Probabilities, decision making and individualization

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Impression and Pattern Evidence Symposium, Clearwater, FL
August 2-5, 2010

ENFSI Proficiency test: Footwear marks 2009

Proficiency test: Footwear marks 2009

Logical framework for evaluative evidence

If we can get the logic right - then this helps us to maintain balance
Footwear mark on curtain

Expert A: concluded to an ID

> Based on the questionable assumption that the defects observed on the sole are acquired

Question 1

Do I expect to observe the features at hand if this sole has made this mark?

Judgment based on the knowledge of how marks are left by soles

Accounting for the time between offence and seizure

Given the elapsed time, the nature of the substrate and of the deposit, the tolerances due to distortion, the features that I have observed on both the mark and the print correspond to my expectations if the mark and the print have a common source
Question 2

What is the probability that the crime mark would match the defendant’s shoe if some unknown sole had left it?

In my opinion, given the nature and quality of the features, the probability of these observations on another unknown sole is extremely low. I consider this as a practical impossibility.

Q1 – What is the probability that the crime mark would match the defendant’s sole if it had left it?

Either: the defendant’s shoe left the mark
Or: some unknown shoe left the mark

Q2 - What is the probability that the crime mark would match the defendant’s sole if some unknown sole had left it?

The term “match” means here that the features observed on the mark and on the print/sole falls within acceptable tolerances – it summarizes the observations made on the mark and the known material. It does not imply a conclusion of individualization.

Summary of questions to be addressed

That is essentially the concept of a LR

Likelihood ratio

Q1 - Probability of the evidence given the prosecution proposition

= Between 0.5 and 1

Q2 - Probability of the evidence given the defence proposition

Well below $10^{-9}$

Logical interpretation is based on the concept of the likelihood ratio: the magnitude of this implies support for one or other of the propositions which the scientist has considered.

LR greater than one means support for the prosecution proposition

LR less than one means support for the defence proposition
Somewhat recognized in the NRC report

> NRC (2009) p. 186: Publications such as Evett et al., Aitken and Taroni, and Evett provide the essential building blocks for the proper assessment and communication of forensic findings.

Identification process: decision

1. Implicitely assigns prior probability
2. Assesses the weight of the evidence
3. Obtains the posterior probability
4. Makes a decision according to an implicit utility function

We can argue that only 2) should be the remit of the forensic scientist and that steps 1), 3) and 4) are the duty of the court.
1.3. Which sole left the mark?

2. Footwear mark Evidence (LR)

Utility (costs/benefits)

4. Decision

Expert A: ID

A priori, the chances for this sole being at the source are very low (10 billion to 1 against)

Expert A: ID

After the evidence (a posteriori), the probability that Doe’s sole is the source of the mark is high: 99.99%

LR = 10^{14}

To individualize, we talk about a likelihood ratio of the order of 10^{14} or more

By analogy... the expert claims he can distinguish every millimeter from the Sun to Pluton...

“The concept of “individualisation,” which lies at the core of numerous forensic science subfields, exists only in a metaphysical or rhetorical sense.” Saks & Koehler, 2008
Expert B: level 2

Either: the defendant’s shoe left the mark
Or: some unknown shoe left the latent mark

Q1 – What is the probability that the crime mark would match the defendant’s sole if it had left it?

Expert B: level 2

"Earth population paradigm"

LR = 6000

A priori, the chances for this sole being at the source are very low (10 billion to 1 against)

After searching a database of 6000 sole designs (coming from people suspected of burglary), the general design observed on the mark had not been found.

After the evidence (a posteriori): the probability that an unknown sole is the source is still very high: 99.9999%
The ENFSI SP/TM WG trick

Before the evidence (a priori):

A priori set to 1:1 (50:50), it is claimed to be “fair and neutral”.


We have moved from the Earth population to two soles!

The ENFSI SP/TM WG scale

These two scales do not follow the same logic:

> Level 1 (ID) and 6 (EXCL) needs more than a likelihood ratio!
> Levels 2, 3, and 5 need to set prior odds of 1:1
> Level 4 (inconclusive) amounts to a likelihood ratio of 1

Proficiency test: Footwear marks 2009

After the evidence (a posteriori): The probability that Doe’s sole is the source is 99.98%, hence the conclusion that it is very likely that the mark has been left by this sole.
Terminology

> The NRC report stresses upon the need for standardised terms to report evidence
> Rightfully alarmed by terms such as:
  > Consistent with
  > Could have come from
  > Match, identical
  > Cannot be excluded

> It refers to the efforts made in the areas of document examination (ASTM standard) and footwear, but...

Terminology

> It should based on sound logical principles

Unfortunately, the reporting scales currently proposed by document examiners, footwear mark examiners, firearms/toolmarks examiners do not stand scientific scrutiny.

Essentially, the proposed terms (probable, very probable, etc.) are examples of ‘transposing the conditional’ and they should be avoided in any reporting practices.

Summary on the ID process

<table>
<thead>
<tr>
<th>Framework (priors)</th>
<th>Evidence</th>
<th>Update (posteriors)</th>
<th>Decision on the ID or Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth population paradigm Or 1:1 priors Case based? Duty of the court</td>
<td>Two generic questions forming a likelihood ratio Duty of the forensic scientist</td>
<td>Require both the priors and the evidence Duty of the court unless instructed otherwise Based on the posterior probabilities and an utility function</td>
<td>Duty of the court</td>
</tr>
</tbody>
</table>

Conclusion

Once you understand the process,

You will abandon the concept of individualisation

and concentrate only the evidence