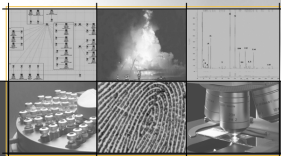


Probabilities, decision making and individualization

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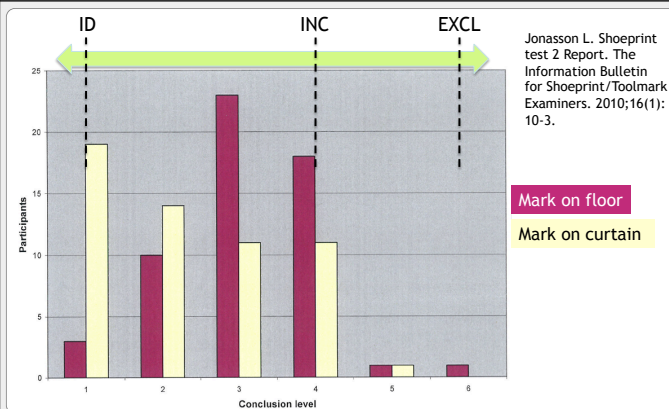
Impression and Pattern Evidence
Symposium, Clearwater, FL
August 2-5, 2010

ENFSI Proficiency test: Footwear marks 2009

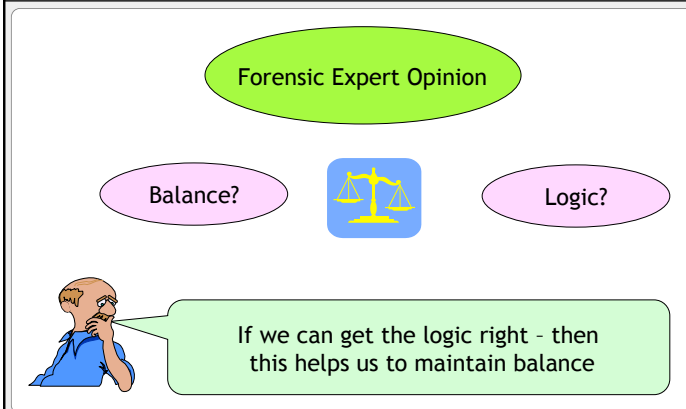
Level	Likelihood ratio	Probability
1	Identification	Identification
2	Very strong support for proposition A Strong support for proposition A	Very probably
3	Moderately strong support for proposition A Moderate support for proposition A Limited support for proposition A	Probably
4	Inconclusive	Inconclusive
5	Limited support for proposition ϕ (ϕ = not A) Moderate support for proposition ϕ Moderately strong support for proposition ϕ Strong support for proposition ϕ Very strong support for proposition ϕ	Inconclusive likely not
6	Elimination	Elimination

Table 1. Conclusion scale

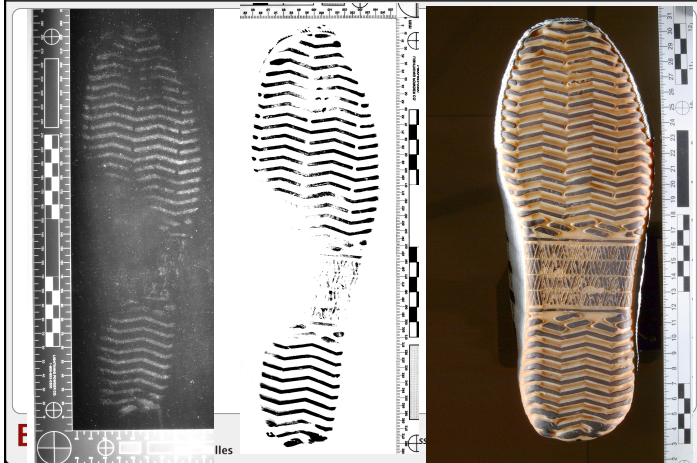
Proficiency test: Footwear marks 2009



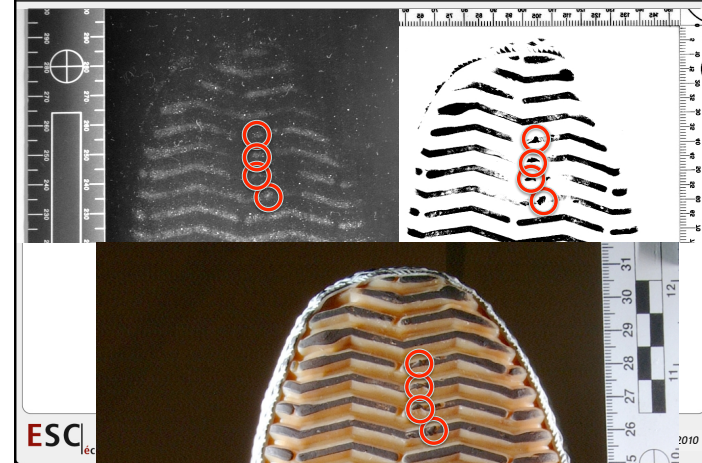
Logical framework for evaluative evidence



Footwear mark on curtain

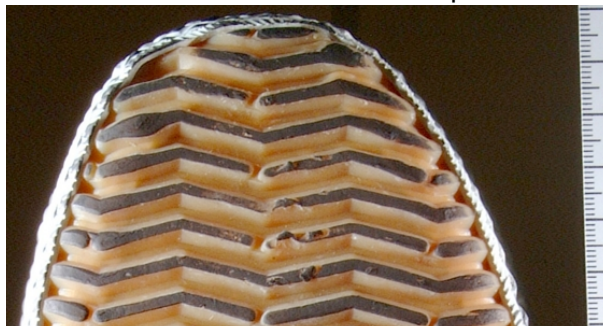


Footwear mark on curtain



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?

Judgment based on the examiner's knowledge of impressions coming from different sources and their features

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.

Summary of questions to be addressed

Either: the defendant's shoe left the mark

Or: some unknown shoe left the mark

Q1 - What is the probability that the crime mark would *match* the defendant's sole if it had left it?

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.*

That is essentially the concept of a LR

Likelihood ratio

Q1 - Probability of the *evidence* given the prosecution proposition

In that case:

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

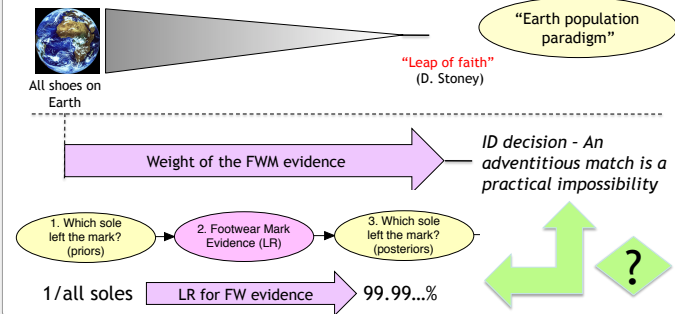


Somewhat recognized in the NRC report

> 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.*

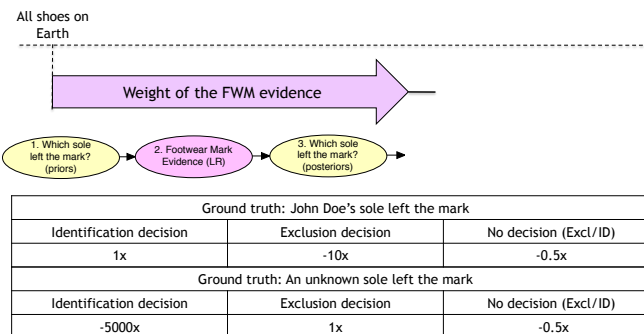
Identification process: probabilities

SWGTHREAD - *Definite conclusion of identity* : This opinion means that the particular shoe or tire made the impression to the exclusion of all other shoes or tires.

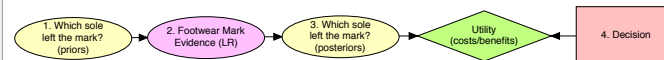


Identification process: Decision

• Biedermann A, Bozza S, Taroni F. Decision theoretic properties of forensic identification: Underlying logic and argumentative implications. *Forensic Sci Int.* 2008;177(2-3):120-32.



What is expert A doing?



1. Implicitly assigns *prior probability*
2. Assesses the *weight of the evidence*
3. Obtains the *posterior probability*
4. Makes an *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.



Probabilistic network

1./3. Which sole left the mark?

2. Footwear mark Evidence (LR)

Utility (costs/benefits)

4. Decision

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Expert A: ID

1./3. Which sole left the mark?

2. Footwear mark Evidence (LR)

Utility (costs/benefits)

4. Decision

1.0E-8 John Doe's sole left the mark
-316.666667 An unknown sole left the mark
100 An unknown sole left the mark
-166650
33.333333 Identification
49.999999 Exclusion
33.333333 No decisions (Excl/ID)
-50
Utility (costs/benefits)

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

“Earth population paradigm”

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Expert A: ID

1./3. Which sole left the mark?

2. Footwear mark Evidence (LR)

Utility (costs/benefits)

4. Decision

99.990001 John Doe's sole left the mark
-316.666667 An unknown sole left the mark
0.009999 An unknown sole left the mark
-166650
33.333333 Identification
49.995000 Exclusion
-999.990011 No decisions (Excl/ID)
33.333333 No decisions (Excl/ID)
-50
Utility (costs/benefits)

The best decision to take is Identification

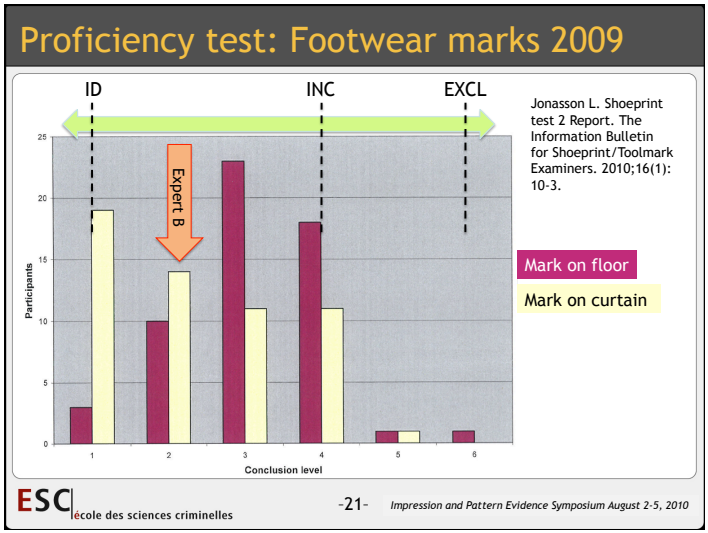
After the evidence (a posteriori), the probability that Doe' sole is the source of the mark is high: 99.99% LR = 10¹⁴

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To individualize, we talk about a **likelihood ratio** of the order of 10¹⁴ 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? **Between 0.5 and 1**

Q2 - What is the probability that the crime mark would *match* the defendant's sole if some unknown sole had left it? **1/6000**

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.

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Expert B: level 2

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

"Earth population paradigm"

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Expert B: level 2

LR = 6000

After the evidence (a posteriori): the probability that an unknown sole is the source is still very high: 99.9999%

"Earth population paradigm"

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The ENFSI SP/TM WG trick

We have moved from the Earth population to two soles!

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

ENFSI Expert Working Group Marks Conclusion Scale Committee, “Conclusion Scale for Shoeprint and Toolmarks Examination”, *Journal of Forensic Identification*, vol. 56, pp. 255-280, 2006.

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The ENFSI SP/TM WG trick

LR = 6000

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.

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The ENFSI SP/TM WG scale

Level	Likelihood ratio	Probability
1	Identification	Identification
2	Very strong support for proposition A	Very probably
3	Strong support for proposition A	Probably
4	Moderately strong support for proposition A	
5	Moderate support for proposition A	
6	Limited support for proposition A	
4	Inconclusive	Inconclusive
5	Limited support for proposition ϕ ($\phi \neq \text{not } A$)	likely not
5	Moderate support for proposition ϕ	
5	Moderately strong support for proposition ϕ	
5	Strong support for proposition ϕ	
5	Very strong support for proposition ϕ	
6	Elimination	Elimination

Table 1. Conclusion 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

ESC École des sciences criminelles -27- *Impression and Pattern Evidence Symposium August 2-5, 2010*

Proficiency test: Footwear marks 2009

Jonasson L. Shoeprint test 2 Report. The Information Bulletin for Shoeprint/Toolmark Examiners. 2010;16(1): 10-3.

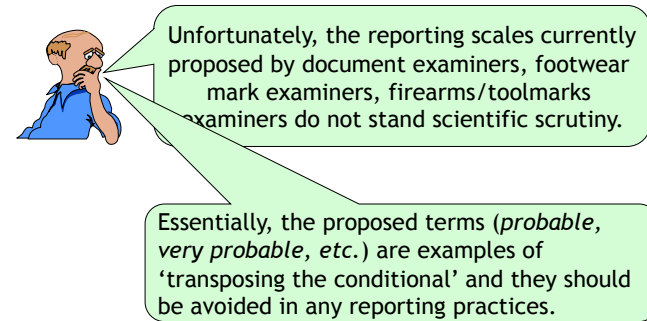
ESC École des sciences criminelles -28- *Impression and Pattern Evidence Symposium August 2-5, 2010*

Terminology

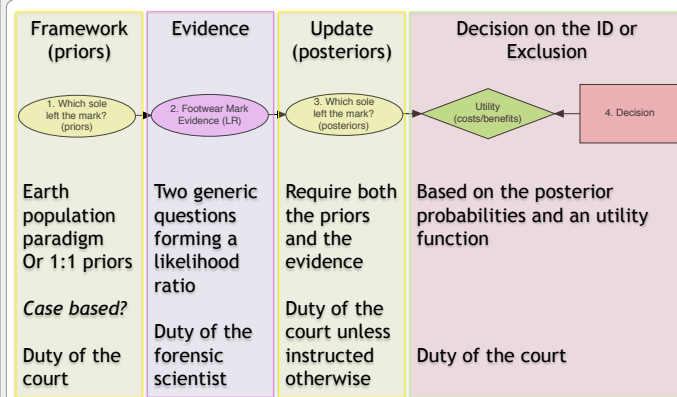
- > The NRC report stresses upon the need for standardised terms to report evidence
 - > Rightfully alarmed by terms such as:
 - > *Consistent with*
 - > *Could have come from*
 - > *Match, identical*
 - > *Cannot be excluded*
- > It refers to the efforts made in the areas of document examination (ASTM standard) and footwear, but...

Terminology

- > It should be based on sound logical principles



Summary on the ID process



Conclusion

