Admissibility of DNA Genetic Profiling Evidence in Criminal Proceedings: The Case for Caution

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I. INTRODUCTION

Since its debut in a Florida courtroom in 1987, DNA "fingerprinting" evidence has captured the attention of prosecutors, defense attorneys and the popular press. As the newest method of establishing identity, DNA profiling has been widely touted as "the most powerful, most accurate piece of forensic evidence that's ever been created." DNA profiling was developed by molecular biologists for use in the genetic research of inherited diseases. DNA testing has since been heralded as the answer to legal quandaries ranging from murder to paternity. Using minute traces of genetic material extracted from seemingly harmless sources such as a single strand of hair, a speck of dried blood, a drop of saliva, or a semen stain on a bedsheets, DNA testing is often referred to as DNA "fingerprinting," this term is disfavored because of its tendency to "create unsubstantiated beliefs and expectations in the minds of judges and jurors." Therefore, this Comment will refer to this technique as either DNA "profiling," "analysis," or "testing."


2. While DNA testing is often referred to as DNA "fingerprinting," this term is disfavored because of its tendency to "create unsubstantiated beliefs and expectations in the minds of judges and jurors." Burk, DNA Fingerprinting: Possibilities and Pitfalls of a New Technique, 28 JURIMETRICS J. 455, 468-69 (1988). Therefore, this Comment will refer to this technique as either DNA "profiling," "analysis," or "testing."

3. See, e.g., Moss, DNA—The New Fingerprints, A.B.A. J., May 1, 1988, at 52 (noting that DNA profiling "could revolutionize law enforcement"); Lewis, supra note 1, at 52 (DNA typing is the greatest boon to forensic biology since fingerprinting).


5. See White, Lalouel, Lathrop, Leppert, Nakamura & O'Connell, Mapping Approaches to Gene Identification in Humans, 147 W.J. MED. 423, 423 (Oct. 1987) (noting the use of DNA testing to diagnose a predisposition toward inheritable genetic diseases such as sickle-cell anemia, Huntington's Disease, and muscular dystrophy).

6. Burk, supra note 2, at 455. DNA testing is used in establishing parentage. By comparing the DNA prints of the child and the alleged parents, experts can establish family blood lines with unprecedented precision." Thompson & Ford, DNA Typing: Promising Forensic Technique Needs Additional Validation, TRIAL, Sept. 1988, at 56. While the admissibility of DNA testing in civil actions such as paternity cases is also not fully resolved, this Comment confines its examination to the admissibility of DNA testing in criminal cases, where the need for reliability and precision of scientific methods is greatest.

7. Moss, supra note 3, at 66. Urine samples cannot be utilized in the DNA screening process because urine does not contain DNA. Comment, DNA Identification Tests and the Courts, 63 WASH. L. REV. 903, 909 n.27 (1988).
testing attempts to identify criminals by "matching" the suspect's own DNA with samples acquired at the crime scene.\(^8\)

Although DNA profiling technology is still in its forensic infancy, the technique has permeated the legal system with amazing speed,\(^9\) leaving defense attorneys reeling in its wake.\(^{10}\) Oddly enough, the seemingly resigned complacency of defense attorneys confronted with DNA evidence has fueled DNA's meteoric transition from the scientific laboratory to the court of law.\(^{11}\) Thus, DNA testing experienced a relatively tranquil initiation into the legal system. However, defense attorneys and various segments of the scientific community have recently awakened to potential problems with the reliability of DNA evidence. DNA, like several innovative evidentiary techniques before it, has finally come under attack.\(^{12}\) The question now seems to be whether DNA has earned its place in court because of its accuracy and reliability as a tool of identification, or whether judges, juries, and defense attorneys, like laypersons, have been dizzied by the whirlwind of scientific terminology and overzealous claims of the media and the commercial laboratories which perform DNA testing.\(^{13}\)

This Comment will assess the present status of DNA testing, focusing particularly on the legal questions stemming from the technique's strengths and limitations when put to forensic applications. Part II provides a basic explanation of DNA and the scientific principles underlying DNA profiling. This background is essential in order to competently evaluate the reliability and admissibility of DNA test results. Part II also profiles the two distinct methods of DNA typing currently offered by commercial laboratories in the United States. Part III presents a discussion of the two principle legal standards for

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8. Moss, \textit{supra} note 3, at 66. DNA profiling offers several advantages over traditional methods of examining biological specimens. For example, DNA profiling is more precise and reliable than blood group typing and can be performed on samples of a much smaller size. Thompson & Ford, \textit{supra} note 6, at 56. See also, Moss, \textit{supra} note 3, at 66-67 (outlining advantages of DNA profiling).

9. Between 1987 and 1989, DNA profiling evidence was utilized in approximately eighty cases throughout the nation. Williams, \textit{supra} note 4, at 26.

10. Houston defense attorney Moses Sanchez, after losing a criminal case in which DNA evidence was introduced, stated:

   It's devastating. When an expert comes in and says there's a one in 700 million chance that your man is not the one—and you know he's one of only 30 million black men in the country—it just kills you. It intimidates the jury.

   The defense bar better get ready.


11. In each of the first three appellate criminal cases in which DNA evidence was admitted by the court, defense attorneys failed to call any expert witnesses to challenge the introduction of the DNA test results. See \textit{infra} notes 174, 195, 206 and accompanying text.


the admissibility of novel scientific evidence and the problems associated with each. Part IV analyzes the admissibility of DNA evidence within the framework of each admissibility standard, and concludes that the present state of DNA technology has not yet achieved the level of reliability required by either standard. Part V examines the four criminal decisions involving DNA evidence which have reached the state appellate level thus far. Finally, Part VI delves beyond the parameters of admissibility, focusing on potential abuses associated with DNA profiling. In particular, this Comment will address the constitutional issue of the fourth amendment protection against illegal search and seizure as it applies to the taking of genetic samples. Additionally, in light of DNA’s unequalled ability to reveal personal information unrelated to identity, the possibility of a nationwide DNA data bank will be explored in terms of constitutional protections of individual privacy.

II. SCIENTIFIC BACKGROUND

A. A Simplistic Explanation of DNA

The human body is composed of individual units called cells. In turn, each cell contains 46 chromosomes arranged in 23 sets of two. One chromosome per pair is inherited from each parent. It is these chromosomal capsules which hold the genetic information known as deoxyribonucleic acid, commonly referred to as DNA. The DNA molecule is arranged in a double helix configuration. The rungs of this “twisted ladder” consist of genetic building blocks called bases. There are four types of bases, known by the designations “A,” “T,” “C,” and “G.” These bases join in pairs in a system-


15. Kelly, Rankin & Wink, Method and Applications of DNA Fingerprinting: A Guide for the Non-Scientist, 1987 CRIM. L. REV. 105, 106 [hereinafter Kelly]. During meiosis, the process of egg or sperm formation, portions of the chromosomes are rearranged. Thus, a child will possess traits which are recognizably similar, but not identical, to his parents. Id. at 108.

16. Id. at 105-06. See also, Burk, supra note 2, at 456.

17. Contrary to common belief, all molecules are not miniscule. When stretched to its full length, the DNA molecule measures over six feet in length. Note, The Dark Side of DNA Profiling: Unreliable Scientific Evidence Meets the Criminal Defendant, 42 STAN. L. REV. 465, 469 (1990).

atic fashion: "A" always joins with "T," and "C" always joins with "G." One author likens the structure of DNA to a "zipper" having bases for teeth. This zipper of coded information will only zip up with a strand of DNA having a corresponding sequence of bases along the chain. Once the DNA strand is zipped, each sequence of bases along the chain of the DNA molecule is "read" by the cell and translated into a physical characteristic. Thus, all the components of a person’s appearance which make him unique—for example, height, build, hair and eye color—are predetermined by DNA. Each person’s molecular pattern of DNA is itself unique. It is this factor of undisputed distinctiveness which is the basis of all forms of DNA testing.

B. The Goal of DNA Profiling

DNA profiling operates under a very simple premise: No two individuals have identical ordering of DNA base sequences; therefore, two samples which match must necessarily have come from the same person. Inherent in this theory is the assumption that, if there are differences in two DNA samples, the laboratory technician will be able to detect them. This is not an easy task. Because all human beings belong to the same species, they are much more anatomically similar than different. Consequently, the vast majority of DNA base pair sequences do not vary from person to person.

However, DNA profiling is possible due to the recent discovery of techniques which allow scientists to locate regions of DNA where dramatic variations between individuals do occur. These areas of variation are known as polymorphisms.

19. Kelly, supra note 15, at 106; Burk, supra note 2, at 457. While the bases always join with a corresponding mate, each person’s DNA has an individualized order of base pairs. Comment, supra note 7, at 910. “A,” “T,” “C,” and “G” stand for adenine, thymine, cytosine, and guanine, respectively.


21. Comment, supra note 7, at 909. DNA is often referred to as a genetic blueprint because it possesses all the information necessary to assemble the entire human body. Thompson & Ford, supra note 6, at 58. However, each cell reads only the portion of the blueprint which pertains to its specific function. Burk, supra note 2, at 457.


23. Thompson & Ford, supra note 6, at 58. For example, all human beings normally have two arms, two legs, and one head. These common features are the result of similar sequences of DNA shared by all individuals. Lewis, supra note 1, at 47.

24. Thompson & Ford, supra note 6, at 58.

25. Id. The first polymorphic site was discovered by A. Wyman and R. White. Comment, supra note 7, at 911 n.34. Since this breakthrough, scientists have identified more than three thousand polymorphic regions. Lander, DNA Fingerprinting on Trial, 339 NATURE 501, 501 (1989).
C. Overview of Current DNA Profiling Techniques

Polymorphic DNA segments can be detected and analyzed in two ways. Of the three commercial laboratories\(^{26}\) in the United States which perform DNA profiling tests, Cellmark Diagnostics\(^{27}\) and Lifecodes\(^{28}\) employ the first method, known as “restriction fragment length polymorphism (RFLP) analysis.”\(^{29}\) The remaining laboratory, Cetus,\(^{30}\) examines polymorphic segments via an alternative method called “allele specific probe analysis.”\(^{31}\) Because RFLP and allele specific probe analysis differ greatly in both theory and procedure, a brief explanation of each technique is warranted.

1. RFLP Analysis

This approach involves breaking the chain of DNA into small segments, locating the polymorphic sites,\(^{32}\) and then measuring the length of these polymorphic fragments.\(^{33}\) Polymorphic fragments vary dramatically in length among different individuals, offering a promising method of identification.\(^{34}\)

This process is accomplished in seven basic steps.\(^{35}\) First, a relatively pure sample of DNA is extracted from forensic evidence.\(^{36}\)

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26. Cellmark Diagnostics, Lifecodes Corporation, and Cetus Corporation. Moss, supra note 3, at 66-67. A fourth DNA typing laboratory was opened by the FBI in January, 1989. Its services are available free of charge to any law enforcement agency nationwide. During its first year of existence, the FBI lab received over seven hundred requests for DNA profiling. Williams, supra note 4, at 31.

27. Cellmark Diagnostics, based in Germantown, Maryland, was the first American laboratory to introduce the technique developed by British geneticist Alec Jeffreys. Thompson & Ford, infra note 29, at 56.

28. Lifecodes Corporation is based in Elmsford, New York. Id.


30. Id. Cetus Corporation is based in Emeryville, California. Thompson & Ford, supra note 6, at 56.

31. Thompson & Ford, supra note 29, at 64.

32. This is accomplished through the use of genetic probes. Genetic probes are small pieces of DNA selected specifically because they possess base sequences complementary to the sequence which the scientist desires to lock onto. Thompson & Ford, supra note 29, at 63 n.83 and accompanying text.

33. Thompson & Ford, supra note 6, at 58. See also Thompson & Ford, supra note 29, at 63-64.

34. Id.

35. See Thompson & Ford, supra note 29, at 64-76 (outlining seven scientific procedures undertaken in RFLP analysis).

36. The biological material is chemically and enzymatically treated in order to release the DNA. Then the DNA is treated with enzymes and organic solvents in order to purify it. Id. at 65. In cases of rape involving more than one perpetrator, DNA profiling results are often inconclusive due to the commingling of seminal fluid from dif-
Next, the DNA is cut into segments with a mixture of restriction enzymes. Some, but not most, of the resulting fragments contain polymorphic DNA segments.

The third step consists of a sorting process known as gel electrophoresis. The DNA restriction fragments are placed in agarose gel, a substance which closely resembles Jell-O. An electrical current is then sent through the gel, causing the fragments to move toward the opposite end of the tray. The longer DNA fragments move more slowly through the gel than the shorter DNA fragments. Thus, when the electric current is removed, the DNA fragments will have moved different distances and will be dispersed across the gel in correlation to their length.

The fourth step in RFLP analysis is called Southern Blotting. The array of DNA fragments is transferred from the gel slab onto a thin nylon membrane. This transfer creates a blot.

The fifth step in RFLP analysis is known as hybridization. In hybridization, a radioactive genetic probe is introduced to the collection of fragments. The probe sorts out the polymorphic segments of DNA—those that will differentiate among individuals—from the millions of other segments. The genetic probe locks onto the polymorphic fragments and excludes all others. The probe's radioactive source. However, the combination of seminal and vaginal secretions poses no such problem. See Burk, supra note 2, at 464.

37. Thompson & Ford, supra note 29, at 65. There are two problems associated with DNA extraction: insufficient quality of DNA and contaminated DNA. Id. at 65-67. See also supra note 7 and accompanying text (forensic evidence amenable to DNA typing).

38. These restriction enzymes, "biological scissors," seek out particular base sequences, typically four to twelve base pairs in length, and sever the pairs from the remainder of the DNA strand. The severance locations are called restriction fragments. Comment, supra note 7, at 912 n.42.

40. Id.
41. Burk, supra note 2, at 459.

42. Thompson & Ford, supra note 29, at 69. The electrical current causes DNA, a negatively charged molecule, to migrate toward the positive pole at the end of the tray. Id. at 69 & n.114; Burk, supra note 2, at 459.

43. Thompson & Ford, supra note 29, at 69. This concept is easily visualized if one thinks of people running through a dense forest carrying batons of varying lengths. Persons carrying the longer batons will naturally have more difficulty navigating through the trees and, therefore, will move more slowly than those carrying the shorter batons. Burk, supra note 2, at 459-60.

44. Thompson & Ford, supra note 6, at 59.


46. Thompson & Ford, supra note 29, at 71. The purpose of this transfer is simply to avoid the inconvenience of manipulating the DNA while it is in the "messy" gel. Burk, supra note 2, at 460.

47. Thompson & Ford, supra note 29, at 71.

48. Id. This process is like passing a large magnet over a haystack in order to locate several needles within the mountain of hay. Id.
activity ensures that the researcher can locate the position of the fragments on the blot.49

Lifecodes' “DNA-Print” test utilizes a single-locus probe. In criminal cases, Cellmark utilizes this same technique.50 The single-locus probe is designed to bond with DNA sequences that occur only once on the DNA strand. This technique normally results in a DNA print consisting of two bands.51

Once the radioactive probe has bound itself to the polymorphic segments, the sixth step in RFLP analysis is undertaken. In this step, called autoradiography, the blot is put on x-ray film.52 A pattern of dark bands will appear on the x-ray film, marking the locations of the radioactive probes, and thus, the location of the polymorphic segments of DNA.53

Finally, the DNA print is interpreted. This is accomplished by comparing the pattern of bands from the crime scene specimen with the sample taken from the criminal suspect or victim. The matching of the samples can be performed visually by human technicians or by computer.54

2. Allele Specific Probe Analysis

The process utilized by Cetus Corporation is much simpler than RFLP, but not necessarily as useful in criminal cases. Instead of measuring the length of polymorphic segments, this test uses probes to determine whether segments, known as alleles, are present in a DNA sample.55

Using extreme heat and cold, the number of alleles in a DNA sample is amplified, creating millions of alleles where only one may have

50. Id. at 72. Cellmark utilizes a multilocus probe in paternity cases. The multilocus probe seeks out and bonds with DNA sequences in more than one polymorphic locus which results in approximately fifteen interpretable bands. Id. This Cellmark test is much more specific, but harder to interpret, than the single-locus probe technique. Id.
51. Thompson & Ford, supra note 29, at 72. This is because chromosomes come in pairs; one inherited from each parent. However, if both parents have the same blood type, only one band will be produced on the Lifecodes DNA print. Id. at 72 & n.125
52. Thompson & Ford, supra note 29, at 74.
53. Id.
54. Id.
55. Thompson & Ford, supra note 6, at 62. “If the length polymorphism approach is like using a magnet to find a needle in a haystack, allele specific probes are like using a metal detector to see if a particular type of needle is present or not.” Id.
been present before. Next, a probe is added to the sample. If the desired allele is present, the probe will attach itself to it. Finally, the sample is placed on x-ray film, where a dot will appear if the probe has connected with the allele being sought. Thus, the Cetus process gives a simple yes or no answer. This is somewhat of a drawback, however, for a significant portion of the population may possess the same allele. Thus, a series of probes is necessary in order to distinguish between individuals with any degree of certainty.

Having reviewed the technology involved, the legal aspects which bear on the admissibility of DNA profiling will now be considered.

III. THE LEGAL STANDARD FOR ADMITTING DNA TYPING EVIDENCE

Before admitting novel scientific evidence, a court must screen the underlying technique to ensure the reliability of its results. The legal admissibility of DNA typing evidence can be determined only after deciding what legal standard should govern. Traditionally, courts have relied on one of two alternative tests in evaluating the reliability of novel scientific evidence. The majority of jurisdictions still utilize the test set forth in Frye v. United States (the Frye test). An increasing minority of states, however, employ the more liberal standard of the Federal Rules of Evidence (the Federal Rules test).

A. The Frye Test

In 1923, the D.C. Circuit Court of Appeals considered the admissibility of systolic blood pressure evidence in a case of first impres-
In an eight-paragraph opinion which cited no authority for its conclusion, the court precluded the introduction of the evidence and announced the following standard as the threshold for admissibility: Evidence derived from innovative scientific techniques will be admissible only after the theory has gained general acceptance within the relevant scientific field. The foundational premise of the Frye rule is that "general acceptance" is indicative of reliability. "Once a procedure is sufficiently established to have gained general acceptance in the particular field in which it belongs, it presumably has gone through an extended period of use and testing within the scientific community and is reliable."

1. Justifications for the Frye Test

Beyond the assurance of reliability, several other justifications for the Frye test exist. Supporters stress that the concepts underlying novel scientific evidence are often beyond a lay person's ability to understand and critically evaluate. The Frye standard attempts to correct this weakness by placing the determination of reliability in the hands of experts familiar with the theory. "In effect, a technical jury passes judgment on the probative value of the evidence before it is presented to a lay jury, which might be unduly swayed by the perceived infallibility of 'science.'" In this way, the Frye test relieves the court of the burden of establishing per se reliability. Instead, the judge need only satisfy himself that experts in the relevant field consider the technique reliable.

66. Id. at 1014. In a frequently quoted passage, the court stated:
   Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.
69. Comment, supra note 7, at 933. See United States v. Addison, 498 F.2d 741, 743-44 (D.C. Cir. 1974) (scientists are better equipped than courts or lay juries to assess reliability); People v. Kelly, 17 Cal. 3d 24, 31, 549 P.2d 1240, 1244, 130 Cal. Rptr. 144, 148 (1976) (scientific community which developed the novel evidentiary technique should determine its reliability).
70. Thompson & Ford, supra note 29, at 54 (noting that judges can more easily assess the opinion of experts than the reliability of the technique itself).
Another justification for the Frye test is its assurance that at least a minimum number of experts are able to review the reliability of the innovative evidence. This forecloses the possibility that litigants will be unable to challenge the evidence due to an inability to locate knowledgeable experts.71 Defendants of the Frye test also emphasize that the standard eliminates the need to re-examine a novel technique's admissibility in subsequent cases once the issue has been decided.72 Finally, the Frye standard promotes uniformity in decisions.73

2. Criticism of the Frye Test

While the majority of courts have embraced the Frye test, the standard has been the target of several “scathing” attacks.74 Some critics find fault with the premise of the test. One court derided the Frye standard, stating that “[a] determination of reliability cannot rest solely on a process of ‘counting [scientific] noses.’”75 Other commentators point to difficulties in applying the test, characterizing it as vague and ambiguous.76 Much of the alleged ambiguity is caused by the Frye court’s failure to quantify the standard by which a scientific technique may be considered “generally accepted.”77 Courts have also encountered difficulty in identifying the “relevant field” of science to which the technique belongs and from which the elusive

71. Id. (citing United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974)).
72. Note, supra note 64, at 779. See also Reed v. State, 283 Md. 374, 388, 391 A.2d 364, 371 (1978) (“Without the Frye test or something similar, the reliability of an experimental scientific technique is likely to become a central issue in each trial in which it is introduced, as long as there remains serious disagreement in the scientific community over its reliability.”).
73. People v. Kelly, 17 Cal. 3d 24, 31, 549 P.2d 1240, 1244-45, 130 Cal. Rptr. 144, 148-49 (1976). The court stated that: “Individual judges whose particular conclusions may differ regarding the reliability of particular scientific evidence, may discover substantial agreement and consensus in the scientific community.” Id. at 31, 549 P.2d at 1245, 130 Cal. Rptr. at 149. See also, Reed, 283 Md. at 387-88, 391 A.2d at 370-71 (pointing out that decisional inconsistency is avoided).
75. United States v. Williams, 583 F.2d 1194, 1198 (2d Cir. 1978) (“In testing for admissibility of a particular type of scientific evidence, whatever the scientific ‘voting’ pattern may be, the courts cannot in any event surrender to scientists the responsibility for determining the reliability of that evidence.”).
76. See Giannelli, supra note 74, at 1223. See also Williams, 583 F.2d at 1198 (noting that “[d]ifficulty in applying the ‘Frye test’ has led a number of courts to its implicit modification”).
77. See Giannelli, supra note 74, at 1205, 1210-11. See also Note, supra note 64, at 780.
“general acceptance” of experts must be drawn.78

However, the most compelling argument against Frye is that it requires the exclusion of valuable scientific evidence until such time as it attains widespread acceptance.79 This delay between development in the laboratory and introduction to the courtroom is viewed by some as a frustration of the search for truth and justice.80 These criticisms have led some jurisdictions to abandon the Frye test in favor of more liberalized standards of admissibility which focus on the weight of the evidence rather than its reputation in the scientific community.81

B. The Federal Rules Test

The principal alternative to the Frye test is the relevancy standard contained within the Federal Rules of Evidence.82 Under the Federal Rules test, novel scientific evidence is treated in the same manner as other evidence. The fact that the evidence is derived from an innovative technique is not necessarily a bar to admissibility.83 Under the relevancy approach, the validity of novel scientific evidence is ana-

78. See Gianelli, supra note 74, at 1208-10. One author stated:
   “Deciding what is the proper field to which a novel test belongs is in itself a
   chore. Most novel tests represent new approaches to the solution of old
   problems by a process which is unknown, or belongs to a different field. Be-
   cause of this, the person developing a novel test frequently finds himself on
   the fringes of his scientific discipline, and perhaps overlapping into other
   disciplines.”
Moenssens, supra note 74, at 17.

79. See Gianelli, supra note 74, at 1223-24; Imwinkelried, supra note 63, at 265.
   “During the 1970’s, Frye proved to be a formidable barrier to the introduction of prose-
   cution scientific evidence. . . . Defense counsel invoked Frye so successfully that the
   commentators almost unanimously deplored the fact that Frye banned many promis-
   ing forensic techniques from the courtroom.” Imwinkelried, supra note 63, at 263.

    1974) (refusing to apply Frye test in probation revocation case)).

81. See Gianelli, supra note 74, at 1228-31 (current acceptance of the Frye test).

82. MCCORMICK ON EVIDENCE §§ 202, 203 (2d ed. 1972). See also 3 J. WEINSTEIN &
    M. BERGER, WEINSTEIN’S EVIDENCE § 702[03] (1980) (advocating a balancing approach
    weighing probative value of novel scientific evidence against other factors such as the
    necessity of the evidence and the possibility of utilizing limiting instructions).

83. Rule 401 defines relevant evidence as “evidence having any tendency to make
    the existence of any fact that is of consequence to the determination of the action
    more probable or less probable than it would be without the evidence.” FED. R. EVID.
    401.

Under Rule 402, “all relevant evidence is admissible, except as otherwise provided
by the Constitution of the United States, by Act of Congress, by these rules, or by
other rules prescribed by the Supreme Court pursuant to statutory authority. Evi-
ence which is not relevant is not admissible.” FED. R. EVID. 402.
lyzed in terms of its probative value. Expert testimony regarding novel scientific evidence is generally admissible if it is helpful to the trier of fact and probative of a material issue. However, this evidence will be excluded if the probative value of the evidence “is substantially outweighed by the danger of unfair prejudice.”

1. Probative Value

The threshold of admissibility under the Federal Rules test is a demonstration that the proffered evidence has some degree of probative value. In order to be probative, evidence must be relevant. Relevance, in turn, necessarily depends upon reliability. Because most judges are unable to evaluate the reliability of a scientific technique based on either prior experience or logical inference, the court is usually forced to rely on the opinions of scientific experts.

While general acceptance of the technique by experts in the relevant field (the Frye standard) would fulfill the requirement of reliability and, hence, probative value, no such “general acceptance” is required under the Federal Rules. In fact, the opinion of one qualified expert may be enough to establish probative value under the Federal Rules test. Thus, in comparison to Frye, the Federal Rules provide a more lenient standard, favoring the admissibility of evidence.

2. Dangers of Unfair Prejudice

While a particular piece of evidence may be probative, it is not necessarily admissible. The Federal Rules grant the court discretion to exclude evidence upon finding that the danger of admitting the evidence substantially outweighs its probative value. The principal

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84. Giannelli, supra note 74, at 1235.
85. See FED. R. EVID. 702 (testimony by experts).
86. See FED. R. EVID. 403 (exclusion of relevant evidence on grounds of prejudice).
87. FED. R. EVID. 401. See also Giannelli, supra note 74, at 1247 n.379. (“Under the relevancy approach, the validity of a novel technique is analyzed in terms of its probative value. If a technique is not valid or reliable, results derived from that technique are not considered probative.”).
88. See United States v. Ridling, 350 F. Supp. 90, 94-95 (E.D. Mich. 1972) (“acceptance of the basic theory is part of the process of making the evidence relevant”); State v. Williams, 388 A.2d 500 (Me. 1978) (“voiceprint” analysis held sufficiently reliable to be relevant).
89. Giannelli, supra note 74, at 1235-36.
90. See also Strong, Questions Affecting the Admissibility of Scientific Evidence, 1970 U. ILL. L.F. 1, 22. (“In the case of scientific evidence the court will generally be forced to accept the probative value of the evidence as what a qualified expert testifies it to be”) (emphasis in original).
91. Giannelli, supra note 74, at 1236.
92. See Comment, supra note 7, at 935-38.
93. FED. R. EVID. 403. The rule states that: “Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejud-
danger associated with the introduction of novel scientific evidence is its tendency to mislead the jury. In spite of this latitude, courts tend to apply the test liberally and admit most evidence.94

IV. APPLICATION OF THE LEGAL STANDARDS TO DNA PROFILING

A. Admissibility of DNA Profiling Under the Frye Test

In assessing the admissibility of DNA profiling under the Frye standard, uncertainties abound. Uncertainties, not only as to the end result, but also as to the standard itself. Indeed, where a court ends up is largely determined by its choice of a starting point.95 The first step which a court must take in applying the Frye test to DNA evidence is to determine the relevant field in which DNA profiling belongs.96

Like many other scientific techniques, DNA profiling is not easily compartmentalized within the exclusive domain of a single profession or scientific field.97 The areas of molecular biology, genetics, population genetics, chemistry, biology, and biochemistry have been suggested as suitable choices for DNA profiling.98 While these categories seem appropriate at first glance, there are problems associated with each of them.

By selecting fields such as biology and chemistry, the judiciary would be drawing an arena which is too broad, encompassing a majority of scientists who have little or no practical experience with DNA profiling techniques. If this were in fact the relevant field, DNA profiling would not be able to garner the general acceptance necessary under Frye because the majority of these scientists have no connection with DNA testing.

However, narrowing the field to those scientists who perform DNA testing is likewise an untenable position. Such a category is still too
broad, for it primarily embraces molecular biologists and geneticists
who have employed the technique only in the research laboratory, a
setting fundamentally unlike a forensics crime lab where accurate re-
results are crucial. Indeed, scientific researchers are exceedingly toler-
ant of error, secure in the knowledge that unanticipated results will
be verified through a highly repetitive research process. Moreover,
most scientific research will, in all likelihood, be duplicated by other
researchers working independently on the same project. Thus, any error in theory or technique utilized by the researcher will usu-
ally be brought to light.

Forensic laboratories, by contrast, lack such safeguards. Errors in
DNA testing could quite easily go undetected if the results are not
diametrically opposed to the prosecutor's theory. The suspects to
whom other evidence points the finger of guilt, and thus the individu-
als most in need of accurate testing results, would therefore be at
great risk of injustice.

Therefore, due to the medical researcher's high threshold for er-
ror, perhaps their general acceptance also should not be the standard
by which to gauge the admissibility of DNA analysis in criminal
cases. It has been suggested that a better choice for the "relevant
field" would be scientists who are experienced in making critical de-
cisions based on the results of a single DNA test: medical diagnosti-
cians, for example.

However, problems exist with this selection as well. While scient-
ists involved in medical diagnosis may be experienced in DNA typ-
ing, their experience consists exclusively of performing DNA analysis
on clean, fresh genetic samples. Unfortunately, the samples
presented to crime labs are usually less pristine. In fact, contami-
nated specimens are the rule rather than the exception in the crime
lab. For example, DNA samples derived from crime scenes may
be subject to bacterial contamination, physiological alteration.

100. Id.
101. Id. at 57.
102. Id. at 56-57.
103. Id. at 56. See also id. at 66-67 (examining reliability of DNA typing on contam-
ninated samples).
104. Id. at 56. In discussing his experience with DNA samples in both research and
forensic laboratories, one scientist explained that, in a research laboratory, sterility of
the sample is a paramount concern. Accordingly, if a sample accidentally falls on the
floor, it typically is not used. However, "in forensics, all of the samples have been on
the floor, so you don't really know what you've got." Cooke, Standards Sought for
105. Bacterial contamination can cause erroneous hybridization of the DNA mole-
cule, resulting in the appearance of false and misleading bands on the x-ray which, if
gone undetected, could result in "false positive" findings. See Comment, supra note 7,
at 921.
106. The chemicals contained in many detergents have been shown to produce
and degradation due to time lapse or exposure to the elements.\textsuperscript{107}

Thus, DNA profiling is destined to fail the \textit{Frye} standard unless the relevant field is narrowed further and defined as those forensic scientists acquainted with the analysis of DNA samples for forensic uses. Since forensic DNA analysis is a recent scientific development, the number of such experts is, as would be expected, quite limited. In fact, apart from a sparse grouping of scientists within subdivisions of environmental biology, physical anthropology, and evolutionary biology, the only scientists with relevant experience in testing "dirty" samples are those employed by the commercial laboratories which market their techniques to law enforcement agencies nationwide.\textsuperscript{108} Therein lies a further problem.

The \textit{Frye} standard necessarily contemplated that the experts whose acceptance is determinative of admissibility would be impartial.\textsuperscript{109} However, most cases involving DNA evidence to date have suffered a distinct lack of impartial expert witnesses.\textsuperscript{110} In fact, defense attorneys have lost several battles against the admissibility of DNA largely because of their inability to locate expert witnesses other than those associated with the commercial laboratories. Faced with favorable testimony from the prosecution's witnesses and with no witnesses testifying for the defense at all, there is a danger that

\textsuperscript{107} Id. at 65-66. While DNA has been extracted from a 2400 year old Egyptian mummy, see Paabo, \textit{Molecular Cloning of Ancient Egyptian Mummy DNA}, 314 \textit{Nature} 644 (1985), in reality, such DNA samples are too degraded to be useful in DNA profiling. Thompson \& Ford, \textit{supra} note 29, at 66 n.93.

\textsuperscript{108} Thompson \& Ford, \textit{supra} note 29, at 56. Experts familiar with contaminated genetic specimens are scattered throughout various academic disciplines. However, their shared experience constitutes the only common denominator among them. \textit{Id.} at 56 n.65.

\textsuperscript{109} General acceptance is not achieved by the expert opinion of one individual, especially if that expert is not impartial. \textit{See}, e.g., People v. Tobey, 401 Mich. 141, 146, 257 N.W.2d 537, 539 (1977) (admission of voiceprint evidence held reversible error since expert witnesses were not "disinterested and impartial"). \textit{But cf.} United States v. Wright, 17 C.M.A. 183, 37 C.M.R. 447 (1967) (testimony of the developer of voiceprint technology stating in essence that the method was virtually infallible was admitted by the court).

\textsuperscript{110} For instance, Dr. Michael Baird, manager of forensic testing for the Lifecodes Corporation and Dr. Alec Jeffreys, developer of the technique used by Cellmark, have been called upon extensively to testify for the prosecution in several \textit{Frye} hearings. Baird's testimony was a cornerstone of the prosecution's case in People v. Castro, 144 Misc. 2d 956, 545 N.Y.S.2d 985 (N.Y. Sup. Ct. 1989). \textit{See also infra} notes 181-85 and accompanying text.
some courts may mistakenly conclude that the "general acceptance" standard of Frye has been met on this basis alone.111

Granted, prosecutors have also called upon the testimony of biologists and geneticists unassociated with commercial laboratories. However, because these scientists are unfamiliar with the testing of contaminated DNA specimens, they do not constitute members of the "relevant field" and their general acceptance is irrelevant under Frye. Thus, at this stage, the only relevant testimony comes from biased experts who "naturally paint a rosy picture of the test and its accuracy."112

Unless this "bias factor" is treated by the judiciary as merely an issue of weight rather than admissibility, the number of qualified experts within the relevant field will be severely limited. This being the case, the widespread consensus of experts envisioned by Frye will become illusory, replaced by the opinions of a few unbiased experts, assuming any can be found.113

At present, there is no suitable relevant field from which to garner general acceptance. Given this gaping hole in the case for admitting DNA evidence, the judiciary should hesitate before admitting DNA evidence under Frye.

Should a court be successful in delineating a relevant field suitable for application of the Frye test, the next step would be to evaluate whether the scientists working in that field have generally accepted DNA profiling analysis as reliable.114 Before this can be accomplished, however, the court must decide another threshold question: namely, what must be accepted.115

There is an ongoing debate as to whether the Frye standard mandates a finding of general acceptance of the scientific technique, the theory underlying the technique, or both.116 The D.C. Circuit Court of Appeals has interpreted Frye as requiring acceptance of the theory.117 Other courts, however, refer exclusively to acceptance of the

111. See infra notes 167-238 and accompanying text for a discussion of appellate court decisions to date.
112. See Burk, supra note 2, at 468. Currently, the corporations marketing DNA profiling are earning $40 million per year. Unger, Court Challenge Casts Pall over DNA Testing Industry, NEWSDAY, July 30, 1989 (Business), at 47.
113. Giannelli, supra note 74, at 1209-10.
114. Id. at 1210-11.
115. Id. at 1211.
116. Id.
117. United States v. Addison, 498 F.2d 741 (D.C. Cir. 1974). The court stated: "The Frye standard . . . requires that the [theory] from which the deduction is made be sufficiently established to have gained general acceptance in the particular field in which it belongs." Id. at 743 (brackets in original) (quoting Frye v. United States, 293 F. 1013, 1014 (1923)). See also United States v. Alexander, 526 F.2d 161, 163 n.3 (8th Cir. 1975) (requiring "general acceptance in the relevant scientific community of the theory underlying such technique").
By focusing on one aspect to the exclusion of the other, courts are able to manipulate the Frye standard to fit their desired conclusion. The reliability of the theory behind DNA analysis is not disputed. DNA analysis has proven itself reliable in the realm of genetic research. By defining the Frye standard as requiring general acceptance of only the theory underlying DNA profiling, the courts are able to ignore the shortcomings of the various techniques when applied to contaminated samples in a forensic lab. The Castro court broke ground by recognizing the need to ensure the reliability of both the theory and the technique. To do otherwise would emasculate the Frye standard, stripping it of the ability to screen out reliable theories that fall apart under realistic testing conditions.

Finally, having decided what must be accepted and by whom, the court must then endeavor to assess whether DNA profiling evidence has, in fact, achieved general acceptance in the relevant field. While it seems evident that both the theory and the techniques employed in DNA profiling must be examined, the present commercialized nature of DNA testing makes it difficult, if not impossible, to evaluate the techniques employed to derive a criminal identification.

Both Lifecodes and Cellmark, as business entities competing for shares in an extremely lucrative field, keep their laboratory techniques confidential in order to safeguard their respective trade secrets. By asserting their proprietary rights, the commercial laboratories are able to shield their techniques from the scientific community at large. In fact, in some of the DNA Frye hearings to date, the only scientists who have reviewed the testing procedures used by the commercial laboratories were hand-picked by the laboratories themselves. Furthermore, defense attorneys have been systematically denied access to the laboratory notes and other internal documentation concerning the procedures employed.

119. See Kelly, supra note 15, at 110.
121. For a general discussion of the Castro opinion, see supra notes 223-38 and accompanying text.
122. Giannelli, supra note 74, at 1215.
123. Thompson & Ford, supra note 29, at 59.
124. Id. at 59-60.
125. See Cooper, DNA Case Is First Before a State High Court, 11 NAT'L L.J., July
Because of their self-imposed vow of silence, the commercial laboratories have placed themselves in a contradictory situation. The laboratories send their experts to Frye hearings to attest to their technique's general acceptance among the scientific community. At the same time, however, the laboratories assert their right to confidentiality, and thus shield themselves from the critical eye of scientists unassociated with the corporations.126

This “two-faced” approach to admissibility may pose less of a problem in the future due to the recent emergence of studies conducted by independent researchers with the consent of the commercial laboratories.127 However, until such time as these independent studies become widespread, the commercial laboratories’ assertion of proprietary rights will adversely impact the likelihood that DNA profiling has been generally accepted. Currently, general scientific acceptance cannot occur given the atmosphere of secrecy which shrouds DNA profiling technology from public view.

B. Admissibility of DNA Profiling under the Federal Rules

Although the Federal Rules test does not require general acceptance of the evidence, and therefore constitutes a more liberal standard of admissibility than the Frye test, DNA profiling fails to meet this basic standard of admissibility as well. When closely examined, the probative value of DNA profiling evidence is substantially outweighed by the danger of unfair prejudice which may result from its admissibility.

1. Probative Value

Under the Federal Rules test, probative value is necessarily a function of reliability.128 Thus, while the Federal Rules test abandons the general acceptance standard of Frye, the court must still inquire as to the reliability of the novel scientific technique. The primary authority on the reliability of scientific evidence under the Federal Rules test is United States v. Williams.129 In deciding whether to admit voiceprint technology into evidence, the court focused on five indicia of reliability: (1) the potential for error associated with the new tech-

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126. Thompson & Ford, supra note 29, at 60.

127. One such study conducted by the California Association of Crime Lab Directors questioned the reliability of the Cellmark technique. Daily J., Feb. 28, 1990, at 1, col. 4. The study concluded that Cellmark declared erroneous matches in 2% of the blind samples. Id.

128. See supra notes 87-88 and accompanying text.

129. 583 F.2d 1194 (2d Cir. 1978).
nology; (2) the presence and observation of testing standards; (3) the
degree of care in which the test has been performed and the test’s
susceptibility to abuse; (4) whether the technique bears an analogous
relationship to other scientific techniques which have been deemed
admissible; and (5) the existence of “fail-safe” characteristics.130 If
the Williams definition of reliability is valid, DNA profiling fails the
Federal Rules test for admissibility. Accordingly, each of these fac-
tors will be addressed.

To begin with, the rate of error associated with DNA profiling has
not been determined; however, given two factors, it is presumably
quite high. First, DNA prints are often “ambiguous or difficult to in-
terpret.”131 Although DNA prints are often likened to the computer
barcodes utilized by supermarkets, the comparison is strained. In re-
ality, the bars on DNA prints are much less well-defined than prod-
duct codes, and “look a lot more like fuzzy caterpillars.”132 Moreover,
two DNA profiles from the same person may look slightly different
from each other. Likewise, two DNA profiles from separate individu-
als may look surprisingly similar.133

Thus, the profiling expert is placed in a difficult position. In set-
ting the threshold for declaring a match, he must allow himself suffi-
ciently wide “latitude of acceptance” in order to compensate for
minor variations between prints of the same person, while at the
same time guard against the danger of mistakenly declaring a
match.134 At present, there are no uniform guidelines regarding
matching standards.135 Therefore, the fate of criminal suspects may
hinge on the subjective interpretation of a single lab technician.136

The other factor which indicates that DNA profiling is subject to a
high rate of error is its reliance on statistical predictors. Scientists
must rely on statistical probabilities in declaring matches because
DNA tests compare only small segments of DNA.137 It is crucial to
bear in mind that no person’s DNA is unique at any particular loca-

130. Id. at 1198-99.
133. Thompson & Ford, supra note 29, at 87-88. Minor variations in DNA prints are
commonly referred to as “slop.” Id. at 87.
134. Id. at 87-88.
135. Id. at 88; Sherman, supra note 132, at 24, col. 4 (“Different labs use different
matching rules . . . . And there is no scientific consensus yet on what is appropriate.”).
136. Thompson & Ford, supra note 29, at 88; Sherman, supra note 132, at 24, col. 4.
137. Sherman, supra note 132, at 25, col. 2.
Only the pattern of DNA in its entirety is unique. DNA researchers "agree that it is possible that there could be two or more people with the same few lines of the same length in the same places." Thus, the reliability of DNA profiling depends on the researcher's ability to examine multiple segments and accurately calculate the probability that a match at any given locus is a random product of chance. Currently, there are no uniform standards for determining the likelihood of a coincidental match. A greater concern, however, centers around the sufficiency of population data bases, in terms of both size and racial diversity.

In order to achieve an accurate distribution of alleles representative of the population at large, the data base must be composed of a sizable, freely-mixing community. Studies based on small homogeneous populations will produce misleading results that do not necessarily hold true for the overall population. Presently, however, there is no consensus among scientists as to the minimum size data bank necessary to ensure reliable results. Surprisingly, one set of statistics which has been repeatedly cited in support of DNA profiling reliability was derived from a study of only twenty people. Although studies done by Lifecodes have drawn upon a much larger data base, critics still voice doubts as to the sufficiency of the sample population.

Similar concerns arise in relation to the racial and ethnic compositions of the data bases used by the commercial laboratories. Recognizing that each racial group will contain more of certain alleles than the overall population, the commercial laboratories divide the data base populations by race. Nonetheless, critics claim that this safeguard is inadequate by itself because it operates under the mistaken assumption that ethnic and racial groups mate purely at random within the confines of their racial or ethnic classification. The system thus fails to account for subpopulations within each group which

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138. Note, supra note 17, at 488.
139. Id.
140. Sherman, supra note 132, at 25, cols. 2-3 (stressing that researchers are currently unsure as to how often various band patterns occur within a certain population).
141. Note, supra note 17, at 488.
142. Id.
143. Id. at 489.
144. Id.
145. Id.
146. Burk, supra note 2, at 465-66. This study is often cited for the proposition that the chance of a coincidental match between two individuals is one in thirty billion.
147. Id. at 466. Lifecodes has published two studies which were based on populations of seven hundred and nine hundred people each. Note, DNA Typing: A Rush to Judgment, 24 GA. L. REV. 669, 678 n.44 (1990).
148. Note, supra note 17, at 489.
149. Id. at 489-90.
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...tend to be heavily inbred, thus possessing more alleles in common than the population at large.  

With regard to the second Williams factor, the DNA profiling industry is sorely lacking in the area of standardization and regulation. Beyond the deficiencies in matching standards, there are no uniform regulations to govern the procedures employed by the commercial laboratories. While the commercial laboratories have established procedural standards of their own, these self-imposed standards do little to ensure the reliability of the industry as a whole.

The third factor proposed by the Williams court entails an evaluation of the care with which the procedure is performed, and its potential for abuse. Of course, the inquiry into the carefulness of the technicians will have to be undertaken on an individualized basis. However, such inquiries may be meaningless without standardized procedures against which a particular laboratory's performance can be compared. Moreover, the potential for abuse of DNA profiling is great. For example, psychological researchers have shown that, in the matching stage, the crucial decision as to the degree of similarity necessary for a "match" may be affected by the priorities of the laboratory scientist. In other words, police criminologists, whose goal is to assist the state in prosecution, may select a much lower matching threshold than would a commercial laboratory which, because of its commercial interest in stressing the uniqueness of the DNA pattern, may set an unusually high standard for matching.

The fourth Williams factor, whether there exists an analogous relationship to other routinely admitted scientific evidence, does little to establish DNA as a reliable scientific technique. In fact, it is very difficult to find a similar technique with which any analogy to DNA would be appropriate. Some analogies possibly could be drawn between DNA and gel electrophoresis. However, such comparisons

150. Sherman, supra note 132, at 25, col. 3. For example, DNA probability calculations assume that "Mexican-American Hispanics are just as likely to have children with Cuban-American Hispanics as they are with each other and that Caucasian Catholics, Protestants, and Jews mate randomly." Id.

151. Dr. Eric Lander notes that DNA testing facilities are "virtually unregulated—with the paradoxical result that clinical laboratories must meet a higher standard to be allowed to diagnose strep throat than forensic labs must meet to put a defendant on death row." Sherman, supra note 132, at 24, col. 3 (citations omitted).

152. Thompson & Ford, supra note 29, at 88 (citing Bruner, On Perceptual Readiness, 64 PSYCH. REV. 123 (1957)).


154. For a general discussion of this gel electrophoresis, see Jonakait, supra note 68, at 853.
would not necessarily aid in the admissibility of DNA profiling technology because gel electrophoresis has a tortured history of its own, having been declared inadmissible in both California and Michigan.\textsuperscript{155}

The final Williams factor, whether "fail-safe" characteristics exist, is likewise unfulfilled by current DNA profiling techniques. While the genetic profiles of the parents serve as an inherent control mechanism in paternity testing, no such built-in safety net exists in the arena of forensic DNA testing.\textsuperscript{157} "Forensic samples are of unknown origin and thus have countless numbers of possible alleles. Therefore, all of the controls for the forensic test must be imposed from the outside."\textsuperscript{158}

2. Danger of Unfair Prejudice

If, after considering the reliability factors proposed by Williams, a court finds DNA profiling to be probative, it would then have to consider the dangers that would accompany the admission of DNA profiling in a jury trial.

As with any other novel scientific evidence, the greatest danger associated with DNA profiling evidence is its potential to mislead the jury.\textsuperscript{159} The possibility that the jury will be dazzled by the scientific glitter of DNA profiling technology is certainly great. As one appellate court noted, the scientific evidence which accompanies DNA, "unlike that presented with fingerprint, footprint or bite mark evidence, is highly technical, incapable of observation, and requires the jury to either accept or reject the scientist's conclusion that it can be done."\textsuperscript{160} Thus, a jury faced with DNA's highly technical process and accompanying statistical interpretations will likely accept the testimony of the expert witnesses without question.\textsuperscript{161} Critics caution that DNA casts a looming shadow over other more traditional methods of proof such as alibis and eyewitness testimony when presented to a jury of laypersons.\textsuperscript{162}

Moreover, the necessity of presenting statistical evidence to the

\textsuperscript{156.} People v. Young, 425 Mich. 470, 391 N.W.2d 270 (1986).
\textsuperscript{157.} Note, supra note 17, at 511.
\textsuperscript{158.} Id.
\textsuperscript{159.} See United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974) (novel evidence may "assume a posture of mystic infallibility in the eyes of a jury of laymen").
\textsuperscript{161.} This appears to be the case already, as indicated by glowing magazine and newspaper reports which praise DNA as a catalyst of quick jury verdicts: "It took the jury twelve minutes to find Jones guilty." Williams, supra note 4, at 26.
\textsuperscript{162.} Gest, Convicted By Their Own Genes, 105 U.S. NEWS AND WORLD REP., Oct. 31, 1988, at 70 (stating that juries are unable to treat DNA profiles as "just one piece of evidence to be considered").
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jury along with DNA evidence also raises the danger of unfair prejudice. Studies have shown that jurors often misinterpret statistical information. Recognizing this problem, many courts have excluded statistical evidence as more prejudicial than probative. Banning statistical evidence in the case of DNA, however, would pose a far greater danger. Jurors might then assume that a DNA match conclusively links the defendant to the evidence. Therefore, until DNA testing advances to a higher degree of precision, its utility as an evidentiary tool in jury trials is questionable.

Finally, "an exaggerated popular opinion of the accuracy of a particular technique [could make] its use prejudicial or likely to mislead the jury." Once again, DNA falls easily into this trap, as media reports unabashedly proclaim that "DNA can rule out everyone else in the world as a possible perpetrator of a crime."

In applying the Federal Rules balancing test, DNA has little probative value due to its unproven reliability. Furthermore, given the complexity of the technique and its tendency to mislead the jury, the probative value of DNA evidence is substantially outweighed by the dangers of unfair prejudice.

Thus, when examined closely, DNA profiling evidence fails to meet the admissibility standards under either Frye or the Federal Rules test. However, in struggling with this admissibility puzzle, the courts have employed innovative interpretations of both standards, often resulting in the admissibility of DNA profiling evidence.

V. JUDICIAL ACCEPTANCE OF DNA PROFILING EVIDENCE

To date, only four criminal cases involving the admissibility of

163. For example, one study indicated that jurors mistakenly reasoned that if a defendant's blood type is found in only ten percent of the population, there is a ninety percent chance that he is guilty. Thompson & Schumann, Interpretation of Statistical Evidence in Criminal Trials, 11 HUMAN BEHAV. 167, 170 (1987).


166. Marx, DNA Fingerprinting Takes the Witness Stand, 240 SCIENCE 1616 (1988). See also Moss, supra note 3, at 69-70 ("disputing the technology is like disputing the law of gravity").
DNA profiling evidence have climbed to the state appellate level. Of these four, two were decided in *Frye* jurisdictions. The other two, decided in Florida and Virginia, rested on the more liberal foundation of the Federal Rules test.

A. Admissibility of DNA Profiling Evidence under the Federal Rules Test

1. *Andrews v. State*

Reaching the appellate level in 1988, the *Andrews* case was one of the first criminal cases to utilize the controversial DNA evidence. Tommie Lee Andrews was charged with aggravated battery, burglary, and sexual battery. The victim never saw her assailant, who "jumped on top of her, and covered her face with a sleeping bag." Police arrested Andrews, who was subsequently convicted by a trial court which, over protests by the defense, admitted into evidence findings of a DNA profile that linked Andrews to the rape.

The defendant appealed the trial court decision. However, the defense did not mount a serious attack on the admissibility of DNA, choosing instead to focus its challenge on the methods used by the commercial laboratory that conducted the test. The court of appeals, however, deemed a review of both questions necessary. Therefore, the court examined the admissibility of DNA evidence, although it received little assistance from defense counsel who failed to call a single expert witness.

Following a lengthy discussion of the two standards of admissibility for scientific evidence, the court decided to employ the Federal Rules test. After pronouncing DNA evidence "helpful to the jury," the court commenced its inquiry into the probative value of the DNA profiling evidence. Here, the court utilized the indicia of reliability set forth in a federal third circuit opinion, *United States v. Down*...
These factors, while not identical, are similar to those promulgated by Williams. The court first addressed DNA's "relationship to more established modes of scientific analysis." Noting DNA's solid reputation for reliability in terms of medical research, the court found that such nonjudicial use is a valid indicator of DNA reliability. Nowhere in its evaluation of DNA's reliability, however, did the court attempt to delineate possible factors which might make a perfectly acceptable tool of medical research wholly inappropriate for use in the criminal courtroom.

Next, the court examined scientific literature pertaining to the reliability of DNA. Once again, though, the inquiry was less than thorough. The court relied exclusively on the testimony of a scientist employed by a commercial laboratory who stated that he "was unaware of any [publications] that argue against the test's reliability." Finally, the court heard testimony concerning the rate of error associated with DNA profiling techniques. The court adopted the view that "if there was something wrong with the process, it would ordinarily lead to no result being obtained rather than an erroneous result." Upon these findings, the court held that DNA testing is reliable, and therefore, probative.

The court then turned its attention briefly to the possible danger of unfair prejudice associated with the admission of DNA profiling evidence. While recognizing that DNA profiling involves highly techni-
cal concepts which could overwhelm a jury, the court asserted that this factor “requires courts to proceed with special caution, [but] it does not of itself render the evidence unreliable.” Furthermore, the court dismissed without debate the danger associated with allowing the testimony of potentially biased expert witnesses, adding that “neither Frye nor our evidence code require impartiality.”

The court of appeals thus affirmed the decision of the trial court, holding DNA profiling evidence admissible in criminal proceedings.

2. *Spencer v. Commonwealth*

In a bifurcated jury trial held in October of 1989, the Virginia Supreme Court addressed the DNA admissibility question on appellate review. Timothy Wilson Spencer had been convicted and sentenced to death in three separate trials stemming from the rapes and murders of three women. Two of those convictions, “based on DNA fingerprinting and precious little other evidence,” were the subject of earlier appeals.

Spencer challenged the admissibility of the DNA test results, claiming that the state had failed to establish the general acceptance and reliability of DNA profiling. In assessing the admissibility of the DNA evidence, the court declined to follow the *Frye* test, choosing instead to employ a relevance standard. In this appeal, the court held the DNA evidence admissible, without analysis, relying on its prior admissibility holdings in *Spencer I* and *Spencer II*.

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184. *Id.*
185. *Id.* at 849 n.9.
186. *Id.* at 850-51.
189. *Id.*
191. 238 Va. at 573, 385 S.E.2d at 855-56. Spencer unsuccessfully advanced this same argument in *Spencer I* and *Spencer II*. *Id.* at 573, 385 S.E.2d at 856.
192. Spencer urged the court to employ the *Frye* standard in reaching its verdict on the admissibility of DNA profiling evidence. *Id.* at 573 n.5, 385 S.E.2d at 856 n.5. The court rejected the adoption of the *Frye* test, relying on its holding in *Spencer I*. *Id.* (citing *Spencer I*, 238 Va. at 290 n.10, 384 S.E.2d at 783 n.10). The court noted, however, that DNA testing would pass the *Frye* test if it were applied. *Id.*
193. *Id.* at 573 n.5, 385 S.E.2d at 856 n.5. This relevancy standard, set forth in O'Dell v. Commonwealth, 234 Va. 690, 695-96, 364 S.E.2d 491, 504-05 (1988), bears only a slight resemblance to the Federal Rules test. However, it does necessitate a finding of reliability, and therefore, it is most appropriately dealt with in this section.
194. *Spencer*, 238 Va. at 573, 385 S.E.2d at 856 (citing *Spencer I*, 238 Va. at 290, 384 S.E.2d at 783; *Spencer II*, 238 Va. at 315, 384 S.E.2d at 797).
It is necessary, therefore, to review those decisions in order to ascertain the basis for the court's reliability finding.

In both *Spencer I* and *Spencer II*, the court's ultimate determination of the reliability of DNA profiling evidence was based almost exclusively on testimony of state witnesses. As in *Andrews*, the defense was unable to locate any expert witnesses of its own to contradict the state's claims of reliability.195 Worse yet, the defense conceded that "DNA tests are accepted 'as reliable within the scientific community,' " and that "the trial court had little choice but to accept the DNA printing evidence."196 While these concessions were obviously damaging to the defendant's position, they should not have foreclosed the admissibility question.

The *Spencer* court erroneously equated the lack of defense witnesses with reliability. Moreover, the court failed to consider factors of unfair prejudice, including the inherent bias of some the state's witnesses197 and the use of statistical evidence.198 Thus, the court dispensed with the Federal Rules requirement of balancing probative value against unfair prejudice.

In sum, both the *Andrews* and *Spencer* courts misapplied the Federal Rules test in determining the admissibility of DNA profiling evidence. Unfortunately, the courts have not fared significantly better in their application of the *Frye* standard to the DNA controversy.

B. Admissibility of DNA Profiling Evidence Under *Frye*

1. *Cobey v. Maryland*

Following closely on the heels of *Andrews*, the Maryland Court of Special Appeals took up the issue of DNA admissibility in the case of *Cobey v. Maryland*.199 The defendant, Kenneth S. Cobey, was

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196. 238 Va. 275, 289-90, 384 S.E.2d 775, 782-83 (1989) (citations omitted). The defense did maintain, nonetheless, that the court "should hold off until another day any decision that DNA printing is acceptable evidence in the courts of Virginia." Id. at 290, 384 S.E.2d at 783.
197. Dr. Michael Baird who testified for the state in *Spencer I*, and Dr. McElfresh who testified for the state in *Spencer II* and *Spencer III*, were both employed by the commercial laboratory (Lifecodes) which performed the DNA testing. *Spencer I*, 238 Va. at 289, 384 S.E.2d at 782; *Spencer II*, 238 Va. at 313, 384 S.E.2d at 796-97; *Spencer III*, 238 Va. at 573-74, 384 S.E.2d at 856-57.
198. *Spencer I*, 238 Va. at 289, 384 S.E.2d at 782; *Spencer II*, 238 Va. at 314, 384 S.E.2d at 797.
charged with raping a young woman in September of 1985. Over Cobey's objection, the trial court admitted into evidence the results of a DNA test which declared a match between the defendant's blood sample and a semen stain on the victim's clothes. As was the case in Andrews, defense attorneys challenged only the methodology utilized in the DNA test. However, the court declared that "the novelty of the question requires that we address both the frontal assault on Cellmark's methodology as well as the admission into evidence generally of DNA fingerprints."

Under the guidance of Frye, the court proceeded to analyze the admissibility of DNA. The court reviewed the trial court testimony of five expert witnesses for the state who testified that DNA is generally accepted within the scientific community. However, the court failed to elaborate on any of this testimony, and focused instead on the lack of contradictory evidence. This left the impression that defense counsel's failure to locate expert witnesses of its own may have allowed the state to prevail by default.

In addition to the defendant's failure to present expert testimony, the court was influenced by the acceptance of DNA evidence in other jurisdictions. Unfortunately, this reliance on judicial precedent is a dubious basis by which to gauge general acceptance under the Frye test. In fact, "this use of prior judicial decisions undercuts the rationale supporting Frye—that those most qualified to judge the validity of a technique should have the determinative voice." The Frye test depends on general acceptance by the scientific community, not the judiciary. Moreover, by looking to Andrews for support, the court did not achieve even a second-hand finding of general acceptance, because the Andrews court applied the more liberal Federal Rules test, which obviates the need to prove general acceptance.

Adding further to the opinion's appearance of superficiality, the

200. Id. at 33, 559 A.2d at 391-92.
201. Id. at 34, 559 A.2d at 392. The defendant was tried twice on the sexual offenses and related charges. The first judgment was reversed and remanded for a new trial. Id. at 33 n.2, 559 A.2d at 391 n.2. See also Cobey v. State, 73 Md. App. 233, 533 A.2d 944 (1987). This appeal is the result of the second trial. Id.
202. 80 Md. App. at 34, 559 A.2d at 392.
203. Id.
204. Id.
205. Id. at 35, 559 A.2d at 392, 398.
207. Giannelli, supra note 74, at 1218-19 (emphasis in original).
court neglected any mention of the proper field from which the trial court gleaned a finding of general acceptance. Nonetheless, after a general discussion of the DNA profiling procedure, the court ruled that the trial court did not err in admitting the DNA evidence.208

2. State v. Schwartz

On November 3, 1989, the Minnesota Supreme Court broke new legal ground by becoming the first state appellate court in the nation to exclude DNA profiling evidence in a criminal trial. The watershed case, State v. Schwartz,209 arose from the brutal stabbing of a young woman in May of 1988.210 Armed with a valid search warrant, law enforcement officials retrieved a blood-stained pair of jeans from the defendant's home.211 A similarly soiled shirt, allegedly belonging to the defendant, was found near the crime scene.212 DNA profiling analysis was performed on these items, resulting in a match between the victim's blood and the blood-stained clothing.213 These findings were introduced in the trial court on the state's motion, over the objection of defendant Schwartz. However, simultaneously with granting the state's motion to admit DNA evidence, the court certified three admissibility questions to the Minnesota Court of Appeals, which immediately certified these same questions to the Minnesota Supreme Court.214

After determining that the admissibility issue would be governed by the Frye standard,215 the supreme court turned to the question of general acceptance of DNA profiling. As a first step toward this goal, the court noted DNA's general acceptance among medical researchers.216 While this information is noteworthy, it is of little use in assessing the admissibility of DNA unless medical research is the relevant field from which general acceptance is to be drawn. As this Comment has previously discussed,217 such a choice would be unwise. Nowhere in its opinion, however, did the court reveal its selection of

208. Cobey, 80 Md. App. at 43, 559 A.2d at 398.
209. 447 N.W.2d 422 (Minn. 1989).
210. Id. at 423.
211. Id.
212. Id.
213. Id. at 423-24.
214. Id. at 424-25.
215. Although the court briefly entertained a discussion on the merits of the Federal Rules approach, it concluded that the Frye standard “facilitates more objective and uniform rulings.” Id. at 424.
216. Id. at 425.
217. See supra notes 102-07 and accompanying text.
a relevant field for purposes of evaluating general acceptance under *Frye*.

Still searching for general acceptance, the court recited a string of decisions from other jurisdictions which have admitted DNA evidence.\(^{218}\) However, unless the judiciary is the relevant field, this inquiry is a futile exercise as well. Nevertheless, on these bases, the court held that DNA profiling analysis is generally accepted.\(^{219}\)

Despite its finding of general acceptance, the Minnesota Supreme Court refused to admit the proffered DNA evidence.\(^{220}\) After reviewing the trial court testimony of twelve expert witnesses, the court determined that the commercial laboratory’s methodology was unreliable, prone to false positives, and deficient in control procedures.\(^{221}\) Thus, the court held that DNA test results are admissible only if derived in laboratories that comply with appropriate standards and controls, and whose testing data and results are available to defense counsel.\(^{222}\)

3. *People v. Castro*

While the case of *People v. Castro*\(^{223}\) is not an appellate court decision, it nonetheless merits discussion since the *Castro* hearing has been referred to as “the most comprehensive and extensive legal examination of DNA forensic identification tests held to date in the United States.”\(^{224}\) In fact, the *Frye* hearing in *Castro*, which concluded in August of 1989, constituted the first denial of admittance of DNA evidence by a trial court.

The defendant, Joseph Castro, was charged with the stabbing deaths of a young mother, seven months pregnant, and her two-year-old daughter.\(^{225}\) During the arrest, an observant police officer noticed a speck of blood on Castro’s wristwatch.\(^{226}\) Although Castro claimed that the blood was his own, DNA profiling tests performed on the sample concluded that the blood in fact belonged to the adult

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\(^{219}\) 447 N.W.2d at 426.

\(^{220}\) Id. at 428. The court stated that: “While we agree with the trial court that forensic DNA typing has gained general acceptance in the scientific community, we hold that admissibility of specific test results in a particular case hinges on the laboratory’s compliance with appropriate standards and controls, and the availability of their testing data and results.” Id.

\(^{221}\) 447 N.W.2d at 426-28.

\(^{222}\) Id. at 428.


\(^{224}\) Id. at 956-57, 545 N.Y.S.2d at 985.

\(^{225}\) Id. at 957, 545 N.Y.S.2d at 985.

\(^{226}\) Id.
victim. The admissibility of these test results was the subject of the pretrial hearing and the court's decision.

The Castro hearing, which lasted over three months and produced five thousand pages of recorded testimony, was the first proceeding in which the defense mounted a serious attack on the admissibility of DNA. In contrast to previous cases in which the testimony of the states' expert witnesses went unchallenged, the Castro defense called five expert witnesses of its own.

In analyzing the admissibility of DNA, the court formulated its own interpretation of the Frye standard, breaking it down into two basic inquiries: 1) "Is there a theory, which is generally accepted in the scientific community, which supports the conclusion that DNA forensic testing can produce reliable results?" and, 2) "[A]re there techniques or experiments that currently exist that are capable of producing reliable results in DNA identification and which are generally accepted in the scientific community?" Beyond the requirements of Frye, the court ruled that a pretrial hearing should be held in all cases involving DNA evidence to determine the answer to the following question: "Did the testing laboratory perform the accepted scientific techniques in analyzing the forensic samples in this particular case?"

In evaluating the court's formulation of Frye, several deficiencies are immediately apparent. The court disregarded the need for general acceptance of the technique when put to forensic application.

227. Id. at 957, 545 N.Y.S.2d at 985-86.
228. Id. at 957, 545 N.Y.S.2d at 986.
230. 144 Misc. 2d at 958, 545 N.Y.S.2d at 986. Testifying for the defense were: Dr. Conrad Gilliam, an expert in genetics and molecular genetics; Dr. Lorraine Flaherty, an expert in molecular genetics and quality control; Dr. Eric Lander, an expert in genetics and population genetics; Dr. Phillip Green, an expert in genetics and population genetics; and Dr. Howard Cooke, an expert on genetic probes. Id.
231. Id. at 959, 545 N.Y.S.2d at 987.
232. The court summarily dismissed the issue of the forensic reliability of DNA profiling. Quoting from a University of Virginia Law Review, the court stated that: "There is nothing controversial about the theory underlying DNA typing. Indeed, this theory is so well accepted that its accuracy is unlikely even to be raised as an issue in hearings on the admissibility of the new tests." Id. at 961, 545 N.Y.S.2d at 989 (quoting Thompson & Ford, supra note 29, at 60-61).
233. Id. at 959-60, 545 N.Y.S.2d at 987-88. The court noted that "[a] scientist may have no trouble accepting the general proposition that DNA typing can be done reliably, yet still have doubts about the reliability of the test being performed by a particular laboratory." Id. at 973, 545 N.Y.S.2d at 999 (quoting Thompson & Ford, DNA
Moreover, the court engaged in an act of legal wizardry when it found that the second prong of the Frye inquiry was satisfied. By the Castro court’s own definition, novel scientific evidence must be supported by techniques that currently exist and are capable of producing reliable results.234 While noting that two experts testified that DNA profiling would be able to produce reliable results in “approximately six months,”235 the court nonetheless held that DNA profiling met the Frye requirements.236 In an attempt to reconcile this seemingly fatal contradiction, the court stated that “to breathe any meaning into the opinion of these highly respected and rather brilliant scientists one must conclude that the test is presently reliable and will remain so for the next six months.”237

In its final determination, however, the court found that despite DNA’s general acceptance in the scientific community, the laboratory had failed to apply proper techniques in this instance. Accordingly, the court foreclosed the possibility of admitting the DNA evidence in Castro’s case.238

After reviewing these ground-breaking cases, it is apparent that a trend toward admissibility of DNA is forming. However, a common scheme of legal analysis on which to base such decisions has not yet been established. Until such a consensus is reached, the doubts surrounding the admissibility of DNA will remain. Beyond these questions of admissibility, however, looms an equally large but often overlooked issue: the constitutionality of DNA profiling as an instrument of criminal justice.

VI. CONSTITUTIONAL CONSIDERATIONS

In addition to challenging the reliability of DNA evidence, criminal defendants are also likely to challenge the constitutionality of the DNA identification process. Presently, at least three bases exist upon which an unconstitutionality claim could be premised.

The first constitutional concern associated with the forensic use of DNA profiling is one of “fundamental fairness.”239 In examining the economics of DNA profiling in the courtroom, it is clear that prosecutors have a distinct advantage over defendants. This is because the


234. 144 Misc. 2d at 958, 545 N.Y.S.2d at 987.
235. Id. at 972, 545 N.Y.S.2d at 995.
236. Id. at 973, 545 N.Y.S.2d at 995.
237. Id. at 972-73, 545 N.Y.S.2d at 995.
238. Id. at 977, 545 N.Y.S.2d at 997-98. Rather than relying on objective matching standards, the Lifecodes laboratory had “eyeballed” the match. Williams, supra note 4, at 29.
239. Williams, supra note 4, at 31.
FBI laboratory offers its DNA profiling skills to law enforcement agencies free of charge.\textsuperscript{240} Defense attorneys, on the other hand, will likely utilize commercial laboratories. For many defendants, the cost of DNA profiling by commercial firms will be prohibitively high.\textsuperscript{241} Moreover, a sizable number of criminal defendants are indigent. The Supreme Court has held that the state must provide indigent defendants with the instruments necessary to prepare an adequate defense.\textsuperscript{242} Thus, if DNA profiling technology becomes a commonplace evidentiary technique, the doctrine of equality may require that the state provide funding to such defendants, giving them access to both DNA testing and expert witnesses.\textsuperscript{243} It is questionable whether the judiciary budget can bear such a burden at the present time.\textsuperscript{244}

The second area of concern stems from the dangerous combination of a national obsession with fighting crime together with the aura of infallibility which has surrounded the DNA profiling technique since its media debut.\textsuperscript{245} Because of DNA's unequaled potential to identify criminal suspects, critics of DNA profiling fear that frustrated law enforcement officials, lacking sufficient evidence to make arrests, may be tempted to obtain genetic samples from suspects in violation of their constitutional rights.\textsuperscript{246} The United States Supreme Court has stated that police officers may obtain blood samples for the purpose of determining intoxication without the consent of the subject.\textsuperscript{247} However, in most situations, such extractions cannot be performed absent a warrant obtained pursuant to a finding of probable cause.\textsuperscript{248} Even without a warrant, though, extraction of blood will not constitute an illegal search and

\textsuperscript{240} Id. See also supra note 26.

\textsuperscript{241} See Sherman, supra note 132, at 25. Cellmark charges $490 for each DNA test, and $1000 per day for expert testimony. Lifecodes is only marginally less expensive, charging $325 per test and $750 for expert witnesses. Id.

\textsuperscript{242} Burk, supra note 2, at 470 (citing Britt v. North Carolina, 404 U.S. 226 (1972); Griffin v. Illinois, 351 U.S. 12 (1956)).

\textsuperscript{243} The Supreme Court has already held that states may have to pay for an indigent defendant's psychiatric evaluation and corresponding expert testimony. Ake v. Oklahoma, 470 U.S. 68 (1985).

\textsuperscript{244} For instance, one public defender's office recently spent over $50,000 in preparation for a trial involving DNA evidence. The defense attorney now "concedes that it is unlikely that the . . . public [defender's] office is going to spend $50,000 defending the next person prosecuted with DNA." Williams, supra note 4, at 32.

\textsuperscript{245} See supra notes 3, 4 and accompanying text.

\textsuperscript{246} For a general discussion of this constitutional issue, see Burk, supra note 2, at 470-71.


seizure if the situation presents both “exigent circumstances” and probable cause for the invasion of the suspect’s reasonable expectation of privacy.\textsuperscript{249}

Thus, blood samples may always be taken provided there is probable cause to believe that a suspect is intoxicated. The rapid decrease in the suspect's blood-alcohol ratio over time provides the element of exigency. No such exigent circumstances exist, however, in relation to DNA sampling. In contrast to the variability of blood-alcohol levels, each person’s genetic code remains static over his entire lifetime.\textsuperscript{250} Thus, there is no danger that crucial evidence will be destroyed while the wheels of justice slowly churn out a search warrant.

While it may appear, therefore, that the individual is protected against bodily invasions designed to yield DNA samples by the safeguard of “detached scrutiny by a neutral magistrate,”\textsuperscript{251} this protection is far from being a legal certainty. In 1968, the United States Supreme Court, in \textit{Terry v. Ohio},\textsuperscript{252} sanctioned a limited search on less than probable cause where necessary to confirm or dispel an officer’s suspicion that a suspect is concealing a weapon.\textsuperscript{253} These searches are commonly referred to as “\textit{Terry frisks},” attesting to the intended brevity of the search contemplated by the \textit{Terry} Court.

Thus, the facts of \textit{Terry} necessitated a ruling only on the permissibility of investigatory detention on less than probable cause. The Supreme Court has yet to issue a ruling on the constitutionality of brief, in-field detention of suspects for identification purposes. However, in \textit{Hayes v. Florida},\textsuperscript{254} the Court went as far as to say that, “a brief detention in the field for the purpose of fingerprinting, where there is only reasonable suspicion not amounting to probable cause, is [not] necessarily impermissible under the Fourth Amendment.”\textsuperscript{255} The Court did, however, stop short of holding that compulsory identification procedures could occur under circumstances lacking probable cause.\textsuperscript{256}

The Supreme Court, therefore, has entertained the idea of enlarging one of the “few specifically established and well-delineated exceptions” to the traditional requirements of the fourth amendment in

\begin{itemize}
\item \textsuperscript{249} \textit{Schmerber}, 384 U.S. at 770-71.
\item \textsuperscript{250} Absent mutation, a person's DNA will remain exactly the same throughout his life, and even after his death. Thompson & Ford, \textit{supra} note 29, at 62. Chemotherapy also might alter DNA to a slight degree. Burk, \textit{supra} note 2, at 470 n.68.
\item \textsuperscript{251} \textit{See Katz}, 389 U.S. at 356.
\item \textsuperscript{252} 392 U.S. 1 (1968).
\item \textsuperscript{253} \textit{Id.} at 30-31.
\item \textsuperscript{254} 470 U.S. 811 (1985).
\item \textsuperscript{255} \textit{Id.} at 816.
\item \textsuperscript{256} \textit{See id.} at 816-18.
\end{itemize}
the case of fingerprinting.\textsuperscript{257} However, even if the Court ultimately rules that in-field detention without probable cause for the purpose of fingerprinting is constitutional, the extension of that premise to include genetic sampling would be a clear violation of the spirit of \textit{Terry v. Ohio}.\textsuperscript{258} Two basic tenets support this premise.

First, the Supreme Court has expressly stated that \textit{Terry} frisks are constitutional within the fourth amendment only if the procedures employed are "the least intrusive means reasonably available to verify or dispel the officer's suspicion in a short period of time."\textsuperscript{259} DNA profiling is most often performed using samples of fresh blood. Given the fact that this method of identification requires probing beneath the surface of the suspect's skin, DNA profiling techniques are obviously more intrusive than traditional fingerprinting methods.\textsuperscript{260}

Furthermore, the Court has held that the "reasonableness" of a particular search or seizure shall be determined by balancing an agency's need for the evidence against the magnitude of the invasion of a suspect's personal privacy.\textsuperscript{261} Traditionally, the ruler against which the level of intrusion was measured was the degree to which the body was physically invaded. However, this standard may be outdated and inappropriate in its application to DNA profiling, which involves not only a physical invasion, but a psychological invasion as well. This psychological invasion is due to DNA's unmatched ability to expose personal and private details wholly unrelated to physical identification of the suspect.\textsuperscript{262}

Given this extreme level of intrusiveness, it is evident that DNA profiling easily surpasses both the degree of invasion associated with fingerprinting and the needs of the police to conduct an in-field identification procedure without a warrant. Thus, these factors strongly indicate that DNA profiling should not be considered in the same category as less intrusive identification techniques, should the Court choose to expand the scope of \textit{Terry}. In fact, because of DNA's ability to reveal personal information, the fourth amendment's protections against unreasonable searches and seizures should apply to a greater, rather than lesser, degree in the case of DNA profiling.\textsuperscript{263}

\textsuperscript{257} Note, \textit{supra} note 17, at 528 (quoting \textit{Katz}, 389 U.S. at 351).
\textsuperscript{258} \textit{Id.} at 529.
\textsuperscript{259} \textit{Florida v. Royer}, 460 U.S. 491, 500 (1983).
\textsuperscript{260} Note, \textit{supra} note 17, at 529-30.
\textsuperscript{261} \textit{Id.} at 528 (citing \textit{Davis v. Mississippi}, 394 U.S. 721, 727-28 (1969)).
\textsuperscript{262} For a detailed discussion of this issue, see \textit{infra} notes 266-81 and accompanying text.
\textsuperscript{263} Note, \textit{supra} note 17, at 527.
Finally, even if the Court determines that DNA evidence was properly obtained under the fourth amendment, one further constitutional issue remains, the consequences of which are likely to reverberate beyond courtroom walls and throughout the population at large. Currently, the groundwork is being laid for a nationwide computer network which will store the genetic profiles of certain criminal offenders who have been convicted of sexual or violent offenses.264

Civil libertarians are concerned that such a data bank system is extremely prone to abuse.265 Specifically, it is feared that the profiles contained within DNA data banks could be used to discriminate against individuals, depriving them of rights and privileges such as health benefits and employment opportunities.

Genetic discrimination is, indeed, a very real threat. DNA is a powerful tool for investigative intelligence. DNA is able to reveal, with chilling accuracy, facts about a person's past, present, and future, which he himself might not know.266 For instance, DNA can mark an individual as a carrier of AIDS, prove that he is adopted or of unknown parentage, and confirm that he is predisposed to develop certain genetic illnesses.267 “As scientists decipher the molecular misprints that determine our medical fate, these most intimate of details may be sought after by outsiders with a financial stake in knowing them.”268

Should the information contained in DNA data banks be made available to, or inadvertently fall into the hands of, either insurance companies or employers, the results could be devastating on both an individual and a community level. For example, employers could use DNA data in order to screen out job applicants who might be susceptible to various occupational hazards, in order to reduce corporate group-health premiums.269

Another group who might be interested in accessing information contained within DNA data banks is insurance companies. The insurance industry survives by classifying people by risk, charging

264. Sherman, supra note 132, at 25. State legislatures in California, Colorado, Nevada, and Virginia have all instituted procedures for collecting blood samples from selected prisoners for use in developing DNA data banks. Id.
265. Id.
266. As noted previously, the reliability of DNA profiling as an instrument of genetic research is not disputed. See supra note 119 and accompanying text.
267. Address of John K. Van de Kamp, Attorney General of California, at the California Criminalistics Institute Seminar on DNA Identification, Los Angeles, California, at 3 (Jan. 7, 1988) [hereinafter Van de Kamp].
269. Id. Because group-health premiums are based on the group’s actual health care costs, “it’s in an employer’s economic interest to avoid hiring heavy healthcare [sic] users.” Id.
greater premiums to those in high-risk categories. In addition, insurance companies engage in the routine practice of refusing to cover "pre-existing conditions." Thus, an individual whose DNA profiling information is revealed to insurance companies may be precluded from coverage of genetic illnesses which he has a potential to develop, or worse yet, be denied health coverage altogether.\footnote{270}

This type of discrimination is not the product of civil libertarians' fertile imaginations. In fact, the potential for misusing genetic information was dramatically revealed in the early 1970s in connection with sickle-cell anemia, a genetic blood disorder to which blacks are especially prone. In a well-intentioned, but ultimately misguided attempt to detect carriers of the disease, several states\footnote{271} drafted legislation designed to screen the black community for the trait.\footnote{272} Lack of confidentiality provisions in these bills led to abuses of the information obtained, and ultimately to discrimination against persons whose names were contained within the screening files.\footnote{273}

Beyond the obvious potential for abuse by employers and the insurance industry, DNA data banks also lend themselves to abuse by the criminal justice system itself. For example, California Attorney General John Van de Kamp has pointed to a real possibility that such data banks would create a temptation for frustrated law enforcement agents to "engage in genetic fishing expeditions."\footnote{274} For instance, Van de Kamp postulated that if researchers' theories are correct in linking criminal tendencies to chromosomal deficiencies, "there will surely come a day when a desperate detective tries to run a search for every person with that deficiency in the vicinity of a series of un-
solved murders."\textsuperscript{275}

Supporters of the DNA information network do not envision such an intrusive data bank system.\textsuperscript{276} The proposed DNA data bank system would store only the genetic profiles of certain criminals.\textsuperscript{277} However, Professor E. Donald Shapiro of New York School of Law cautions that, as DNA data banks proliferate, information will be kept not only on violent criminals, but on citizens from other segments of the population as well.\textsuperscript{278} Professor Shapiro stresses that the FBI's fingerprint files, which were originally intended for identification of criminals alone, now also contain the fingerprints of ordinary, law-abiding citizens.\textsuperscript{279} Furthermore, commercial laboratories have already instituted plans for their own private DNA data banks. Currently, the Lifecodes corporation is promoting its own version of a DNA storage bank, which has been referred to as a "baby bank."\textsuperscript{280} The company hopes to entice parents to buy storage space in its data bank for genetic information which could be used to identify their children in the event of a kidnapping.\textsuperscript{281}

While supporters of the proposed DNA data bank stress that the system would be strictly safeguarded against unauthorized intrusions, similarly safeguarded computer files have been violated repeatedly.\textsuperscript{282} Furthermore, in this age of interlocking data bases, "[e]fforts to safeguard data bases will at best be short-lived; history has proved that where there's a larcenous will, there is also a way."\textsuperscript{283}

Thus, in assessing the use of DNA in the legal arena, the courts must not allow the power of scientific technology to overshadow the fundamental concepts of personal freedom and individual rights. They must come to the realization that a technological advancement which performs flawlessly in the laboratory may nonetheless remain unsuitable for application in the courtroom.

VII. CONCLUSION

By its very nature, scientific evidence creates both excitement and
concern. DNA profiling is no exception. Given its potential as an instrument of justice, the courts have understandably strived to avoid unnecessary caution and undue delay in moving DNA profiling technology toward admissibility. At the same time, however, the judiciary must be cognizant of the technical limitations of the test and the dangers which lurk in the unknown. Despite the wondrous possibilities associated with DNA which could revolutionize criminal investigation, the benefits will not be without cost. While DNA testing may be fully suited to scientific research, it has not proven itself to be reliable in forensic situations. Hopefully, the judiciary will rethink its interpretation of the standards of legal admissibility as applied to DNA profiling, keeping in mind that their decisions will alter people's lives and legal positions. To do otherwise is to turn the courtroom into a research laboratory and defendants into guinea pigs. Until such time as further studies on the reliability of DNA are conducted, the legal community should approach DNA testing with cautious optimism.

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