Reporting and Presenting LRs

Reporting LRs

As can be seen from the definition of the likelihood ratio

$$\mathsf{LR} = \frac{\mathsf{Pr}(E|H_p)}{\mathsf{Pr}(E|H_d)},$$

- an LR > 1 supports the prosecution hypothesis, meaning that the evidence is more likely if H_p is true than if H_d is true;
- an LR < 1 supports the defense hypothesis;
- an LR = 1 is consistent with the observations being equally likely under the considered hypotheses.

Reporting LRs

The likelihood ratio is usually reported using phrases such as:

"The evidence is . . . more likely if the suspect is the donor of the sample than if someone else is the donor of the sample".

It is important to note that the LR is not an absolute measure of the weight of evidence, but is dependent on the underlying hypotheses.

How to express the LR in terms of a verbal 'equivalent'?

Verbal Scales

A verbal scale for evidence interpretation, applied to the prosecution proposition:

Likelihood Ratio	Verbal Equivalent
$1 < LR \le 10$	Limited support (for H_p)
$10 < LR \le 100$	Moderate support (for H_p)
$100 < LR \le 1000$	Moderately strong support (for H_p)
$1000 < {\sf LR} \le 10000$	Strong support (for H_p)
$10000 < LR \le 1000000$	Very strong support (for H_p)
1000000 < LR	Extremely strong support (for H_p)

The equivalent for H_d is given by taking the reciprocal.

Verbal Scales

The association of words with numbers is subjective and arbitrary.

LR	1	1 - 10	$10 - 10^2$	$10^2 - 10^3$	$10^{3} - 10^{4}$	$10^4 - 10^6$	$> 10^{6}$
Evett & Weir (1998)	—	l		m	S	VS	VS
Evett (2000)	_		m	ms	S	VS	VS
Martire (2015)	_	w or I	m	ms	S	VS	es
Taroni (2016)	n	I	m	S	VS	es	es

Using verbal scales of neutral (n), weak (w), limited (l), moderate (m), moderately strong (ms), strong (s), very strong (vs) and extremely strong (es).

Presenting Evidence

There are a lot of difficult issues that arise in interpreting DNA samples and presenting complex scientific evidence to non-expert judges and juries.

A sufficiently deep understanding of the principles can help an expert witness to make well-informed judgments and find good solutions to the problem of satisfying goals such as clarity, precision and simplicity.

"How forensic evidence is presented is at least as important as what is presented".

"... it is not only what forensic experts say but how they say it that must be considered".

Heuristics and Biases

Valid probabilistic reasoning is not easy, so people often use various tricks, rules of thumb, habits, etc., to reason in daily life. These are called *heuristics*.

Heuristics may suffice for most practical situations, but can lead to systematic errors in probabilistic reasoning (i.e. fallacies).

Bias in Forensic Science

- Attractiveness bias: Attractive criminals get lower sentences.
- *Target/suspect driven bias*: Using a reference profile to resolve drop-outs.
- *Base rate expectation*: Routinely pairing of examiners and reviewers, high verification rates.
- Anchoring: A dice throw influencing sentencing decisions¹.

¹ Playing Dice With Criminal Sentences (Englich et al., 2006).

Reporting and Presenting LRs

Bias in Forensic Science

Cognitive bias (i.e. unintentional bias) affects forensic decisionmaking:

- Biases lead to differences between and within (forensic) experts;
- Bias doesn't necessarily translate into an error in interpretation;
- But cognitive contamination should be avoided just as physical contamination.

This, relatively new, area is often called *cognitive forensics*.

Avoiding Bias

The first step in avoiding cognitive bias is *awareness*: appreciate that it exists, and identify where it resides and affects interpretation, through training and education.

Awareness is necessary, but is insufficient to reduce cognitive bias and contamination: active steps must be taken as mere will power does not control bias.

Several methods have been proposed that can help manage bias sources, such as *Linear Sequential Unmasking*¹.

¹ Strengthening forensic DNA decision making through a better understanding of the influence of cognitive bias (Dror et al., 2017).

Reporting and Presenting LRs

Bias in Forensic Science

What about probabilistic genotyping software?

- Interpretation software can reduce variation in interpretation among examiners.
- It does *not* make interpretation bias free;
- Subjectivity is also involved in software development (and underlying modeling).
- Different software can show LRs varying over 10 logs for the same DNA profiles.