The spectrum of topics encompassing the field of criminalistics is impressive, and makes for a diverse collection of chapters bound within the covers of this volume. The advent of Fourier transform infrared analysis has revitalized infrared spectroscopy as a vibrant forensic science analytical tool. Dr. Ed Suzuki's chapter offers the reader an overview of infrared theory as its applications to forensic science analysis. This chapter is followed by an in-depth treatment of one of the most important recent advances in forensic science technology—infrared microspectrophotometry. One's grasp of the fundamentals of forensic toxicology will be expanded by Dr. David Benjamin's chapter covering the principles of analytical pharmacology. Finally, Petraco and De Forest's chapter re-emphasize the traditional and daily practices employed by crime laboratories for the characterization of a wide variety of physical evidence.

I want to express my appreciation to my production editor, Rose Kernan, for the skills she brought to bear in converting the manuscript to a finished book.

Lastly, I'm deeply grateful to all the contributors of this book, as well as the first two volumes for the time and effort they gave to this series. They all deserve to share in the success of the *Forensic Science Handbooks*.

Richard Saferstein

1

LEGAL STANDARDS FOR THE ADMISSIBILITY OF NOVEL SCIENTIFIC EVIDENCE

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Expert "scientific" testimony has been relied on for assistance in the resolution of legal disputes since at least the fourteenth century.[1] The first recorded use of the testimony of an expert witness at trial occurred in 1665 in England during the religious persecutions styled as witch trials which were so prevalent throughout England at the time.[2] The expert's participation in these proceedings, however, was largely limited to supplementing the evidence against the accused. Another century passed before defendants were permitted to retain their own experts.[3]

The passage of time has only increased the reliance of the criminal justice system on scientific testimony. Just as modern society grows increasingly more dependent on scientific advances—for example, to facilitate communication between distant locations, to speed the processing of information, and to assist in controlling the spread of disease—so have our courts become increasingly more reliant on the use of science in the assessment of evidence.[4] In fact,

scientific proof has now become one of the primary types of evidence relied on in criminal prosecutions.[5]

FACTORS AFFECTING RELIANCE BY THE COURTS ON SCIENTIFIC EVIDENCE

Commentators have pointed to a variety of causative factors to account for the increased reliance by courts on the use of scientific evidence. These factors include the increasing levels of violent crime, the rise in illicit drug use, and informal judicial pressure to upgrade the scientific assessment of evidence.[6] However, in assessing the various reasons that have been offered in support of this increased reliance on the use of such evidence, there appears to be general agreement concerning at least three main contributing factors:[7]

1. The application of science to the resolution of legal issues is but a reflection of the importance of technology to all aspects of our modern life.

2. The Law Enforcement Assistance Administration (LEAA), created in 1968, provided extensive financial support for new forensic techniques.

3. During the 1960s the U.S. Supreme Court under Chief Justice Earl Warren handed down several seminal decisions dealing with the exclusion of evidence improperly obtained under the Fourth,[8] Fifth,[9] and Sixth[10] Amendment to the U. S. Constitution. The cumulative effect of these holdings was to restrict the admissibility, and therefore the impact, of physical evidence and lay testimony which, up until that time, had been the types of evidence most heavily relied on.[11] The Warren Court proposed, as an alternative to the prosecution's dependence on such evidence, a reliance on "[e]xtrinsic evidence independently received through skillful investigation"[12]—a classification clearly intended to include forensic, i.e., "scientific" evidence.

Predictably, therefore, the number of criminal trials relying at least to some degree on scientific evidence increased dramatically during the 1970s[13] to the point where, in a 1980 survey of judges and attorneys by the National Center for State Courts, 44 percent of those responding stated that at least 30 percent of the cases in which they were engaged involved the introduction of scientific evidence.[14] This growth still continues today with the introduction of new forensic techniques such as genetic "fingerprinting."[15]

The evidentiary void[16] resulting from the aforementioned Supreme Court decisions curbing questionable police identification and interrogation practices has largely been filled by increased reliance on the use of forensic techniques. Moreover, an unanticipated but otherwise welcome result of this increased reliance on scientific testimony,has been the development of new methods of analysis, such as the genetic fingerprinting technique mentioned earlier, which permit the forensic expert to obtain the maximum amount of information from the evidence relating to a given incident.

As recognized by Rule 702 of the Federal Rules of Evidence, discussed *infra*, the purpose of introducing scientific evidence at trial is to assist the trier of fact in understanding the issues that underlie a legal dispute.[17] Before the evidence can serve any purpose, however, a trial judge must first determine whether it is admissible. The admissibility standard applied by the judge for this purpose functions as the means through which the values of the legal system are imposed to delimit the scope of scientific knowledge.[18] However, to the student or newly admitted practitioner in the field of forensic science, who is seeking a basic understanding of the rules concerning the admissibility of scientific evidence, the standards may seem to have become modified and confused to the point where they have lost all semblance of consistency.[19] The court's analysis becomes even more complex when the evidence that is sought to be admitted is the result of a newly developed technique or instrument that has no proven track record.

It is therefore the intent of this chapter to examine broadly the primary legal standards (i.e., the *Frye* standard, the McCormick relevancy standard and the Federal Rules of Evidence) which have been developed and adopted to assist trial courts in making determinations of admissibility. By this review, the author hopes to foster an understanding of the interrelationship of the roles of science and law in this critical area.

THE MOTION *IN LIMINE*

Prior to analyzing the various tests relied on in different jurisdictions to determine admissibility, a brief examination of how the admissibility issue initially comes before a court is proper. One common means for raising this issue is the filing of a motion *in limine*.[20] Such motions were once utilized predominantly at the threshold of a trial to obtain a ruling concerning the admissibility of specified evidence. This motion has, however, evolved into a general litigation tool usable at any time before the evidence in question is actually offered at trial.[21]

Typically, the defense makes a motion *in limine* to obtain a pretrial order prohibiting the prosecution from placing certain inflammatory, prejudicial, or irrelevant evidence in front of a jury during the trial.[22] Such motions may also be made, however, by a prosecutor seeking from the court an "all clear" to offer questionable or problematic evidence.[23]

Although the motion *in limine* is occasionally referred to erroneously as a "motion to exclude" or a "motion to suppress," it should be distinguished from these other well-established pretrial procedures that assert that items of evidence or confessions were illegally obtained and therefore inadmissible at trial because they don't meet constitutional standards. The motion *in limine* is interposed solely to obtain a ruling by the court that the evidence to be offered by one's adversary has potentially inflammatory aspects (i.e., it is more prejudi-

cial than probative) that outweigh whatever materiality it would have at trial.[24] Thus

> the distinction between the motion to suppress and the motion *in limine* is that the former is predicated "upon specific constitutional or statutory grounds . . .", while the latter is addressed to the inherent power of the trial court to admit and exclude evidence.[25]

Moreover, as with all evidentiary rulings, the court's determination in ruling on a motion *in limine* is largely discretionary. Thus it is unlikely to be reversed unless patently erroneous.[26]

Although there are no specific federal or state court rules, nor any statutory authorities governing the motion *in limine,*[27] the use of the motion has spread, and today it is accepted in almost every state[28] and in the federal courts[29] as well. No express authority is believed to be required because such motions are seen by commentators and the courts as proper extensions of the trial judge's inherent and discretionary power to govern the admissibility of evidence and to take such precautions as are necessary to ensure that the parties receive a fair trial.[30]

As noted in the foregoing, the traditional procedure is to file a motion *in limine* prior to the selection of the jury. The theory behind this practice is that once the jury is exposed to the prejudicial information, the effect on them will be irreversible, even in the face of a court order striking the evidence coupled with a directive to disregard it. The court will normally hold a hearing in which the admissibility of the particular evidence in dispute is argued. Such hearings are popularly known—for example, in jurisdictions adhering to the *Frye* standard of admissibility (described in detail *infra*)—as a *Frye* hearing.

The issues to be determined at a *Frye* hearing are relatively complex in that the question is not simply whether there is or is not an established evidentiary rule for determining the reliability of the proferred testimony, as there is, for example, in the case of hearsay.[31] Rather, where the threshold issue is the admissibility of evidence based on the application of, for example, a novel forensic technique or the introduction of a new application of an established technique, the evidence clearly is logically relevant to the issues in the case; the judge, however, must be concerned with the legal relevancy of the evidence.[32]

A determination of the legal relevancy of the evidence rests on whether its probative value outweighs the amount of prejudice to the opposing party. In other words, is its value worth what it costs?[33] The court must consider, as a factor in counterbalancing the relevancy of the evidence, whether such evidence may unduly arouse the jury's emotions of prejudice, hostility, or sympathy.[34] If so, the evidence may be excluded even though it is relevant to a determination of the issues in the case. These matters are discussed in greater detail in the section of this chapter concerning the Federal Rules of Evidence.

The *Frye* hearing may last anywhere from a single day to several months, depending on such factors as the novelty of the technique, the complexity of its application, and the views of the related scientific community regarding its efficacy and reliability. The courtroom thus often becomes a classroom wherein competing experts retained by the prosecution and the defense attempt to sway the court to their respective points of view. Expert testimony as to both the underlying scientific principle, as well as the validity of the technique or process applying the principle, may be received by the court.[35]

Many commentators[36] believe that the reliability of evidence derived from a scientific principle rests on a third factor as well—the proper application of the technique on a particular occasion. Alternatively, however, it has been argued that this issue affects the weight, not the admissibility, of the evidence.[37] The burden of proving the reliability of the technique, however, remains (as always) on the party favoring the admission of the evidence.

Since admissibility is normally determined prior to the trial (i.e., before the jury is empaneled or, in the event the motion *in limine* is made during the trial, outside the presence of the jury), it eliminates the possibility that a jury will draw an adverse inference from inaccurate testimony offered by persons who appear, at least to the jurors, to be reputable scientists. Thus, the goal of using this procedure is to have all evidence considered for admission by the court, but only reliable evidence considered by the jury.[38] The standards most commonly relied on to determine this issue are set forth and discussed below.

STANDARDS FOR ADMISSIBILITY

For evidence to be of assistance to the trier of fact, it must be reliable.[39] The reliability of evidence is dependent on the following factors: (1) the validity of the underlying scientific principle, and (2) the validity of the technique applying that principle.[40] Because not all scientific techniques are reliable, however, courts screen novel techniques to determine their reliability before admitting the results of such techniques as evidence.[41]

This analysis is most crucial when it concerns the admissibility of evidence derived from a novel scientific technique, i.e., a technique that has not yet been judicially sanctioned.[42] Once a technique (e.g., fingerprint comparison) is sufficiently established, a court in a subsequent litigation may, if it sees fit, take judicial note of the validity of the principle and/or the technique since the reliability issue has already been settled. Such judicial notice serves to relieve the offering party from the burden of producing evidence concerning these issues.[43]

The admissibility of novel scientific evidence at trial is typically determined by reliance on one of a number of alternative tests. The majority view, known as the *Frye* rule, is based on a 1923 decision of the District of Columbia Circuit Court of Appeals in *Frye* v. *United States.*[44]

The *Frye* Standard

The defendant in *Frye,* having been charged with murder, attempted to introduce at trial the results of a novel "systolic blood pressure deception test," a forerunner of the modern polygraph. The defendant sought to offer expert testimony to demonstrate that while being examined he had truthfully denied any involvement in the crime. The trial court sustained the prosecution's objection to the evidence and refused to permit the defendant to be tested in front of the jury.

On appeal, the defendant relied on the traditional requirements of: (1) relevancy, and (2) helpfulness to the trier of fact.[45] The court, however, without citing any authority or providing any further explanation, interposed an additional burden on the introduction of such novel evidence and 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.* [emphasis added][46]

The court ruled that the polygraph had "not yet gained such standing and scientific recognition among physiological and psychological authorities." [47]

Frye thereafter became, not only the majority view among American courts, but the almost universal view, with the overwhelming majority of federal and state courts following this decision. In fact, at one point in the mid- 1970s, *Frye* appeared to be the controlling test in at least 45 states.[48]

Frye envisions that the admissibility of novel scientific evidence is dependent on an evolutionary process (i.e., a new scientific technique must first pass through an "experimental" stage in which it is reviewed by the relevant scientific community). Only when the technique has been successfully tested and found to produce reliable results does it pass into the "demonstrable" stage where it may receive judicial recognition.[49] Clearly, only when a procedure has passed through the steps of: (1) development, (2) verification, and (3) actual employment, can the community of concerned scientists be aware of both its reliability and its limitations.[50] The rationale underlying the court's reliance on the special admissibility rule is that such "general acceptance" is the best indicator of reliability available to the court.[51]

The *Frye* test is characterized as the most conservative approach to the introduction of novel scientific evidence.[52] It is not enough that a qualified

expert or even several experts believe that a particular technique has reached the demonstrable stage. As one commentator noted:

> Even if the world's leading scientific authority on a subject attests to a new theory, even if a Nobel prize winner in a specific field conducts a thorough, well-designed experiment to validate the technique, the courts cannot admit the evidence until most of the scientists in that specialized field know and approve of the theory.[53]

A variety of arguments have been offered to support reliance on the *Frye* standard for determining the admissibility of novel scientific evidence. The principal rationale advanced is that the general acceptance requirement screens out unreliable scientific evidence.[54] Under *Frye,* judges are not required to assess whether the technique itself is reliable, they need only determine whether experts in the field in which the technique is utilized consider it reliable. *Frye* assumes that the court can more easily determine the latter issue than the former.[55]

Further supporting *Frye* is the argument that requiring general acceptance "[p]rotects prosecution and defense alike by assuring that a minimal reserve of experts exist who can critically examine the validity of a scientific determination in a given case." [56] This test seeks to prevent situations wherein the litigants find it difficult, if not impossible, to find experts capable of a critical examination of the validity of an opponent's scientific evidence.[57]

The existence of a reserve of experts allows for preliminary screening of the technique or instrument that is proposed for admission into evidence. This is believed to protect the lay jury against its natural inclination to be overly awed by experts with seemingly impressive credentials. Most lay jurors are swayed by scientific testimony and tend to overestimate its probative value, thus giving greater weight to these expert opinions than such opinions deserve based solely on their scientific validity.[58] *Frye* helps to ensure that the scientific evidence that is admitted meets the juror's exaggerated expectations: By excluding evidence that does not satisfy the rule, the court ensures that jurors will not be influenced by testimony that sounds more impressive than it actually is.[59]

In *People* v. *Kelly,* a California court held that *Frye* "may well promote a degree of uniformity of decision. Individual judges whose particular conclusions may differ regarding the validity of particular scientific evidence may discover substantial agreement and consensus in the scientific community." [60] In *Kelly* the court stated:

> [O]nce a trial court has admitted evidence based upon a new scientific technique, and that decision is affirmed on appeal by a published appellate decision, the precedent as established may control subsequent trials, at least until new evidence is presented reflecting a change in the attitudes of the scientific community.[61]

Finally, use of the *Frye* test as a method of providing judicial notice of the validity of a particular technique eliminates the necessity of reopening the issue of admissibility in each case, thus substantially diminishing the need for time-consuming hearings on the validity of innovative techniques. This prevents the trial from becoming one of the technique itself and permits the court to focus on "its central concern . . . the rendition of a judgment on the merits of the litigation." [62]

Notwithstanding the widespread adoption of the *Frye* test, the test has been criticized on a variety of grounds. First and foremost is that reliance on this test leads to unacceptable delays in admitting reliable evidence, due to the existence of a cultural lag between the development and the acceptance of new techniques. This period is believed necessary to provide sufficient time for the new method to diffuse throughout the relevant scientific discipline(s) and to create the body of scientific opinion required for "general" acceptability.[63] Critics contend that the delay between proven reliability and a determination of the existence of a scientific consensus regarding validity deprives the courts of an opportunity to consider valuable evidence.[64] Thus, even though "every useful new development must have its first day in court," [65] reliance on the *Frye* test tends to delay that day longer than may be necessary.[66] As one Florida judge has written, "Society need not tolerate homicide until there develops a body of medical literature about some particular lethal agent." [67]

In contrast to this view, the defenders of *Frye*—although admitting that the test erects a difficult standard and does, to a degree, retard the introduction of novel scientific evidence—believe that such a conservative approach is warranted because, as stated in *United States* v. *Addison, supra,* "[s]cientific proof may, in some instances, assume a posture of mystic infallibility in the eyes of a jury of laymen. . . . " [68] *Addison* also states that such a consequence, i.e., delaying the introduction of a new scientific technique, is not an "unwarranted cost." [69]

In addition it is not difficult to conceive that generally accepted but unreliable evidence may still be found admissible, even in jurisdictions adhering to the *Frye* rule. This has occurred, for example, in instances where scientific principles or techniques are accepted by the scientific community, and thus adopted by the courts, prior to the performance of sufficient validation studies. One example of such an instance is the case of the so-called paraffin test for detecting gunshot residues, which was introduced in the early 1930s. The test was quickly accepted for use by law enforcement agencies and, beginning in 1936, the test began to be considered by the courts as admissible evidence. Despite a series of articles questioning the validity of this technique, it was accepted by the courts without question until 1959. It was not until 1967, when the first comprehensive evaluation of the test was published in the scientific literature, that it was found to be unreliable![70]

The *Frye* rule has additionally been criticized based on its effect on the constitutional right of a criminal defendant to present exculpatory evidence.

The cases to date invoking this right usually involve polygraph evidence and hypnotically induced statements offered by the defense.

The argument for admissibility in such instances is that the accused has a constitutional right to introduce reliable evidence that is critical to his or her case, notwithstanding restrictive evidentiary rules such as the *Frye* test.[71] This right has been recognized on compulsory process grounds by the U. S. Supreme Court in, for example, *Washington* v. *Texas*[72] and *Chambers* v. *Mississippi*.[73] The effect of these holdings on the *Frye* rule is demonstrated in *State* v. *Sims*[74] where the Court employed this Sixth Amendment rationale to reverse a trial judge's exclusion, based on the *Frye* test, of polygraph evidence offered by the defense.

The Supreme Court decided *Rock* v. *Arkansas,*[75] where the Arkansas state courts had applied a per-se rule excluding all hypnotically refreshed testimony. The defendant's testimony had been drastically restricted to the facts contained in her recorded prehypnosis statement. On appeal, the Supreme Court, relying on *Washington* and *Chambers, supra,* held that this application of the state rules of evidence violated the accused's right to testify in her own behalf. The Court additionally ruled that the rationale that the state's genuine and legitimate concern with precluding untrustworthy (i.e., not generally accepted) evidence must be balanced against the right of the accused to present a defense.

> This same reasoning can be applied when *Frye* is used to ban whole categories of forensic evidence on the basis of an accused's inability to establish "general acceptance" within an arbitrarily defined scientific community. 'A state's legitimate interest in banning unreliable evidence does not extend to per se exclusions that may be reliable in an individual case.' [76]

In light of the decisions discussed in the foregoing, therefore, due process may require a standard other than general acceptance, thereby rendering the *Frye* standard unconstitutional as applied to evidence offered by criminal defendants.[77]

A third major criticism of the *Frye* standard focuses on the difficulties encountered in applying it.[78] For example, a determination must initially be made as to whether the evidence in question is even subject to the *Frye* test at all.[79] Many courts are uncertain in deciding which evidence to classify as "scientific evidence" subject to a *Frye* analysis.[80] As stated by one Iowa judge,

> Despite [the *Frye* test's] apparent simplicity, distinguishing "scientific" evidence from other areas of expert testimony is a difficult determination in many instances. . . . The instant case illustrates the difficulty of classifying evidence as scientific or non-scientific. The defendant says that the study of blood flight characteristics is itself a science. The witness, on the other hand, testified it was based primarily on physics and mathematics, which imparts accuracy and predictability to the study.[81]

Once the court has determined that the evidence is subject to *Frye,* the next step is to determine exactly what it is that must be accepted; i.e., does the requirement of general acceptance extend beyond the underlying scientific principle to the use of the scientific techniques applying that principle? This issue is not expressly addressed by the court in *Frye,* but commentators typically agree that general acceptance of both the principle and the technique is required.[82]

Courts applying *Frye's* general acceptance test utilize a two-step analysis requiring, first, an identification of the scientific field in which the underlying principle falls, and, second, a determination as to whether the principle has been generally accepted by the members of that field. Both inquiries often lead to the problems discussed in the following.[83]

A judge seeking to identify the appropriate field for a particular technique will quickly find that not all scientific techniques fall within a single field. Often, new techniques compound this problem by incorporating elements relating to several disciplines, so that their categorization is open to a variety of interpretations.[84] For example, in the field of voiceprints, a California court has stated:

> Communication by speech does not fall within any one established category of science. Its understanding requires a knowledge of anatomy, physiology, physics, psychology and linguistics.[85]

This issue has recently arisen again with the introduction of evidence derived from the new DNA fingerprint technique. As one commentator has stated:

> In the case of DNA fingerprinting, should the court look for acceptance by biochemists in general, by specialists in molecular biology or by forensic experts?[86]

Moreover, even when general agreement as to the relevant field exists, the issue becomes one of whether to identify the field as embracing a broad category, such as physics or chemistry, or whether to limit the field in some way.[87] Obviously, the admissibility of the evidence may be affected by the choice of a narrow subspecialty within the broader field.

A leading case in this area is *People* v. *Williams,*[88] which concerns the validity of the Nalline test for detecting narcotic use. In *Williams,* the court upheld the admissibility of the evidence because the scientific test that had been employed had "been generally accepted by those who would be expected to be familiar with its use."[89] Under this view, therefore, the relevant scientific community may be defined as encompassing those who are familiar with the technique offered, rather than all chemists or even all forensic chemists.

This approach is not inconsistent with *Frye,* provided that the "specialized field" is of sufficient size that the *Frye* objective of a consensus judgment can actually be met. If the field is too narrow, the judgment of the "scientific community" becomes that of only a few experts, and thus the "consensus" becomes illusory.[90] As stated by Judge Smith in his oft-cited dissent in the Maryland case of *Reed* v. *State:*[91]

> I find myself somewhat puzzled as to what groups are to be considered in determining whether a process has general scientific acceptance and what knowledge, qualifications and experience are required in order for one to offer an opinion on the subject . . . Are we to undertake some kind of poll to determine whether there is general acceptance — or that the technique would be generally accepted by all of those so trained if they were informed as to what tests have been performed? What practical basis is a trial judge to use in determining whether a technique has general scientific acceptance?[92]

This question has still not been adequately answered.

The next issue to be determined, after the court has pinpointed the scientific field in which to look for acceptance and has decided what it is the members of this field must accept, is what types of proof may be relied on to establish general acceptance by the identified field. The principal methods that have been recognized by the courts for establishing such acceptance are: (1) expert testimony, (2) scientific and legal writings, and (3) judicial opinions.[93]

The most widely used method of establishing general acceptance of a procedure within the relevant scientific community is reliance on the testimony of expert witnesses. This practice has proven to be problematic, however, since it raises a number of additional issues such as: (1) how many experts are necessary to prove general acceptance, and (2) must the experts whose testimony is relied on be disinterested and impartial? Both of these concerns are discussed in the following.

With regard to the first issue, the actual question appears to be whether testimony by a single witness can ever be enough to establish general acceptance. Some courts have imposed a corroboration rule,[94] meaning that at least two experts must testify on the general acceptance issue. In *People* v. *Kelly,* a case involving the voiceprint technique, the court questioned "whether the testimony of a single witness alone is ever sufficient to represent, or attest to, the views of an entire scientific community regarding the reliability of a new technique."[95] The *Kelly* Court called for consideration of:

> the view of a typical cross-section of the scientific community, including representatives, if there are such, of those who oppose the new technique.[96]

Moreover, new scientific techniques are often so new that, when first offered at trial, they are not yet familiar to a majority of the scientific community. In view of this situation, the experts who appear to testify as to the validity and general acceptance of these procedures have frequently been involved in their development. This situation arose in *Kelly* where the court queried whether the expert, a leading proponent of the voiceprint technique,[97] could

"fairly and impartially . . . assess the position of the scientific community." [98]

The same issue arose again more recently in the Michigan case of *People* v. *Young*[99] dealing with the electrophoresis method of blood typing. The Michigan Supreme Court in *Young* held that in determining the scientific community's general acceptance of a novel technique, such general acceptance must be established by disinterested and impartial experts in the particular field to which the technique belongs.[100] This decision has been criticized for a variety of reasons, however, including the seemingly arbitrary manner in which the court assigned the witnesses who appeared to testify as to the reliability of the electrophoresis technique to the category of either "scientist" or "technician." The court that held that "[b]ecause a theoretical understanding is essential, the relevant scientific community is scientists and not technicians," [101] and, after discounting the testimony of all the "technicians," concluded that there was no general agreement in the scientific community concerning the reliability of the electrophoresis technique.[102]

The issue of experts' identification with the technique about which they are called to testify is bound to surface, if it has not already, during the admissibility hearings concerning genetic fingerprinting. Because of the high degree of technical skill necessary for the proper performance of this analysis, some of the experts in this field are employed by firms that offer the test on a commercial basis. It has therefore been argued by some[103] that the experts from these firms will exaggerate the accuracy of the test in order to protect their livelihood.

The second method of proof recognized by the courts for establishing general acceptance is reliance on scientific and legal writings. This represents a type of judicial notice. Courts relying on this type of evidence, however, are not taking notice of the validity of a particular technique. Instead, they are taking judicial notice of the relevant publications in attempting to determine whether general acceptance has been achieved.[104] This practice has been criticized, however, because the court may not discover all of the relevant articles and thus it may not be aware of research questioning the validity of the technique.

Alternately, reliance on scientific and/or legal publications to determine the lack of general acceptance of a particular technique appears to be more acceptable. If, for example, the overwhelming view expressed in the literature is that a particular technique has not been generally accepted, it would be appropriate for a court to balance this view against countervailing expert testimony that the technique was accepted, and to hold that the proponent of the evidence had not met the burden of proof on the general acceptance issue.[105]

Finally, some courts have relied on prior judicial opinions to decide whether general acceptance has been achieved. This practice is not recommended because it serves to undercut the rationale that supports the *Frye* decision, i.e., that those most qualified to judge the validity of a technique should have the determinative voice.[106] In this approach, it is the judge who is

taking judicial notice of the expert testimony contained in prior cases. *Frye*, on the other hand, emphasizes general acceptance by scientists, not by the courts.

Thus, the precise status of the *Frye* test for the admissibility of scientific evidence is not entirely clear. Some courts have accepted it; others have modified it; while still others have claimed to apply it although their decisions implicitly ignored it.[107] Clearly, however, the *Frye* decision has served to shape the debate over the proper standards for admitting evidence based on new scientific techniques.

The Relevancy/Federal Rules Approach

The Relevancy Standard

The relevancy test has become the most widely accepted alternative to the *Frye* standard. This test treats novel scientific evidence in the same manner as all other evidence, weighing the probative value of the evidence against any countervailing dangers arising from the tendency of the evidence to prejudice or confuse the jury. Under the relevancy approach, a lack of general acceptance is not a bar to admissibility, but merely affects the weight given to the evidence.[108] In support of this mode of analysis, Professor McCormick has stated:

> General scientific acceptance is a proper condition for taking judicial notice of scientific facts, but it is not a suitable criterion for the admissibility of scientific evidence. Any relevant conclusions supported by a qualified expert witness should be received unless there are distinct reasons for exclusion. These reasons are the familiar ones of prejudicing or misleading the jury or of consuming undue amounts of time.
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> ***
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> It [the relevancy test] permits scientific opinion of both underlying principles and particular applications to be considered in evaluating the worth of the testimony. In so treating the yeas and nays of the members of a scientific discipline as but one indication of the validity, accuracy and reliability of the technique, the traditional balancing method focuses the court's attention where it belongs—on the actual usefulness of the evidence in light of the full record developed on the power of the scientific test.[109]

When a court admits scientific evidence on this basis, the burden of attacking the reliability of a particular technique is shifted from the proponent to the opponent of the evidence. Under *Frye*, the proponent of the evidence must convince the court that the technique has achieved general acceptance in the particular field in which it belongs. Under the relevancy approach, however, the opposing party must establish a sufficient lack of reliability such that the probative value of the evidence is substantially outweighed by dangers such as unfair prejudice and the potential to mislead the jury and to waste the court's time.[110]

The relevancy approach is similar in many respects to the Federal Rules of Evidence (discussed *infra*). These rules may be viewed as codifying the steps involved in applying the relevancy test, in which a three-step analysis is utilized to determine the admissibility of evidence. First, the probative value of the evidence must be ascertained. Second, any countervailing dangers or considerations that may result from the introduction of the evidence must be identified. Finally, the probative value of the evidence must be balanced against the identified dangers. Each of these steps is discussed in detail in the following.

As mentioned earlier, the first step in analyzing evidence with the relevancy approach is to assess the probative value of the proferred evidence. With regard to this issue, Federal Rule of Evidence 401 states that relevant evidence is "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." However, a critical inquiry then arises as to how a trial judge goes about making a determination concerning the probative value of a novel scientific technique. The probative value of scientific evidence depends on its reliability,[111] since probative value and reliability are synonomous in this context.[112] Because most judges do not have the requisite scientific training to make such a determination, they are often forced to rely on scientific testimony for this purpose, particularly in cases where the scientific technique in question is novel and has not been widely accepted.[113] Thus, in contrast to the *Frye* practice, a determination of probative value made under the relevancy method of analysis could, in some instances, be established by the assertions of a single expert.[114]

Moreover, unlike the *Frye* procedure, the relevancy test does not assure that a novel scientific technique is reliable prior to its admission. The test relies to a great degree on traditional adversary trial procedures to expose deficiencies in new techniques so that the jury may determine for itself the reliability of the technique.[115] For example, one court, in upholding the admissibility of voiceprint evidence, stated:

> Unless an exaggerated popular opinion of the accuracy of a particular technique makes its use prejudicial or likely to mislead the jury, it is better to admit relevant scientific evidence in the same manner as other expert testimony and allow its weight to be attacked by cross-examination and refutation.[116]

Whether the discovery rules and provisions for defense experts that are currently relied on are sufficient to ensure such a challenge in criminal cases has, however, been questioned.[117] Moreover, this view also ignores the possibility that other experts may not be available to provide to the attorneys arguing against the introduction of this evidence sufficient assistance to enable them to prepare effective opposition when a new scientific technique is involved. Thus, cross-examination would most likely be an ineffective means for testing the validity of the novel scientific technique.

The second prong of the relevancy test is identification of any countervailing danger or consideration, as stated in Federal Rule of Evidence 403.[118] The principal danger inherent in the use of scientific evidence is its potential to mislead the jury. It is felt that evidence of this type can and often does "assume a posture of mystic infallibility in the eyes of a jury of laymen." [119] As the court stated in *People* v. *King*,[120] "[J]urors must not be misled by an 'aura of certainty which often envelops a new scientific process, obscuring its currently experimental nature.'" [121]

The final step in the relevancy approach is to balance the probative value of the preferred evidence against the identified dangers or other considerations. Under Federal Rule of Evidence 403, the evidence must be excluded only when the probation value is substantially outweighed by the identified dangers.

Various factors have been submitted by a number of commentators to aid the courts in balancing the countervailing aspects described in the foregoing.[122] After combining these factors in order to eliminate duplication, they consist of the following:

1. The technique's general acceptance in the field
2. The expert's qualifications and stature
3. The use that has been made of the technique
4. The potential rate of error in using the technique
5. The existence of specialized literature
6. The novelty of the invention
7. The extent to which the technique relies on the subjective interpretation of the expert
8. The existence and maintenance of professional standards
9. The presence of safeguards in the characteristics of the technique
10. Analogy to other scientific techniques whose results are admissible
11. The nature and breadth of the inference adduced
12. The clarity and simplicity with which the technique can be described and its results explained
13. The extent to which the basic data are verifiable by the trier of fact
14. The availability of other experts to test and evaluate the technique
15. The probative significance of the evidence in the circumstances of the case and
16. The care with which the technique is employed in the case[123]

Of course, not all these factors need be considered in every case. Moreover, depending on the particular circumstances, some factors will be given different weight than others.

Despite the assertion of some courts, the balancing test is not necessarily easier to apply than the *Frye* test. The problems encountered in determining reliability are, in fact, similar to those encountered in establishing general acceptance. Even where the relevancy approach replaces the *Frye* standard, general acceptance, although not as important, is still considered. As stated by the court in *United States* v. *Williams,* "A technique unable to garner any support, or only miniscule support, within the scientific community, would be found unreliable by a court" [124] even under the relevancy approach.

The Federal Rules of Evidence

The Federal Rules of Evidence were enacted by Congress in 1975[125] after 10 years of study. These rules govern the admissibility of all evidence, including expert testimony, in the federal courts. Further, many states have now adopted codes of evidence similar to the Federal Rules.

For purposes of determining the admissibility of novel scientific evidence, the Federal Rules may be viewed as posing a series of questions, phrased in a manner such that the answer to each question determines whether the court must consider further whether a particular item of evidence is admissible.[126] The initial area of inquiry is under Rule 401. The first question posed by this rule is whether the fact at issue is "of consequence to the determination of the action." Such facts are also frequently referred to as material facts. If the fact is not material, then evidence concerning it is inadmissible, regardless of how persuasive it is.

Conversely, if the fact at issue is material, the second question posed by Rule 401 must be answered: i.e., Does the evidence "hav[e] any tendency to make the existence of [the material fact] more probable or less probable?" If the evidence fails to meet this requirement, it is irrelevant under Rule 402[127] and therefore inadmissible. The entire matter need not be considered further.

Once the evidence in question passes the initial tests, Rule 403 sets up a third hurdle. Is the probative value of the evidence overshadowed by its prejudicial effect on the jury? If so, the evidence is not admissible.

The final area of inquiry, which is reached only if the evidence meets the first three tests, is whether the evidence is competent.[128] Federal Rule of Evidence 702[129] deals specifically with the competency of expert testimony, the principal means by which the validity of a novel scientific technique is typically established.[130] The chief criterion in determining whether expert testimony is appropriate is its helpfulness to the trier of fact, which will depend on the facts of a particular case. If the subject of the testimony is within the ordinary experience of the typical lay juror, then expert testimony would not be helpful and will not be admitted. On the contrary, however, if as little as one day's training is required to understand the evidence or to decide a factual issue, the court will permit expert testimony on the subject.

The issue of whether an expert's testimony would be helpful or not also depends on the question of whether the state of existing knowledge in a particular field is such that an expert's opinion would not be speculative.[131] Despite these limitations, however, courts and commentators view Rule 702 as a liberal standard for the admissibility of evidence, in contrast to *Frye* which admits evidence only from a source that is well-recognized among practitioners in the relevant field.

The adoption of the Federal Rules of Evidence has resulted in a critical reevaluation of the *Frye* rule[132] in that courts and commentators are divided over whether these rules have, in fact, superseded the *Frye* test. Neither the text of the rules nor the accompanying Advisory Committee notes make it clear whether the admissibility test set forth in *Frye* continues in force.

Proponents of the *Frye* rule argue that it remains the law even after the enactment of the Federal Rules because it was the dominant position of the courts at the time the Rules were adopted and the drafters made no statement explicitly repudiating this doctrine. It is additionally argued by adherents of this position that the Federal Rules of Evidence were not intended to be a comprehensive codification of the common law and many common-law rules thus were not incorporated. Under this theory, therefore, admissibility requires, not only that the evidence be relevant and helpful to the trier of fact, but also that it be generally accepted within the particular scientific community.

Conversely, those arguing against the continued vitality of the *Frye* standard in the face of the Federal Rules focus on the language of Rules 401, 402, and 702. Because scientific evidence may be shown to be reliable, and thus relevant under Rule 401, without proof of its general acceptance by the scientific community and because none of the exceptions set out in Rule 402 apply, the standard of admissibility under the Federal Rules is inconsistent with the *Frye* test. Additional support for this argument follows from the fact that the Federal Rules: (1) do not distinguish between scientific and other types of expert testimony, and (2) permit an expert to base an opinion on inadmissible facts or data, as long as such facts or data are of a type reasonably relied on by experts in that field.[133]

Thus, in the words of one commentator:

> Three conclusions can safely be drawn from the differences of opinion concerning the effect of the Rules on the *Frye* standard. One is that nothing in the Rules, their history or the Advisory Committee comments discloses an express intention to repudiate the *Frye* test. The second, however, is that they manifest a spirit of liberal admissibility under traditional relevancy and expert testimony analysis. Third, the rules provide a principled framework that can be substituted for the *Frye* test by courts that reject the *Frye* standard.[134]

The legal system must balance competing concerns whenever novel scientific evidence is offered at trial. While, as some argue, excessive caution can prevent the admission of valuable evidence in a timely manner, there is also the danger that evidence that is accepted without proper validation will later be

determined to be less reliable than promised. However, whatever test for admissibility is chosen for use in a particular jurisdiction, the chief concerns of the court applying the test must be: (1) the reliability of the evidence, (2) the degree to which lay jurors can comprehend the applications and the limitations of the evidence, and (3) the availability to the accused of adequate means to counter an opponent's presentation.

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