graphical/verbal equivalent representation) are used as a standard means for stating the value of evidence (individually and in combination).

A new wave - forensic acoustics

- Is the response so far the beginning of a new wave of adoption of the likelihood-ratio framework?

  – last wave was DNA in the mid 1990s

  – Foreman L.A., Champod C., Evett I.W., Lambert J.A., Pope S. (2003). “Interpreting DNA evidence: A review,” *International Statistics Journal* 71, 473–473. http://projecteuclid.org/euclid.isr/1066768703

A new wave - forensic acoustics

- Can forensic acoustics play a leading rôle in the new wave of adoption of the likelihood-ratio framework?

- Forensic voice comparison has been performed in the likelihood-ratio framework since the late 1990s

– Meuwly D., El-Maliki M., Drygajlo A. (1998). “Forensic speaker recognition using Gaussian mixture models and a Bayesian framework,” *Proceedings of the COST-250 Workshop, Ankara, Turkey*.

– Champod C., Meuwly D. (2000). “The inference of identity in forensic speaker recognition,” *Speech Communication* 31, 193–203. doi:10.1016/S0167-6393(99)00078-3

– Rose P. (2002). *Forensic Speaker Identification*. London, UK: Taylor and Francis.

– Morrison G.S. (2009). “Forensic voice comparison and the paradigm shift,” *Science & Justice* 49, 298–308. doi:10.1016/j.scijus.2009.09.002

A new wave - forensic acoustics

- Can forensic acoustics play a leading rôle in the new wave of adoption of the likelihood-ratio framework?

- Forensic voice comparison makes use of databases, objective measurements, and statistical models
  – data structure which is more similar to most other branches of forensic science than is DNA data

– Morrison G.S. (2011). “A comparison of procedures for the calculation of forensic likelihood ratios from acoustic-phonetic data: Multvariate kernel density (MVKD) versus Gaussian mixture model– universal background model (GMM-UBM),” *Speech Communication* 53, 242–256. doi:10.1016/j.specom.2010.09.005

– Morrison G.S., Rose P., Zhang C. (2012). “Protocol for the collection of databases of recordings for forensic-voice-comparison research and practice,” *Australian Journal of Forensic Sciences* 44, xxx–xxx.

A new wave - forensic acoustics

- Can forensic acoustics play a leading rôle in the new wave of adoption of the likelihood-ratio framework?

- Appropriate metrics of the validity and reliability of forensic voice comparison systems have been developed in forensic voice comparison

  – Morrison G.S. (2011). “Measuring the validity and reliability of forensic likelihood-ratio systems,” *Science & Justice* 51, 91–98. doi:10.1016/j.scijus.2011.03.002

Conclusion

- The appeal ruling in *R v T* is based on a number of misunderstandings about the likelihood-ratio framework and about statistics.

  – its arguments and conclusions are fallacious

- There has been a vociferous response from the forensic-sceince community.

- Does the response so far represent the beginning of a new wave of adoption of the likelihood-ratio framework?

- Can forensic acoustics play a leading rôle in the new wave of adoption of the likelihood-ratio framework?

Thank You