

Revisiting *Dreyfus*:  
A More Complete Account  
of a Trial by Mathematics\*

D.H. Kaye\*\*

ABSTRACT: Legal literature and case law depicts the infamous conviction of Alfred Dreyfus for treason and espionage in 1894 as a prime example of the irresistible power of even grossly fallacious mathematical demonstrations to overwhelm a legal tribunal. This essay shows that Dreyfus is not a case of mathematics run amok, unchecked and uncomprehended. To the contrary, the defects in the mathematical proof were dramatically exposed, and this evidence did not lead Dreyfus's judges to condemn him. This more accurate understanding of the case undercuts the reliance of modern courts and commentators on Dreyfus as an indication or illustration of the alleged dangers of probability evidence in criminal cases.

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\*\* . Regents' Professor, Arizona State University Sandra Day O'Connor College of Law, and Fellow, Center for the Study of Law, Science and Technology. J.D., Yale Law School; M.A. Harvard University; B.S., MIT. I am grateful to George Fisher, William Kruskal, Paul Meier, and Hans Zeisel for comments on a draft of this paper, to Marcelle Chase for locating records of the *Dreyfus* proceedings, and to Fernando Téson for verifying the translations of certain documents.

The courts have had a hard time with "probability evidence."<sup>1</sup> A few have tried to expel nearly all quantitative assessments of evidence.<sup>2</sup> Others have propounded complex and arbitrary rules of admissibility.<sup>3</sup> Still others have uncritically, and perhaps uncomprehendingly, accepted such assessments.<sup>4</sup> This essay examines one notorious case that has been said to fall in the last category. In a brilliant and influential article published over thirty years ago, Professor Laurence Tribe presented the case as a prime example of the irresistible power of even grossly

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1. By "probability evidence," I mean quantitative expressions, derived with the aid of the mathematical theory of probability, of the chances that certain events would occur. Such evidence or argument is not relevant in itself, but is supposed to assist the judge or jury in evaluating the probative force of facts established by other testimony, such as an apparent match in handwriting characteristics, in blood types, in hair fibers, and so on. For surveys of leading cases of "probability evidence" and efforts to extract useful principles from them, see 1 MCCORMICK ON EVIDENCE § 209 (John Strong ed., 5th ed. 1999); D.H. Kaye, *The Admissibility of "Probability Evidence" in Criminal Trials—Part I*, 26 JURIMETRICS J. 343 (1986); D.H. Kaye, *The Admissibility of "Probability Evidence" in Criminal Trials—Part II*, 27 JURIMETRICS J. 160 (1987). A deeper analysis can be found in D.H. KAYE ET AL., *THE NEW WIGMORE, A TREATISE ON EVIDENCE: EXPERT EVIDENCE* § 12 (2004).

The most recent, notorious abuse of criminal probability evidence occurred in the prosecution of Sally Clark for allegedly murdering her two children. *See, e.g.*, Kevin Barraclough, Book Review, 329 BRIT. MED. J. 177 (2004) (reviewing JOHN BATT, *STOLEN INNOCENCE: A MOTHER'S FIGHT FOR JUSTICE—THE AUTHORISED STORY OF SALLY CLARK* (2004)); Stephen J. Watkins, Editorial, *Conviction by Mathematical Error? Doctors and Lawyers Should Get Probability Theory Right*, 320 BRIT. MED. J. 2 (2000).

2. *State v. Schwartz*, 447 N.W. 2d 422 (Minn. 1989); *State v. Kim*, 398 N.W. 2d 544 (Minn. 1987); *State v. Boyd*, 331 N.W. 2d 480 (Minn. 1983); *State v. Carlson*, 267 N.W. 2d 170 (Minn. 1978). *But see State v. Bloom*, 516 N.W.2d 159 (1994) (creating an exception to the Minnesota rule prohibiting testimony as to some probabilities for DNA evidence).

3. *See* D.H. Kaye, *The Probability of an Ultimate Issue: The Strange Cases of Paternity Testing*, 75 IOWA L. REV. 75 (1989).

4. *See* Kaye, *Probability Evidence—Part II*, *supra* note 1.

fallacious mathematical demonstrations to overwhelm a legal tribunal.<sup>5</sup> Not long afterward, Mr. Justice Douglas reiterated this view of the extraordinary power of mathematical evidence to confound court and counsel.<sup>6</sup> A distinguished national panel also described the case to show "the ability of mathematical evidence to paralyze critical examination."<sup>7</sup> And, as the Minnesota Supreme Court attempted for the sixth time to fashion reasonable rules for the admission of expert testimony about DNA evidence,<sup>8</sup> one Justice insisted that "the infamous Dreyfus case" proved that if "an erroneous statistical probability plays any significant role in the conviction of an

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5. Laurence Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329 (1971).

6. *Hull v. United States*, 404 U.S. 893, 895–96 n.3 (1971) (Douglas, J., dissenting from denial of certiorari). Oddly, *Hull* involved little or no quantified evidence. Justice Douglas would have reversed a smuggling conviction because the government lacked direct evidence that defendants, who were walking on a highway, close to two knapsacks of marijuana, and three-quarters of a mile from "possibly the hottest spot on the Mexican border for smuggling," had crossed the border with the marijuana. *Id.* at 894. He reasoned that because the agent's testimony about the "hot spot" was based on "anecdotal experiences in four prior investigations," it amounted to "statistical evidence" that "[c]ourts have been hesitant to admit . . . because of the ease with which it can be abused." *Id.* at 895–96.

7. THE EVOLVING ROLE OF STATISTICAL ASSESSMENTS AS EVIDENCE IN THE COURTS 215 (S. Fienberg ed. 1989). For a more complete description of the panel's work, see D.H. Kaye, *Improving Legal Statistics*, 24 LAW & SOC'Y REV. 1255 (1990). For reviews of psychological research questioning the alleged tendency of jurors to overvalue probability evidence, see D.H. Kaye & J.J. Koehler, *Can Jurors Understand Probabilistic Evidence?* 154(A) J. ROYAL STAT. SOC'Y 75 (1991); William Thompson, *Are Juries Competent to Evaluate Statistical Evidence?* 52 LAW & CONTEMP. PROB. 9 (1989).

8. *See State v. Alt*, 505 N.W.2d 72, 72 (Minn. 1993); *State v. Johnson*, 498 N.W.2d 10 (Minn. 1993); *State v. Jobe*, 486 N.W.2d 407 (Minn. 1992); *State v. Nielsen*, 467 N.W.2d 615 (Minn. 1991); *State v. Schwartz*, 447 N.W.2d 422 (Minn. 1989).

innocent person, the error has not only destroyed the life of the innocent person but has in some sense dehumanized the community."<sup>9</sup>

The case in question is the court-martial of Captain Alfred Dreyfus of the French Army at the turn of the Nineteenth Century.<sup>10</sup> It is a case of such injustice that it toppled a government. But despite the legend in the literature on legal statistics, *Dreyfus* is not a case of mathematics run amok, unchecked and uncomprehended. To the contrary, the defects in the mathematical proof were dramatically exposed, and this evidence did not lead Dreyfus's judges to condemn him. Accordingly, Dreyfus's contrived conviction, as intolerable as it was, does not militate against the admission of "probability evidence."

### **The *Dreyfus* Cases: An Overview**

*Dreyfus* is not a single case, but rather a series of connected military, civil and criminal proceedings. They began in 1894 with a court-martial that convicted Dreyfus of transmitting military secrets to Germany and sentenced him to life imprisonment on Devil's Island. The verdict, which was tainted by a secret dossier, fabricated evidence and widespread anti-Semitism in the French army and populace, became an international *cause célèbre*. As evidence of Dreyfus's innocence began to mount and as it became known that French military authorities had manufactured

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9. State v. Bloom, 516 N.W.2d 159 (1994) (Coyne, J. dissenting). The majority of the court held that an expert may testify to the frequency of occurrence of a DNA profile when this frequency is computed according to a "conservative" procedure devised by a committee of the National Academy of Science. Not long after that, a second Academy committee wrote that this "ceiling" procedure was not necessary. In its view, more extreme probabilities could be justified scientifically. COMMITTEE ON DNA TECHNOLOGY IN FORENSIC SCIENCE: AN UPDATE, NATIONAL RESEARCH COUNCIL, THE EVALUATION OF FORENSIC DNA EVIDENCE (1996).

10. Histories of the Dreyfus affair are plentiful and opinionated. A detailed account by a Parisian lawyer and professor is JEAN-DENIS BREDIN, *THE AFFAIR: THE CASE OF ALFRED DREYFUS* (J. Mehlman transl. 1986), originally published as *L'AFFAIRE* (1983). A shorter essay, which focuses on the legal proceedings, is Martin, *The Dreyfus Affair and the Corruption of the French Legal System*, in *THE DREYFUS AFFAIR: ART, TRUTH AND JUSTICE* 37 (Norman L. Kleeblatt ed., 1987).

additional evidence to keep the case from being reopened, the army and the government were shaken. The discovery of one forgery, purporting to be a letter from an Italian military attaché, prompted the suicide of the colonel working in military intelligence who had prepared it and produced the resignations of the chief of the Army's General Staff and the Minister of War.

France's highest court, the *Cour de Cassation*, sitting *en banc* as a result of special legislation, vacated the judgment of the military court. After five years of brutal conditions on Devil's Island, Dreyfus returned to a second court-martial. At Rennes in 1899, this court again found Dreyfus guilty of treason. Issuing a compromise verdict referring to extenuating circumstances (and prompting Dreyfus to ask "Since when are there extenuating circumstances for treason?"), it sentenced Dreyfus, to another five years confinement. The verdict was so poorly received that within two weeks, the president of the republic pardoned Dreyfus.

After further political upheavals and a War Office report finding that most of the evidence at Rennes either did not relate to Dreyfus or had been altered to make it appear that it did, the *Cour de Cassation* granted a petition for review. In 1906, declaring that no credible evidence of treason ever existed, the court annulled the verdict of the Rennes court-martial.<sup>11</sup> Dreyfus, the man twice convicted of treason, returned to the army and was awarded the cross of the Legion of Honor.

### **Bertillon's Analysis of the *Bordereau***

The document that initiated the 1894 prosecution was a letter, known as the *bordereau*. Retrieved from a wastepaper basket in the German embassy, the *bordereau* listed several relatively unimportant accompanying documents about French artillery and troops. French intelligence officers decided that Dreyfus was the culprit. (Why not? He was a Jew and an Alsatian.) They collected and contrived evidence to support this thesis and ignored or suppressed all contrary evidence.<sup>12</sup> The

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11. Martin, *supra* note 10, at 47, argues that this judgment of acquittal (as opposed to remanding the case to the army) was procedurally improper but political expedient.

12. The actual author was a French officer named Esterhazy who was providing information to the German military attaché.

resulting dossier was enough to convince the French government to convene the 1894 court-martial.

Handwriting experts contacted by the army and the Ministry of Justice who studied the *bordereau* came to conflicting conclusions. The most notorious analysis came from the anthropologist Alphonse Bertillon,<sup>13</sup> who claimed that Dreyfus wrote it in a way that would make it look like a forgery of his own handwriting. Bertillon advanced this "self-forgery" theory at both the military trials and at the criminal libel trial of the novelist, Emile Zola, for his vitriolic public letter, *J'accuse*, which denounced the army for "one of the greatest iniquities of the century" in its handling of the case.

To Bertillon, the proof of "self-forgery" was scientific, incontestable and infallible—in a word, *géométrique*. This proof included computations of the probabilities of selected coincidences between the lengths of certain words and letters in this document and the lengths of certain words and letters in correspondence taken from Dreyfus's home.<sup>14</sup> Furthermore, from obscure lexicographical and graphological coincidences within the document itself, Bertillon divined that the letter contained coded information.<sup>15</sup> For example, he stressed the presence of four coincidences out of the 26 initial and final letters of the 13 repeated polysyllabic words in the *bordereau*. He evaluated at .2 the probability of an isolated coincidence and calculated a probability of  $.2^4 = .0016$  that four such coincidences would occur in normal writing.<sup>16</sup> Likewise, to establish that the letters had been traced over the word

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13. Bertillon, who had invented a system of identifying individuals from various body measurements, headed an office of criminal identification.

14. Tribe, *supra* note 5, at 1332.

15. Mary Gray, *Statistics and the Law*, 56 MATHEMATICS MAG. 67, 68 (1983), and Mode, *Probability and Criminalistics*, 58 J. AM. STAT. ASS'N 628 (1963), rely on a 1928 account, *The Reality of Mathematical Processes*, by Hedrick, in THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS THIRD YEARBOOK 40-41, that refers to the frequency of the letters of the French alphabet within the *bordereau* as contrasted to the proportions found in typical French prose as constituting the statistical evidence against Dreyfus. I found no references to such testimony in the documents collected in LA REVISION DU PROCÈS DE RENNES (1909).

16. Tribe, *supra* note 5, at 1333 n.8.

*intérêt* as it appeared in a letter in Dreyfus's brother's handwriting, Bertillon computed the "amazing" frequency with which certain letters in the *bordereau* appeared over the same letters of the word chain constructed by repeating *intérêt* a number of times, once a variety of complex and ad hoc adjustments had been made.<sup>17</sup>

### The Impact of Bertillon's Testimony

Bertillon's recondite analysis may have had some impact in the first court-martial before the defense had the opportunity to examine his work carefully. The principal exponent of this view is the novelist, Armand Charpentier, who wrote that Dreyfus's counsel, two observers from the General Staff, and the prosecuting attorney "said afterwards that they understood nothing of Bertillon's testimony."<sup>18</sup> As for the judges, Charpentier merely states that "one may think that it was the same," and he remarks that "in any event, they allowed themselves to be impressed by the scientific phraseology of the system."<sup>19</sup>

Since the 1894 proceedings were closed to the public and were not transcribed, Charpentier's attributions seem somewhat speculative. Moreover, most accounts of the court-martial identify a dramatic announcement by a high-ranking

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17. *Id.* at 1333.

18. ARMAND CHAPENTIER, HISTORIQUE DE L'AFFAIRE DREYFUS 47 (1933).

19. *Id.* The British historian, Guy Chapman, provides a slightly different account:

[Bertillon's system] was complex and needed lots of explanation with the aid of diagrams and blackboards. The court heard him through for an hour, stunned by his unintelligible verbosity. All they understood was that Bertillon believed that Dreyfus had forged the *bordereau* in a mixture of his own hand and those of his wife and brother.

GUY CHAPMAN, THE DREYFUS TRIALS 48 (1972).

intelligence official that an "honorable person" informed him that Dreyfus was a traitor as the event that swayed the previously doubtful tribunal.<sup>20</sup>

Although the actual impact of Bertillon's pseudo-science in the first court-martial is difficult to gauge, in all the subsequent proceedings, other experts exposed Bertillon's "proofs" as vacuous.<sup>21</sup> In the Rennes court-martial, for example, a letter provided by the world-renowned mathematician, Henri Poincaré, identified "colossal errors" in Bertillon's analysis and flatly declared that no unprejudiced person with a scientific education could possibly find any merit in it.<sup>22</sup> In a meticulous report prepared at the request of the *Cour de Cassation*, Poincaré and two other distinguished scholars showed that the supposedly improbable coincidences said to confirm Dreyfus's authorship of the *bordereau* were of the type and frequency to be expected when one searches for any and all coincidences.<sup>23</sup> For instance, the relevant probability for the four coincidences in the initial and final letters of the 13 polysyllabic words is not .0016. That figure is the probability of exactly four

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20. *E.g.*, J. BREDIN, *supra* note 10, at 94, quoting A. CHARPENTIER, LES COTÉS MYSTÉRIEUX DE L'AFFAIRE DREYFUS 70 (1930), as reporting that this baseless testimony was "the stroke of the bludgeon that brought Dreyfus down."

21. Those who describe the expert testimony as directed to the relative frequencies of specific letters report that eminent mathematicians explained to the court that while the precise distribution of letters in the allegedly coded message may have been unusual, some such departure from the average was not especially unlikely. Among the many possible proportions in which the letters might appear, any particular set of proportions—even the most likely—is individually improbable. To appreciate this point, consider tossing a balanced coin 100 times. The single most probable outcome is 50 heads and 50 tails, but its probability is less than 1/10. Thus, the mathematician Painlevé, who was to become Prime Minister of France, reputedly declared: "Give me the works of Racine and I will show you that he, too, by your foolish tests, is a traitor, for the works of Racine like the letters of Dreyfus, do not show the most probable distribution." Gray, *supra* note 15; Mode, *supra* note 15 (citing Hedrick, *supra* note 15).

22. LA REVISION DU PROCÈS DE RENNES, RÉQUISITOIRE ECRIT DE M. LE PROCUREUR GÉNÉRAL BAUDOIN 117 (1907).

23. Tribe, *supra* note 5, at 1333; *Rapport de Mm. Les Experts Darboux, Appell, et Poincaré*, in 3 L'AFFAIRE DREYFUS: LA REVISION DU PROCÈS DE RENNES 500 (1909).

coincidences in four words. The probability of four *or more* out of 13 is approximately .7, indicating that such "coincidences" are common.<sup>24</sup>

Thus, the *Dreyfus* case is a clear example of an early abuse of probability theory, but it is not a compelling example of judges or jurors beguiled and bemused by mathematics into convicting an innocent person. The courts-martial and related proceedings were so imbued with anti-Semitism, political machinations, and outright perjury, forgery and fabrications that the mathematical errors pale in significance.<sup>25</sup> Bertillon's forensic forays were more often greeted with ridicule than respect.<sup>26</sup> In the Zola trial, for instance, the reaction to Bertillon's testimony about the "infallible and transcendent method of graphology" was "laughter from the audience."<sup>27</sup> It is not

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24. Tribe, *supra* note 5, at 1333.

25. Martin, *supra* note 10, at 45-46, describes the Rennes trial as follows:

Brought back from his hellish prison stay, Dreyfus appeared a broken man and inspired little confidence. In contrast, the military officers who testified against him . . . were much more impressive. Because of the lax rules of evidence, they were permitted to make impassioned denunciations and to repeat hearsay, much of it long since discredited. Trained magistrates might have sorted through the maze of testimony, but the seven officers on the court-martial board were hardly that. The prosecution argued that Dreyfus's guilt was proved not by a single document or act but by a cat's cradle of evidence that resolved into a pattern indicating that he was a traitor. Unable to discredit every accusation and every document, the defense could not prevail against this nebulous case.

26. JACQUES KAYSER, *THE DREYFUS AFFAIR* 346-47 (N. Bicklet transl. 1931).

27. LOUIS L. SNYDER, *THE DREYFUS CASE: A DOCUMENTARY HISTORY* 300 (1973). At the Rennes court-martial, one witness, a skilled draftsman, showed that Bertillon's measurements of the spacing and positions of letters were inaccurate, and another expert "by applying Bertillon's argument to any page of writing taken up at random, succeeded in demonstrating geometrically and infallibly that that page was a forgery. To the accompaniment of laughter of the whole court, he made use of a page of M. Bertillon's own report for his demonstration! Learned members of the Institute and professors at the Ecole des Chartes also gave evidence which completely destroyed Bertillon's deposition, and all were agreed in declaring once again that the *bordereaux* was written by Esterhazy."

surprising, then, that most accounts do not identify the mathematical testimony as an important cause of the convictions.<sup>28</sup> The opposite view that Professor Tribe injected into the legal literature and case law is based on an obvious misreading of one of these accounts.<sup>29</sup>

Flimsy accusations, supported only by vague character evidence, fabricated hearsay, forged documents and pathological science, make the Dreyfus affair a fascinating chapter in legal history. But it is a poor example of the supposed power of mathematics to paralyze critical thought and to insulate itself from effective

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28. *See, e.g.*, BREDIN, *supra* note 10; CHAPMAN, *supra* note 19.

29. Tribe, *supra* note 5, at 1333–34, cites Charpentier, *supra* note 18, for the view that the Rennes court was "mystified" and "impressed by the scientific phraseology of the system." Charpentier, however, was speculating about the 1894 Paris court-martial. *See supra* text accompanying notes 18–19.

At Rennes, Bertillon was called as the 61st witness. He "went into a long-winded defense in incomprehensible and unintelligible terms of his 'infallible system.'" SNYDER, *supra* note 27, at 300. According to a contemporaneous report in the *London Times*, Bertillon was "absolutely, even ridiculously unintelligible. . . . The Judges and the counsel for the defense assumed an attitude of unimpeachable correctness, and did their best to understand. The public and the journalists, on the contrary, after an hour's heroic effort . . . gave up the task and repaired to the courtyard of the Lycée, there to exchange ideas on the possibility of human credulity." *Id.* at 301. The next two experts to testify did "an effective job in ridiculing Bertillon's evidence." *Id.* at 305. The first "demonstrated with the aid of a blackboard the fallacy of Bertillon's calculations." *Id.* at 305–06. The second "aroused laughter by showing a page borrowed from a report by Bertillon himself and confusing him with it." *Id.* at 306. Likewise, in describing the 1899 trial, Charpentier writes that several experts, including Poincaré, "demonstrated the incoherence and the stupidity of Bertillon's system." Charpentier, *supra*, at 229. *See also id.* at 272.

Nevertheless, one member of the court-martial found Bertillon's approach convincing (*id.* at 229), but surely not because "[t]he very opacity of these demonstrations protected them to some degree from effective spontaneous criticism." Tribe, *supra* at 1333. In advancing these thoughts, Tribe presumably meant to refer to the 1894 trial, where Bertillon's success in impressing the judges was at least a possibility. *See supra* note 18.

refutation. If anything, the *Dreyfus* cases demonstrate that forensic abuses of applied probability can be detected and corrected.

This reconstruction of the events in *Dreyfus* does not mean that "probability evidence" is innocuous and should be routinely admitted. A single set of proceedings, conducted under the glare of publicity in a highly politicized atmosphere, could hardly support so sweeping a claim. But neither can the *Dreyfus* cases be relied on for the proposition that "probability evidence" is too mystifying to be admissible. The apparent consensus in the legal literature that the convictions are paradigmatic of the paralysis of "critical examination" induced by "mathematical evidence"<sup>30</sup> is, on balance, inconsistent with the historical record. Whether the dangers of such evidence are any greater than those of more conventional modes of proof remains an important question for the law of evidence,<sup>31</sup> but the resolution of this issue should no longer be influenced by a dubious reconstruction of the past.

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30. *See supra* note 7.

31. *See, e.g.*, *United States v. Morrow*, 374 F.Supp.2d 51, 63 (D.D.C. 2005) (rejecting defendant's motion to exclude testimony about a DNA identification because of the possibility of confusion over the odds of a DNA match but indicating a willingness to reconsider the issue at trial); *United States v. Coleman*, 202 F.Supp.2d 962 (E.D.Mo. 2002) (suggesting that a geneticist's testimony in a case involving mitochondrial DNA identification that there is a "95 percent chance that 99.93 percent of the people in North America don't have this type" would not be unfairly prejudicial); Daniel Shaviro, *Statistical-Probability Evidence and the Appearance of Justice*, 103 HARV. L. REV. 530 (1989); *Symposium: Debate on Statistics and Evidentiary Theory*, 65 TULANE L. REV. 457 (1991).