

# What is the chance of your being guilty?

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The chance that a random sample of DNA would match that of O.J. Simpson was put at one in 4m. Long odds: but, as Johnnie Cochran, Mr Simpson's counsel, explained to the jury, there are 20m people in the Los Angeles area. Mr Simpson was therefore one of several people whose blood might be matched to the scene and he could not be guilty beyond reasonable doubt.

The probability that one of Sally Clark's children would suffer a cot death was estimated at one in 8,500. The chance of two unrelated incidents in a single family is one in 8,500 multiplied by 8,500, or one in 73m—far larger than the number of new mothers in the UK. The defence account of events was thus so improbable as to leave little doubt of her guilt.

Mr Simpson was acquitted and Ms Clark convicted. But the plausible arguments described above are fundamentally flawed. Ms Clark, who was sentenced to life imprisonment in 1999, was freed by the UK's court of appeal in January. The error in her case is now sufficiently familiar to lawyers to have acquired the title of "the prosecutor's fallacy".

Thomas Bayes, an 18th-century Nonconformist clergyman, discovered that his game of billiards was improved by an understanding of contingent probabilities—the likelihood that an event will occur if some other event has already occurred. He went on to derive Bayes' theorem, by which contingent probabilities are calculated. Contingent probabilities are central to understanding the statistics of the Simpson and Clark cases.

The prosecutor's fallacy is the assertion that, because the story before the court is highly improbable, the defendant's innocence is equally improbable. But all accounts of events in high-profile legal cases are highly improbable. That is why they are high-profile legal cases. The courts do not hear reports of happy families and normal behaviour. Their services are required only for bizarre and unlikely incidents—such as the saga of Nicole and O.J. Simpson and the tragedy of the Clark family.

So juries are not asked to decide whether the events before them are out of the run of everyday experience. They are asked to decide on the most probable explanation of improbable events. This is how the analysis of contingent probabilities developed by Bayes comes into play.

Bayes' theorem resolves the Simpson case quite easily. If Nicole Simpson was not murdered by OJ, she was murdered by someone who, although not her former husband, had DNA matching that of her former husband. This is so unlikely as not to constitute a basis for reasonable doubt.

And Bayes' theorem shows that probability and statistics cannot decide in cases like Mrs Clark's. Unexplained infant death is rare but when it occurs it more often results from natural causes than from murder. A single incident should therefore, in the absence of other evidence, be treated as natural.

But what of a series? The simple theory of probability, as applied by Johnnie Cochran and Professor Sir Roy Meadow, an expert witness in the Clark case, multiplies the probabilities of a series of events together on the assumption that they are unrelated. But it is unlikely that these effects are unrelated. Murderous intent may persist in the mind of evildoers. Genetic and environmental influences that cause death may affect siblings. We simply do not know the relative significance of these factors, so we must look to other evidence - such as the blood sample that, after Ms Clark had spent two years in prison, indicated that her son Harry had probably died of a respiratory infection.

The lesson is that the simple rules of logic and arithmetic involved in probability theory are hard to handle. I have never talked to an audience about a range of possible scenarios without being asked: "But what do you really think is going to happen?" The human mind, uncomfortable with uncertainties and probabilities, prefers to deal with narratives and stereotypes. That is true of trial juries and business people, investors and politicians. And it is one reason they keep making mistakes that damage their reputations, their wealth and, sometimes, the lives and freedom of other people.

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