Bayes’ Theorem in the Trial Process

Instructing Jurors on the Value of Statistical Evidence*

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The use of statistics and probabilities as legal evidence has recently come under increased scrutiny. Judges' and jurors' ability to understand and use this type of evidence has been of special concern. Finkelstein and Fairley (1970) proposed introducing Bayes’ theorem into the courtroom to aid the fact-finder evaluate this type of evidence. The present study addressed individuals' ability to use statistical information as well as their ability to understand and use an expert's Bayesian explanation of that evidence. One hundred and eighty continuing education students were presented with a transcript purportedly taken from an actual trial and were asked to make several subjective probability judgments regarding blood-grouping evidence. The results extend to the trial process previous psychological research suggesting that individuals generally underutilize statistical information, as compared to a Bayesian model. In addition, subjects in this study generally ignored the expert’s Bayesian explanation of the statistical evidence.

INTRODUCTION

Statistics and probabilities are receiving increased attention in the law. Since 1960 there has been a dramatic growth of cases using some form of statistical evidence, with the greatest surge coming in the late 1970s (Fienberg & Straf, 1982; Note, 1983). In light of this increased use in the courtroom, legal scholars have begun to debate the merits of various forms of statistical evidence. These commentators have been especially concerned with judges’ and jurors’ ability to understand and use this evidence. One proposal that has garnered much attention in this debate is

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the proposed explicit use of Bayes' theorem in the trial process. Finkelstein and Fairley (1970) suggested that Bayes' theorem could potentially be used to explain to the trier of fact the proper way to combine certain types of evidence that might otherwise be difficult to understand. Specifically, Bayes' theorem could instruct jurors on how to combine statistical evidence with other, more qualitative, evidence in a trial.1

The Finkelstein and Fairley proposal has been vigorously debated; and out of this debate two opposing views have arisen (see generally Weinstein, Mansfield, Abrams, & Berger, 1983). Tribe (1971a), the main proponent of the first view, assailed the use of Bayes' theorem in the trial process, arguing that the trier of

\[ p(A/B) = \frac{p(B/A)p(A)}{p(B/A)p(A) + p(B/\neg A)p(\neg A)} \]

As an example of how Bayes' theorem would work in the trial process, consider the following hypothetical case involving a defendant on trial for killing his employer with a ball point pen. It was shown at trial, among other things, that the defendant had fought with his boss over a highly sensitive issue and had stormed out of the office early on the day his boss was killed. The body was found by the cleaning crew at 7:00 p.m. that night. The defendant claimed that he had gone home and stayed there but no one could support this contention. An expert testified that the victim had been stabbed repeatedly with a ball point pen that contained a highly unusual kind of ink. The expert further testified that the defendant's pen contained ink of that same type, and that based on highly reliable data one would expect only 5% of all pens to contain that type of ink. The question is, how should a juror integrate this 5% probability figure into the other evidence already heard? Bayes' theorem addresses this question.

Suppose a hypothetical juror believed, prior to hearing the expert testify, that she was 60% confident (i.e., had a subjective probability of 0.60) that the defendant had stabbed his employer with his pen [i.e., \( p(A) = 0.60 \)]. Therefore, it follows that the probability that he did not stab his employer, based on the prior evidence, is 40% [i.e., \( p(\neg A) = 0.40 \)]. Further, as the expert testified, the frequency generally of finding the type of ink that was in the murder weapon was only 5%. This is another way of saying that the probability of finding the particular type of ink in the defendant's pen if he did not stab his employer is 5% [i.e., \( p(B/\neg A) = 0.05 \)]. The final probability needed to use Bayes' theorem is the probability of finding the ink type in the defendant's pen if he had indeed stabbed his employer. This can be assumed to be 100%, because if the defendant did use his pen to kill his employer then it is certain that its ink type matches the ink type of the murder weapon [i.e., \( p(B/A) = 1.0 \)]. These figures can be substituted in as follows:

\[ p(A/B) = \frac{(1.0)(0.60)}{(1.0)(0.60) + (0.05)(0.40)} = 0.967 \]

Therefore, Bayes' theorem provides a straightforward device for assessing the probative value of certain evidence that might otherwise be difficult to assess. In this case if the juror had a subjective belief prior to the expert's testimony that there was a 60% chance the defendant had stabbed his employer then she should have a 96.7% subjective belief after hearing the expert.

It should be noted that the merits of using Bayes' theorem to compute the subjective probabilities in this fashion have been debated on philosophical grounds. Unfortunately, space does not permit a discussion of this debate. The reader is referred to several excellent resources that accomplish this task; see in support of Bayes' theorem DeFinetti (1972) and Savage (1972); and against, see Horwich (1982) and Shafer (1976). Legal commentators have also addressed these issues; see Brilmayer and Kornhauser (1978), Callan (1982), and Tribe (1971a, 1971b). For a discussion of this debate and its relevance to the psychological issues addressed in the present study, see Faigman (1984).