The Real Action at Court Has Always Been Activity

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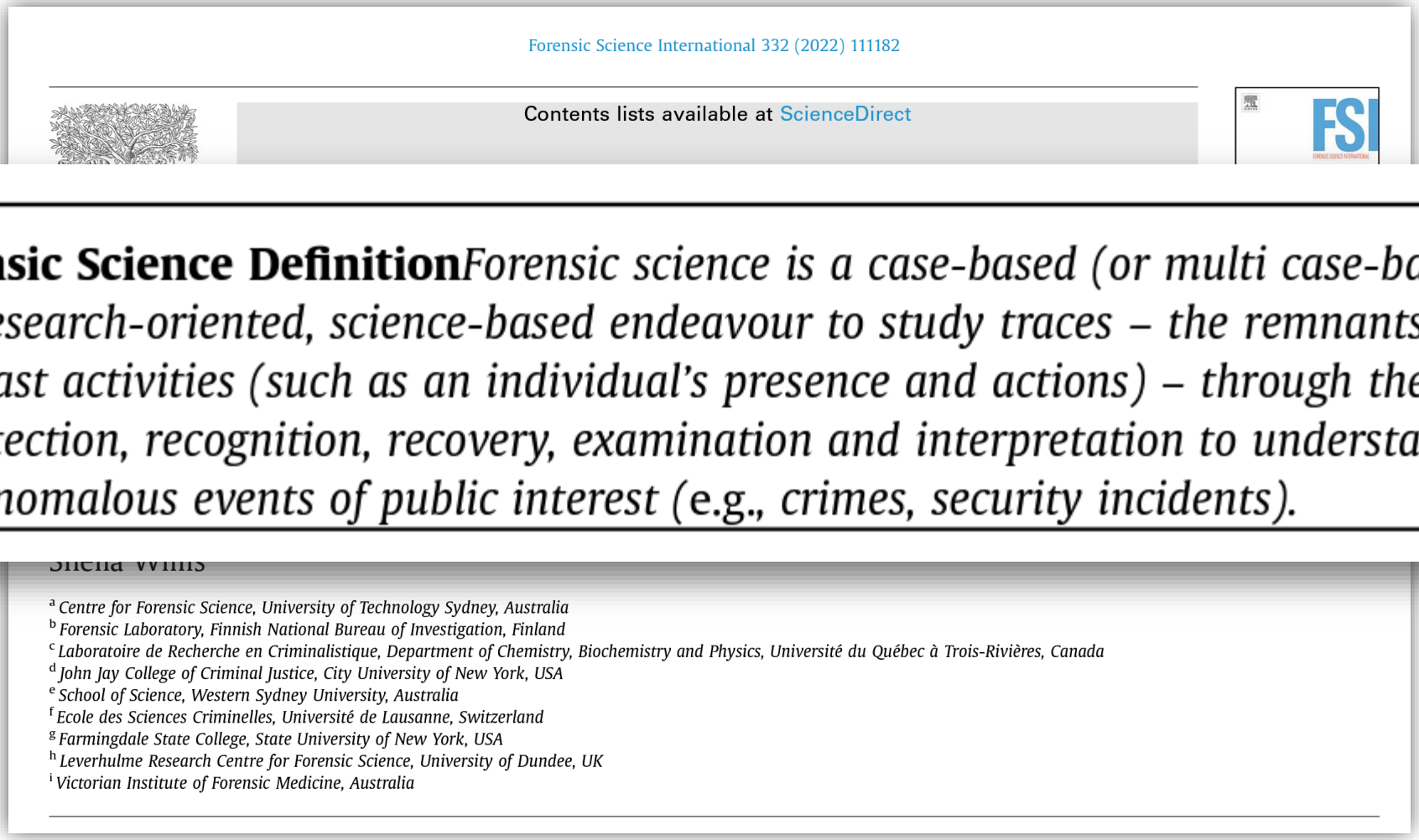
- More important disclaimer:
- I'm not a lawyer, nor am I pretending to be one, but I will discuss a scientist's interpretation of "legal stuff"

What is Forensic Science?

- DNA can deal with “presence” – Sub-source interpretation
- DNA can also deal with “actions” – Activity level interpretation



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Forensic Science Definition *Forensic science is a case-based (or multi case-based) research-oriented, science-based endeavour to study traces – the remnants of past activities (such as an individual's presence and actions) – through their d-etection, recognition, recovery, examination and interpretation to understand anomalous events of public interest (e.g., crimes, security incidents).*

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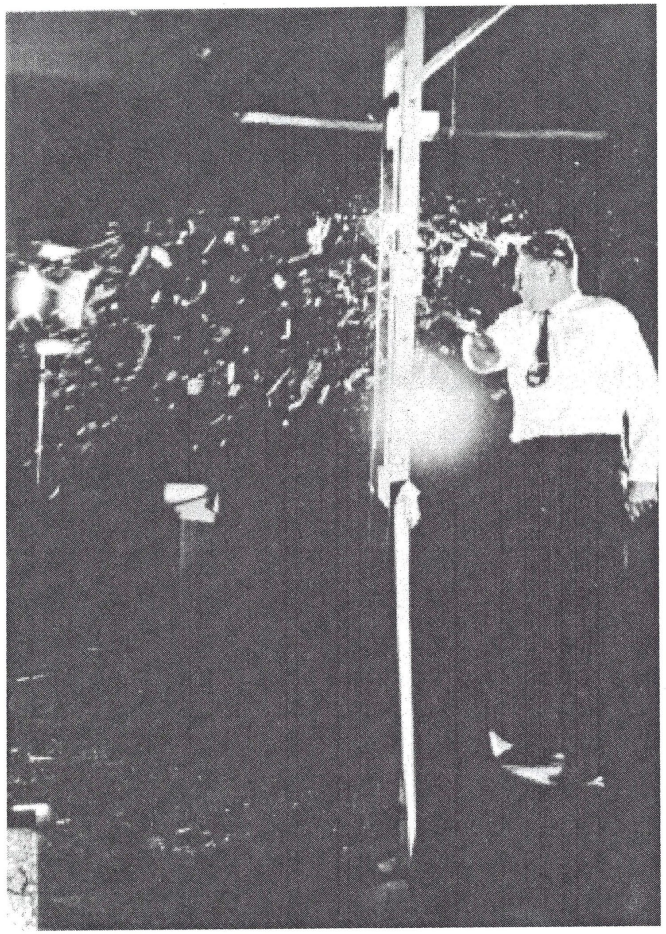
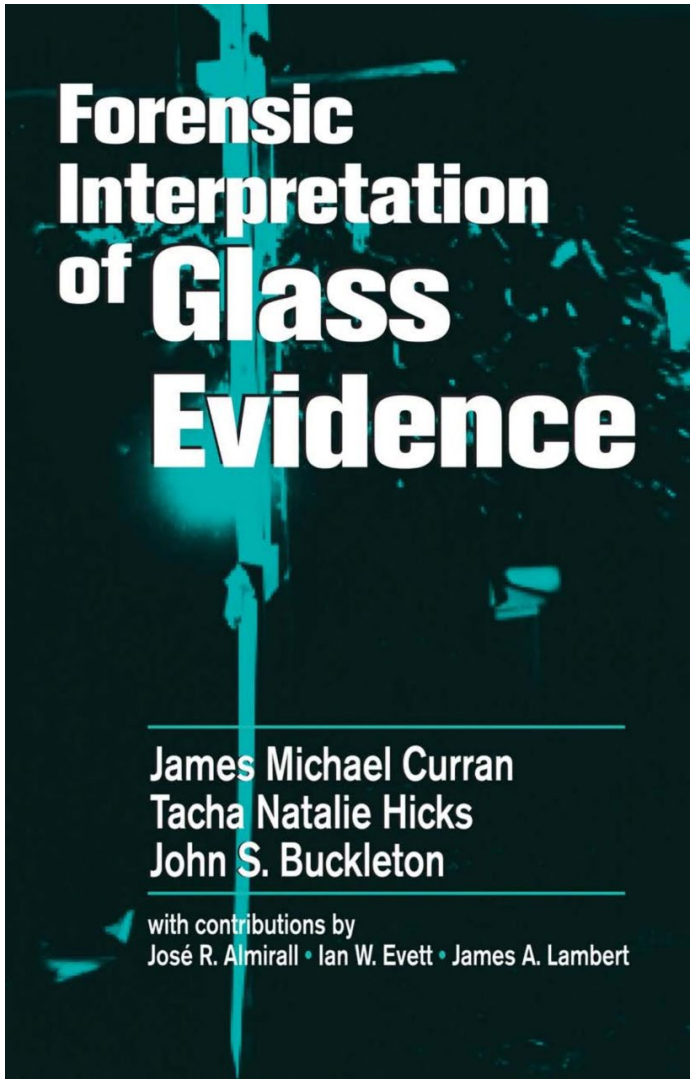
Almost 60-years of activity in forensic science

- Backward fragmentation from breaking glass - 1967

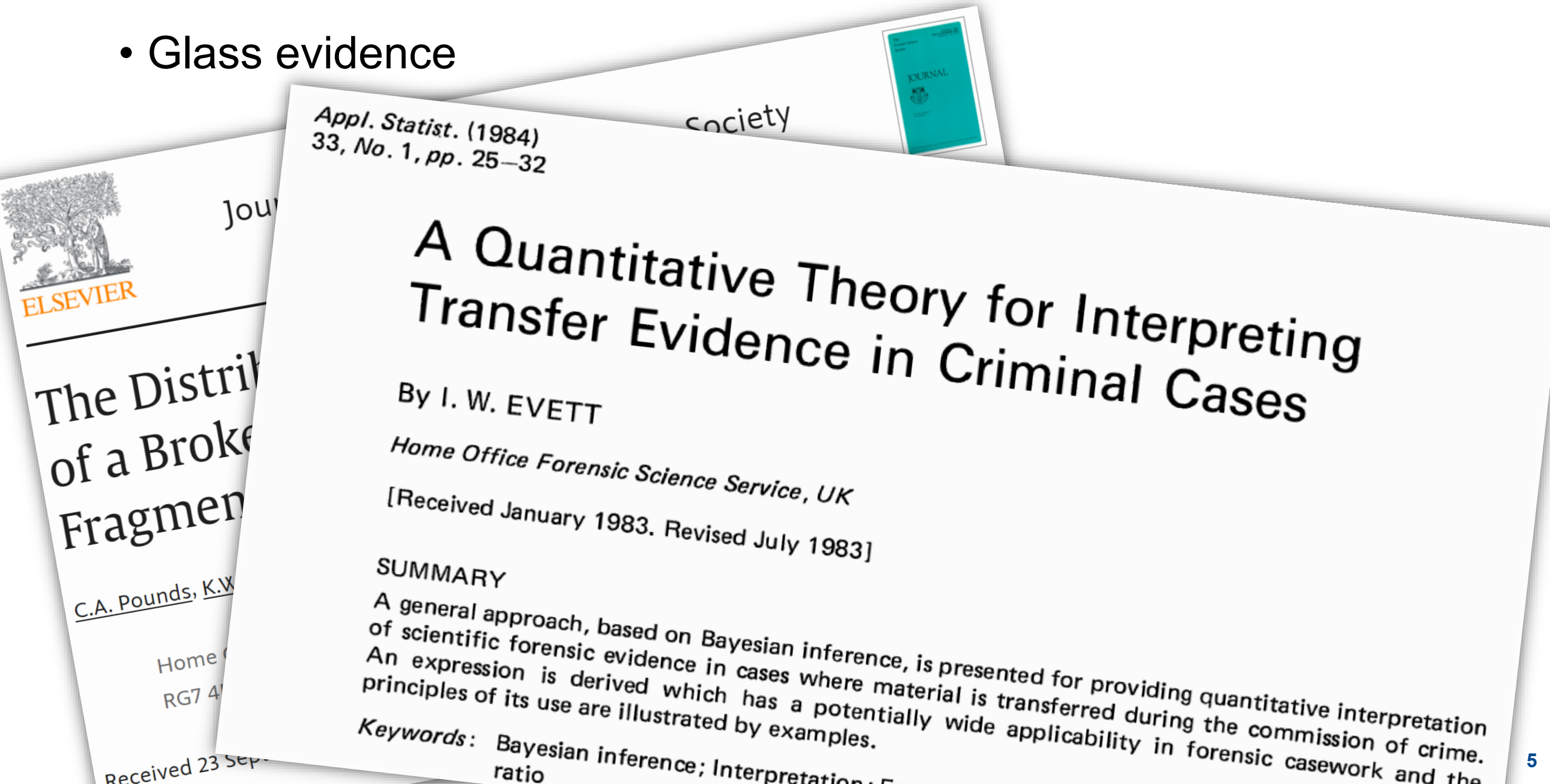


D.F. Nelson and B.C. Revell, Backward fragmentation from breaking glass, *J. Forensic Sci. Soc.*, 7, 58, 1967 (Reprinted with the kind permission of the Forensic Science Society).



Trace evidence is all about activity

- Glass evidence



From the very start for DNA

- Differential extraction in 1985; one specific activity
- Pre-dates Pitchfork conviction in 1986

Forensic application of DNA 'fingerprints'

Peter Gill*, Alec J. Jeffreys† & David J. Werrett*

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A 35-years of Bayesian inference

- Probability of the evidence considered given two competing propositions
- LR was calculated

ELSEVIER

Journal of the Forensic Science Society

Volume 30, Issue 4, July 1990, Pages 215-223

Commentary

The interpretation of glass evidence. A practical approach

Ian. W. Evett, John Buckleton [1]

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The application of Bayesian inference to the interpretation of glass evidence is discussed in the context of four hypothetical glass-on-clothing cases. The emphasis is placed on generating a practical system that could be implemented readily rather than on rigour. The implications of the results on forensic decision making are discussed.

Gun shot residue

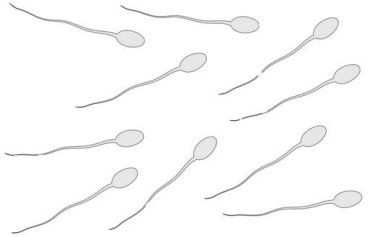
- GSR is 100% activity
- An analysis is performed that looks for trace elements commonly found in gun powder
- What is so special about finding lead, antimony, and barium?
- Activity level propositions:
  - H1 – the elements are present because a gun was fired
  - H2 – the elements are present because of some other activity

What is meant by “activity” in DNA?

- How did the DNA get there?
- Does DNA tell us that?
- But an expert might be able to tell the jury something…
- Examples of “activity” – that haven’t been recognized as such
  - “Is this consistent with primary transfer?”
  - “Is indirect transfer possible?”
  - “If I touch this lectern, and then the next speaker does, is it possible my DNA could end up on their hand?”
- These questions → Possible Explanations

Other examples of activity

- “Did you match the sperm cell DNA to anyone?”



- “Who did the DNA from the blood on the knife blade match?”
  - “The victim.”

- “Did you recover a “touch” DNA profile from the handle of the knife?
  - “Yes, and the suspect cannot be excluded as a possible source.”

NAS report (2009)

- This seems to be where DNA was called the “Gold Standard”

- Maybe this is what started the myth?
  - “DNA is objective”
  - The “Who?” question

- But – Page 41 of NAS Report:
  - For example, the fact that DNA evidence of a victim’s husband is found in the house in which the couple lived and where the murder took place proves nothing.
  - The fact that the husband’s DNA is found under the fingernails of the victim who put up a struggle may have a very different significance.

It’s not a fair fight

- Prosecutor has the advantage
  - They go first
  - They get testimony about “vaginal swabs” and “sperm DNA” and “matches suspect”
  - They get to ask about “touch” DNA or “handler DNA” and “DNA from the knife”
- Defense counters?
  - “Could the DNA on the vaginal swabs
    contaminated toilet tissue after using
  - “Can DNA on a knife handle come fro

What should activity evaluation be?

- Best if done ahead of time - Lots of guidance here; adoption/implementation challenges
  - Two propositions from the case information are developed
    - H1 – Pretty obvious
    - H2 – ?
  - Case information considered is recorded
  - Expectations of results are developed/Probabilities are assigned
    - Literature
    - Adapted by the expert
    - This is subjective
  - LR calculated and reported

- This (almost) never happens, but it should
- Impractical for every case in the real world, many reasons why

Probability based evaluation

- Probability is “scientific”
- Specific mathematical laws
  - Probability has values between 0 and 1 (inclusive)
    - Pr = 0 would be “impossible” – almost never valid
    - Pr = 1 would be absolute certainty – almost never valid
  - The sum of all probabilities must add up to 1
  - Probabilities can be multiplied
    - Unconditional
    - Conditional
    - Overall probability goes down for more “steps” (multiplying decimals)

Dictionary definition of PROBABILITY

- Oxford Languages:
  - The extent to which something is probable
    - “probable” = likely to be the case or to happen
  - MATHEMATICS: The extent to which an event is likely to occur, measured by the ratio of the favorable cases to the whole number of cases possible
- Mirriam-Webster:
  - The chance a given event will occur
  - The ratio of the number of outcomes in an exhaustive set of equally likely outcomes that produce a given event to the total number of possible outcomes
  - A branch of mathematics concerned with the study of probabilities

Dictionary definition of POSSIBLE

- Oxford Languages:
  - Able to be done
  - Able to happen although not certain
  - Able to become; potential

  - MATHEMATICS: (none)

- Mirriam-Webster
  - Being within the limits of ability
  - Something that may or may not occur
  - Having an indicated potential

Probability experts on “possible explanations”

- Ian Evett (pers communication, paraphrased)
  - “The expert that uses ‘possible’ just wants to make friends with the lawyer.”
- de Finetti (1979)
  - “They say and unsay in the one breath, not to risk too much.”
  - “It is never clear what their answers mean.”
  - “Whatever happens, one cannot tell him/her that s/he was wrong.”
- Biedermann (2020)
  - “…lead(s) to an easy life: no real interpretation is required, and often the statements made are little more than statements of the obvious.
- Evett (2000) – via ENFSI Evaluative Guidelines
  - “…may be a statement of the obvious, speculative, or fanciful.”

When probability of the evidence is given

- de Finetti
  - “On the contrary, if questions are asked in such a way as to obtain a probability value as an answer, the ambiguity disappears.”

- Aitken & Taroni (2004) via ENFSI Evaluative Guidelines
  - “Probability is a concept by which one can express uncertainties (about an event or, more generally, an unknown state of affairs). The laws of probability define the values that probability can take and how probabilities combine.

What usually happens

- Nothing was prepared ahead of time
- Maybe not enough case information
- No pre-trial discussions

- Fully prepared expert, but case information provided changed

- Both parties move into “transfer” questions that are clearly related to what will be argued at closing

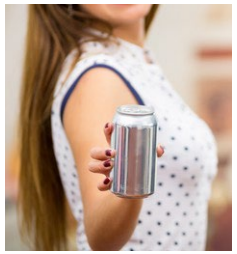
What usually happens

- Is the evidence “consistent with” sex?
- Is it possible the DNA got on the item by indirect transfer?
- Literature comes up:
  - Are you aware of this study where:
  - Everyone gowned up in full space suits,
  - Washed their hands with surgical grade soap three times,
  - Poured bleach on their hands,
  - UV irradiated, bleach cleaned, and autoclaved a knife,
  - P1 spit 4 mL of saliva into his hand,
  - Shook hands with P2, who shook hands with P3 who touched the knife
  - The knife was swabbed and extracted within 30 seconds
  - Two alleles were found of P1 on the knife

What usually happens

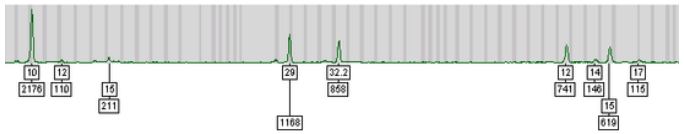
- Inside expert's head:
  - (What does this have to do with a case involving a condom recovered from the trash can in a fraternity house the day after the last Rush Week party and I had to dilute the female fraction 50x?)
- What the expert says:
  - "Yes"

- "So it's possible the DNA got on the condom because the Victim handed a beer to someone, who then transferred the Victim's DNA from the can to the pizza box that was in the trash when a condom was thrown away hours later?"
  - "Well, that's not very likely…."







What if expert gives this answer?

- A: “In my opinion, the DNA on the condom is more likely if sex occurred than if the DNA on the condom came because someone threw out the trash the next morning.”

- Q options:
- “Is that just your opinion?”
- “Did you put that in your report?”
- “Do you have a paper that supports this?”

- Others will say this is “*ad hoc*” or “*ipse dixit*”

But is it “ad hoc”?

- The expert knew that the evidence was a condom
- Sperm seen on microscope; suspect and victim both included as possible contributors
- No extra DNA
- The expert had to dilute the extract 50x (lots of DNA)

- The expert has read up on “transfer” studies
- Expert knows full major profile – after diluting the DNA – is the low frequency result in indirect transfer
- “Throw out the trash” is quaternary

“Ad hoc”?

- The proffered paper involved a large amount of saliva in extreme lab-controlled conditions; found a few alleles
- The “throw out the trash” proposition does not involve a body fluid
- “Baseline knowledge” can be used – even “on the fly”
- (Yes this example was ridiculous; but illustrates the principle)

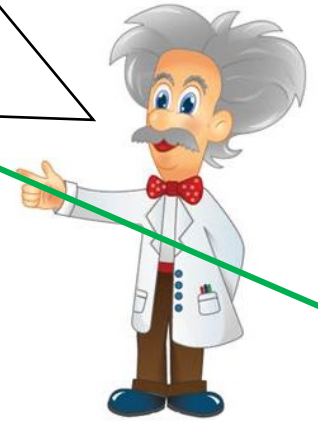
Meanwhile, the jury…

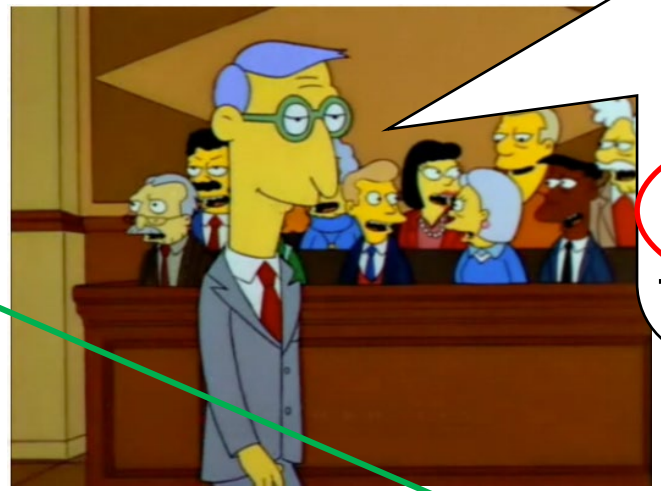
- Why do experts get called to court?
- FRE 702
- A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if the proponent demonstrates to the court that it is more likely than not that:
  - (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
  - (b) the testimony is based on sufficient facts or data;
  - (c) the testimony is the product of reliable principles and methods; and
  - (d) the expert's opinion reflects a reliable application of the principles and methods to the facts of the case.

What if we don't address this directly?

- Concern 1:
  - The weight given for "who" may get applied to the "how"

"The DNA profile from the fingers is 1 billion times more likely if it originated from Ms. Buchanan than from an unknown person."





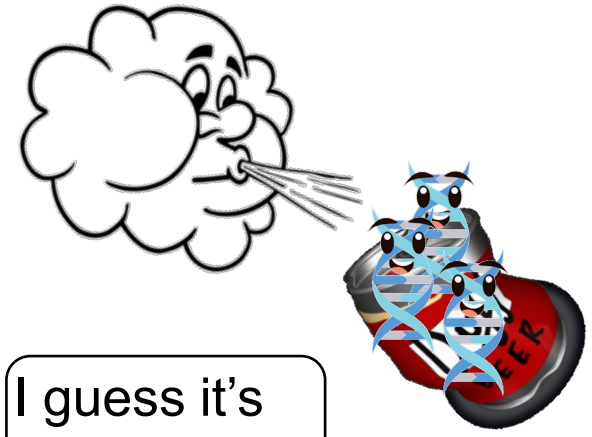
"The DNA expert said it was 1 billion times more likely that Mr. Gatsby digitally penetrated Ms. Buchanan."

Source ≠ activity

Note this is also transposed conditional – the proposition is the focus, not the evidence

What if we don't address this directly?

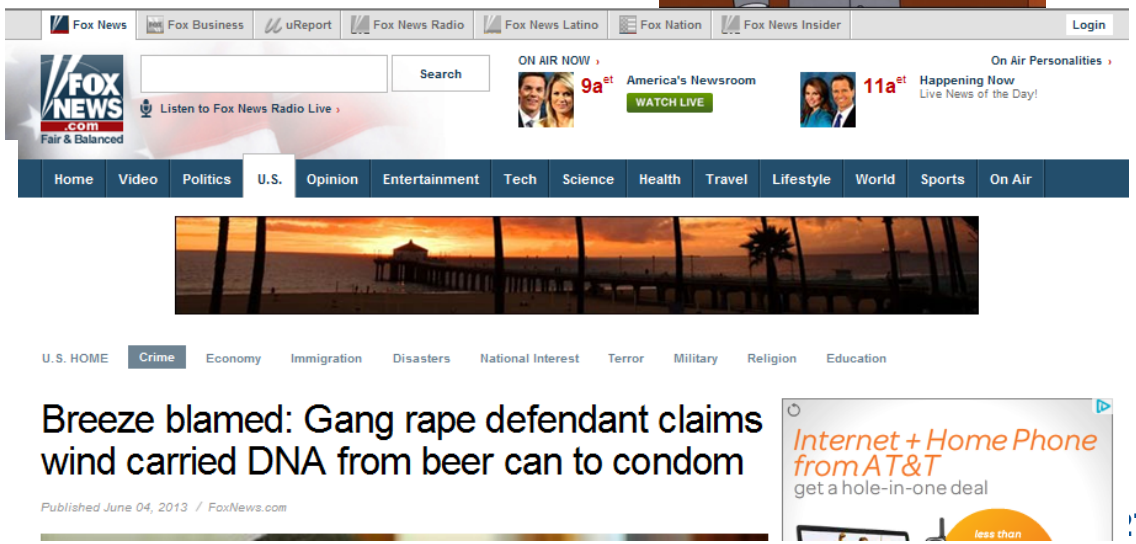
- Concern 2:
  - Lay persons (juries, attorneys, judges) may assign their own values to the evidence – and have no expert knowledge



I guess it's possible

The attorney for a man charged in the 2009 gang rape of a 16-year-old girl is claiming that wind could have transferred the defendant's DNA from a beer can to a used condom found at the crime scene.

The DNA on that nearby beer can could have been blown by the wind onto the condom



How does “relevance” relate to “possible transfer”?

- FRE 401 – Test for Relevant Evidence
- Evidence is relevant if:
  - (a) it has any tendency to make a fact possible; and
  - (b) the fact is of consequence in determining the action

- Evidence is relevant if:
  - (a) it has any tendency to make a fact more or less probable than it would be without the evidence; and
  - (b) the fact is of consequence in determining the action

Subjective or science?

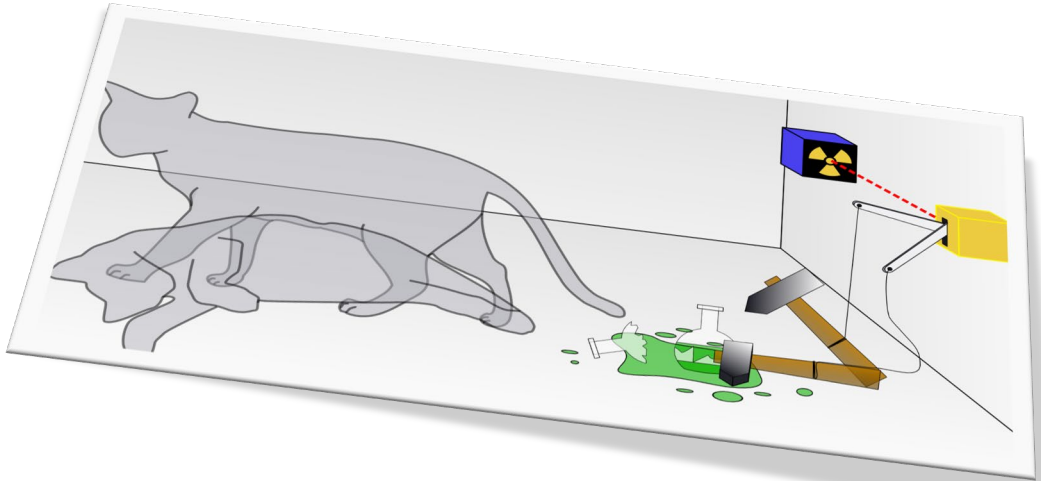
- “That’s just your opinion! It’s subjective, not science!”
- All probabilities are subjective
- Probability is how scientists deal with uncertainty
- Uncertainty is built into forensic cases
- Different experts can/will give different evaluations of findings given activity propositions

Subjective or Science?

- What do the giants in probability say?
- de Finetti – “Probability does not exist” (1975)
- Biedermann – “Probability is not something that can be known or not known: probabilities are states of mind, not states of nature.” (2018) (adapted from de Morgan (1838))
- Lindley (and others) – Probability is a measure of your degree of belief and is conditioned on the status of information of the subject who assess it
- Evett – “There is no situation in which one can have a probability without making at least one assumption” (1996).

But what about “hard science” like physics

- Shrödinger – “Since the knowledge may be different with different persons or with the same person at different times,
- they may anticipate the same event with more or less confidence,
- and thus different numerical probabilities may be attached to the same event.”



From the US Court of appeals for the Third Circuit

2.09 Opinion Evidence (Expert Witnesses)

The rules of evidence ordinarily do not permit witnesses to state t

own opinions about important questions in a trial, but there are excepti

these rules.

You will hear testimony from Gill Grissom

Because of *(his)(her)(their)* **knowledge, skill, experience,**

training, or education in the field of everything in forensics

(Mr.)(Ms.)(Dr.) (name) **will be permitted to offer** *(an)* **opinion***(s)* **in that field**

and the reasons for *(that)(those)* **opinion***(s)*.

Not the last word…

You may disregard the opinion*(s)* entirely if you decide that *(Mr.)(Ms.)(Dr.) (name)*'s opinion*(s) (is)(are)* not based on sufficient knowledge, skill, experience, training, or education. You may also disregard the opinion*(s)* if you conclude that the reasons given in support of the opinion*(s)* are not sound, or if you conclude that the opinion*(s) (is)(are)* not supported by the facts shown by the evidence, or if you think that the opinion*(s) (is)(are)* outweighed by other evidence.

More of a fair fight?

- Defense:
  - Challenge “consistent” and how it relates to the laws of probability
  - Vigorous cross to ensure the testimony is:
    - Logical, Balanced, Transparent, Robust
  - Make the prosecution prove the activity – as a specific element
  - Be aware of cases that have been overturned
    - South Carolina v. Phillips; Connecticut v. Dawson; Connecti
  - Be proactive about your proposition??
  - Pretrial conferences??
  - Have your expert do what the ot
    - Find papers that actually relate to t
    - Develop some probabilities
    - Argue “reasonable doubt” – either w
  - Try to get DNA evidence thrown o

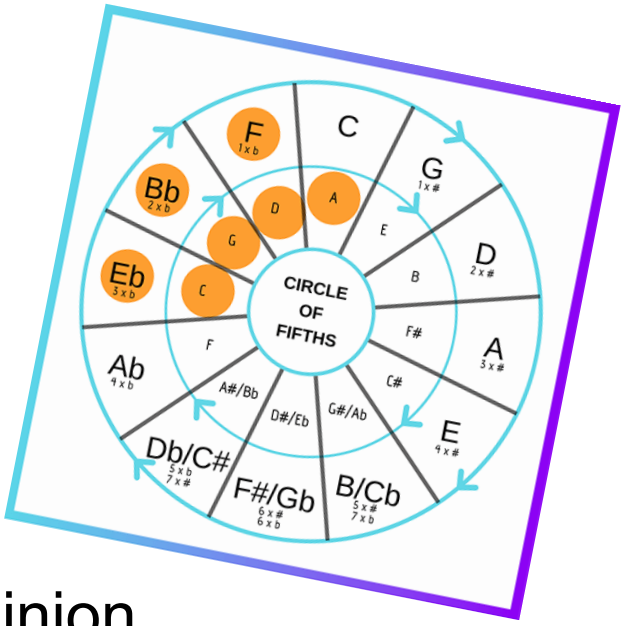
More of a fair fight?

- Prosecution
  - Provide case information
  - Be clear about proposition(s)
    - You might need to be the source of both
    - There's always another proposition
  - Be ready to "prove" the activity element
    - Use propositions based on actual activities
    - "Touched" isn't one; neither is "bled" or "handled"
  - Cross examine the other expert on "studies"
    - Make them explain why that study matters
    - "Is that the result that happened most of the time, or just a few times?"

Fair fight

- Both parties
  - Learn how to ask questions
    - Probability based response
    - Focus on the evidence
    - Challenge badly phrased questions

- Experts
  - Be prepared; ask for information
  - Be prepared; READ LITERATURE!!!
  - Be prepared; practice your testimony
  - Be prepared; be ready to defend your subjective opinion
  - Be prepared; READ LITERATURE
  - (Be Joe Pass and Oscar Peterson)



Closing

- Activity is nothing new
- If you don’t think experts should address it,
- Don’t ask the questions
- You (almost) always ask the questions
- The experts need to handle the questions appropriately

Thank you

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