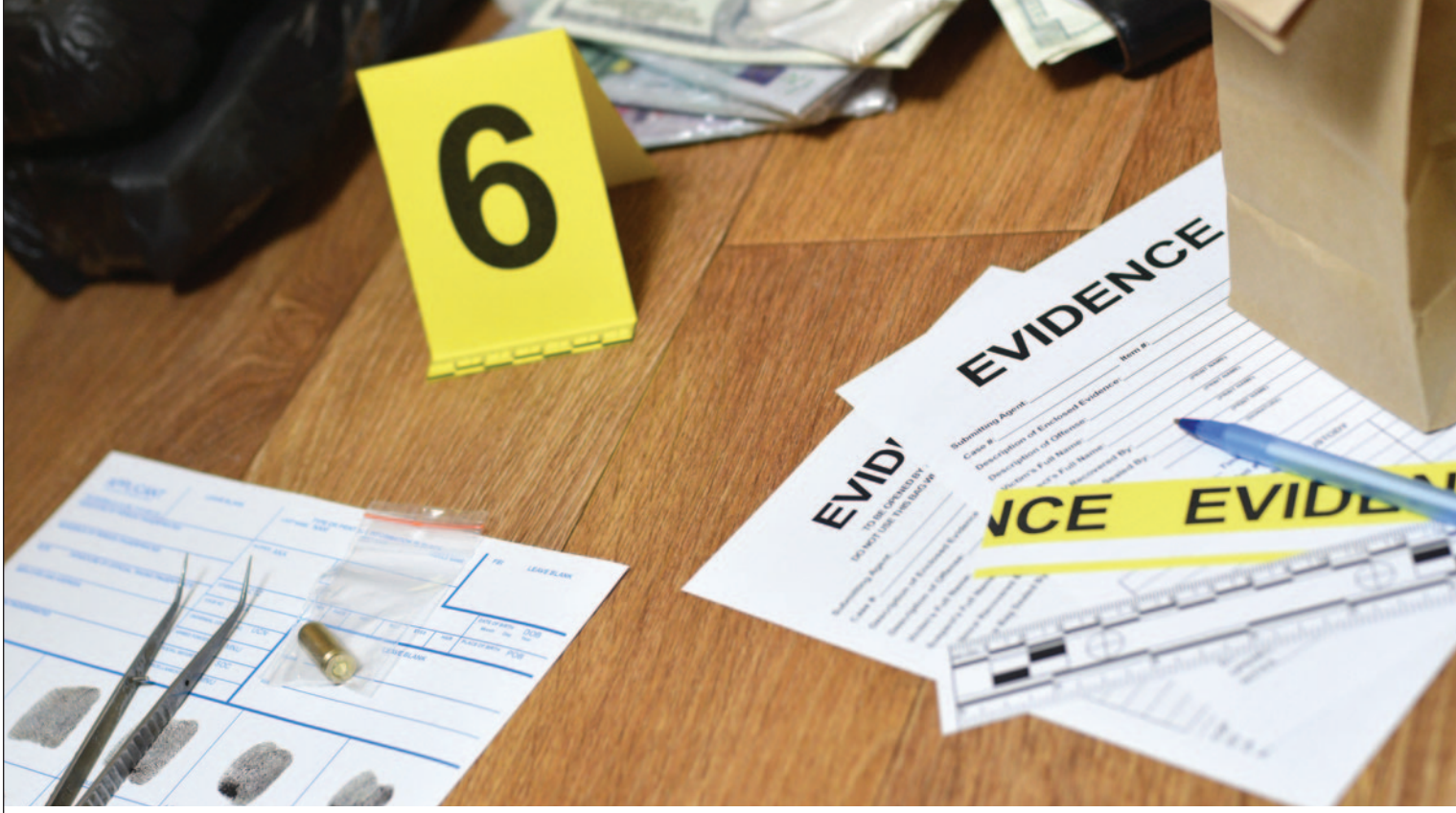

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Science in the Courtroom: Challenging Faulty Forensics

Robert Lee Stinson spent 23 years in prison for a murder that he did not commit after two forensic odontologists testified that bite marks on the victim were a match to Mr. Stinson's teeth.[1] The victim was a 63-year-old woman who had been raped, stabbed, and beaten to death. Investigators identified eight bite marks on the victim's body, and two forensic odontologists testified at trial that the bite marks "had to have been made by teeth identical" to Mr. Stinson's. The chairman of the Bite Mark Standards Committee of the American Board of Forensic Odontologists also testified that the evidence was "high quality" and "overwhelming." No other direct evidence linked Mr. Stinson to the murder, but he was convicted of first-degree murder and sentenced to life in prison. Twenty years later, in 2005, DNA testing of saliva and bloodstains on the victim's sweater excluded Mr. Stinson. In addition, independent forensic experts reviewed the bite mark evidence and determined that Mr. Stinson *did not* match the indentations. Mr. Stinson was exonerated in 2009 after the prosecutors dropped all charges against him. In 2012, the true perpetrator, Moses Price Jr., was charged with, and pled guilty to, second-degree murder after DNA linked him to the crime.

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Many other exonerees have lived similar nightmares. Philip Scott Cannon spent nine years in prison in Oregon for a murder that he did not commit after an expert testified that he had conducted "comparative bullet lead analysis" to purportedly match bullets recovered from the victims' bodies to bullets seized from Mr. Cannon's home.[2] Kevin Martin spent 30 years in prison in the District of Columbia for a murder and rape that he did not commit after a hair analyst concluded that a pubic hair found on the victim's shoes matched Mr. Martin's hair.[3] Stephan Cowans spent six years in a Massachusetts prison for an assault and attempted murder that he did not commit after two fingerprint examiners mistakenly matched Cowans' print to a latent print found at the scene.[4]

Over the last 25 years, there has been an increasing reliance on forensic science to guide criminal investigations and secure criminal convictions.[5] In many ways, forensic science has "undergone a sea change in the last 20 years, because what was traditionally an anecdotal profession has matured into a true laboratory science."[6] Although there have been some extraordinary successes for the forensic science community, there has also been a growing skepticism about the supposed infallibility of some forensic sciences, the handling of forensic evidence in crime laboratories, and the interpretation of physical evidence in the courtroom.[7]

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1. *Frye*, *Daubert*, and the Federal Rules

Federal Rule of Evidence ("FRE") 702 or the state law equivalent generally governs the admissibility of scientific evidence in the courtroom. Trial courts consider whether experts possess the necessary qualifications to testify and, more generally, whether expert testimony is sufficiently reliable to be admitted under *Daubert*[8] (or *Frye*[9]) and FRE 702.[10]

Some people in the legal community find fault with the application of *Daubert* because it offers appellate courts no clear standard to review decisions made by trial courts.[11] Trial judges, therefore, enjoy great discretion in admitting or excluding scientific evidence.[12] According to a report by the National Research Council of the National Academy of Sciences ("NAS"), "[t]he vast majority of the *reported* opinions in criminal cases indicate that trial judges rarely exclude or restrict expert testimony offered by prosecutors; most *reported* opinions also indicate that appellate courts routinely deny appeals contesting trial court decisions admitting forensic evidence against criminal defendants."[13] The opposite is true for civil cases since plaintiffs and defendants in those cases are equally as likely to have access to expert witnesses.[14] Oddly, appellate courts are more willing to question the admissibility of scientific evidence made by trial courts in civil cases rather than criminal cases.[15]

Courts, whether civil or criminal, however, are tasked with the same responsibility: to act as "gatekeeper" to "ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable."[16] That responsibility is especially important in criminal cases involving forensic disciplines because research suggests that jurors tend to overvalue an expert's experience and stated certainty in his conclusions and undervalue the validity and accuracy of forensic techniques.[17] In addition, the "CSI Effect" — by which jurors have come to expect the presentation of forensic evidence in every case and expect it to be conclusive[18] — has caused some actors in the criminal system to offer expert testimony in forensic disciplines that have yet to be validated and proven reliable.[19]

2. The Scientists Have Weighed In

It has been more than 10 years since the National Academy of Sciences released its groundbreaking report on the state of forensic sciences in the courtroom.[20] Published in 2009, the "NAS Report" concluded that, with the exception of nuclear DNA analysis, no forensic method has been thoroughly shown to have the capacity to consistently connect forensic evidence to specific individuals or sources.[21] The NAS Report made clear that "problems, irregularities, and miscarriages of justice [could not] simply be attributed to a handful of rogue analysts or underperforming laboratories."[22] The NAS Report, instead, found that the problems are systemic and pervasive due to a lack of resources, standardization, training, and peer-reviewed studies to establish the scientific basis and validity of many forensic methods.[23] Significantly, the NAS Report concluded that "[m]uch forensic evidence — including, for example, bite marks and firearm and toolmark identifications — is introduced in criminal trials without any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline."[24]

Many attorneys expected that the NAS Report would lead to a great sea change in the admissibility of faulty or misleading forensic sciences in the courtroom. But that sea change on admissibility has yet to come.

Since the NAS Report, scientists have weighed in through a number of different means, including the National Commission on Forensic Science ("NCFS") established in 2013 and the Organization for Scientific Area Committees for Forensic Science ("OSAC") established in 2014. Stakeholder input, including from the scientists themselves, has driven momentum in this area. For example, the NCFS — which existed for four years from 2013 to 2017 until the Department of Justice elected not to renew its charter — made a number of significant recommendations, including a recommendation for independent validation of forensic techniques and oversight by the National Institute of Science and Technology.[25] As another example, the OSAC, organized by forensic discipline area, has been working to evaluate existing standards and create new standards in a number of areas.[26]

The impact of the NAS Report did not end there. In 2017, the President's Council of Advisors on Science and Technology released its groundbreaking report on forensics in criminal courts (the "PCAST Report").[27]

The PCAST Report, like the NAS Report before it, focused on forensic "feature-comparison" methods.[28] "Feature-comparison" methods are "methods that attempt to determine whether an evidentiary sample … is or is not associated with a potential 'source' sample … based on the presence of similar patterns, impressions, or other features in [each] sample."[29] This analysis that professes to "match" an unknown item of evidence to a specific known source is called "individualization."[30]

DNA analysis is an example of a feature-comparison method.[31] A DNA analyst may seek to determine, for example, whether DNA found on the victim at a crime scene matches the DNA of a suspect thought to be the perpetrator. The examiner will analyze the "features" of each sample and offer an opinion about the probability of a match arising by chance.[32] Other examples of feature-comparison methods include hair analysis (*e.g.*, do the features of the hair found at the scene of a murder match the features of the hair belonging to the suspect?) and fingerprint analysis (*e.g.*, do the features of the latent fingerprint found at the scene of a burglary match the features of a ridge pattern on the suspect's finger?).[33]

In its 150-page report, PCAST examined the weaknesses that plague the forensic sciences long-relied upon to convict in this country.[34] Generally,

> PCAST concluded that there are two important gaps [in the state of forensic science]: (1) the need for clarity about the scientific standards for the validity and reliability of forensic methods and (2) the need to evaluate specific forensic methods to determine whether they have been scientifically established to be valid and reliable.[35]

The PCAST Report was not universally welcomed. Several months after its issuance, PCAST released an Addendum to the report, which describes the input from stakeholders "expressing a wide range of opinions."[36] The Addendum describes, for example, the response from the Department of Justice, attempting to discredit the report by suggesting that the PCAST authors failed to consider relevant research studies.[37] The Addendum describes PCAST's effort to solicit additional studies and DOJ's subsequent conclusion "that it had no additional studies for PCAST to

consider."[38] The Addendum goes on to confirm the conclusions in the report and provide additional information for courts to consider.[39]

Still, courts are regularly admitting faulty or misleading forensics in criminal cases.[40]

3. Impediments to Change

The absence of any "sea change" in the admissibility of faulty or misleading forensic sciences is not from a lack of effort. The years of work that went into the NAS Report and the PCAST Report, as well as the ongoing work through OSAC, show significant investment. Since those reports, there have been trainings across the country for lawyers to digest and understand the implications of the gaps in forensic methodology.[41] Articles have been written to better educate those who work in or are impacted by this area of the criminal justice system,[42] and even mainstream media has delved into the topic and created public awareness.[43]

The reported decisions on admissibility, however, still show a surprising lack of change.[44] The absence of real change in admissibility could be attributed to the reality that the law needs time to catch up to science. Judges and lawyers rightly recognize that "[l]aw lags science; it does not lead it."[45] For that reason, some delay should be expected before the state of the law properly reflects the state of the science. The expected delay may explain the lack of significant change in admissibility since the publication of the PCAST Report in 2016, but it does not fully explain the endurance of flawed forensics in criminal cases. After all, the NAS Report was written more than a decade ago in 2009. NAS reported much of what was echoed in the PCAST Report. Still, the law lags behind.

The few reported cases that address the PCAST Report suggest that a more fundamental part of human nature may be getting in the way — namely, a resistance to change. Many courts ultimately leave the decision of "scientific validity" in the hands of the jury by forcing the defendant to rely on cross-examination.[46] The reliance on the traditional tools of the adversarial system likely comes from *Daubert* where the Court wrote, "[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence."[47] Rather than relying on the scientific method of peer review,[48] courts are regularly putting the decision into the hands of lay juries to decide what is, and what is not, reliable science.

The sentiment in some of the cases discussing the admissibility of challenged forensic evidence reveals an impediment to reform in the justice system. Law is based on precedent. Judges and lawyers "treat like cases alike,"[49] and the criminal justice system holds dear that guiding principle to ensure consistency and equal protection before the law. Science works at the opposite end of the spectrum — changing as knowledge changes. "Science is not an encyclopedic body of knowledge about the universe. Instead, it represents a *process* for proposing and refining theoretical explanations about the world that are subject to further testing and refinement."[50] The two areas — law and science — are fundamentally at odds when they intersect. Still, they intersect.

The news is not all bad. Some courts are starting to recognize scientific uncertainty, and some judges are starting to understand the probabilistic nature of many types of forensic evidence.

The Supreme Court, in *Daubert*, recognized the conflict between law and science:

> It is true that open debate is an essential part of both legal and scientific analyses. Yet there are important differences between the quest for truth in the courtroom and the quest for truth in the laboratory. Scientific conclusions are subject to perpetual revision. Law, on the other hand, must resolve disputes finally and quickly. The scientific project is advanced by broad and wide-ranging consideration of a multitude of hypotheses, for those that are incorrect will eventually be shown to be so, and that in itself is an advance. Conjectures that are probably wrong are of little use, however, in the project of reaching a quick, final, and binding legal judgment — often of great consequence — about a particular set of events in the past.[51]

The *Daubert* Court considered the conflict only in the context of the trial court's new role as "gatekeeper" to exclude evidence.[52] It did not consider the impact of precedent when courts choose to admit scientific evidence.[53]

The Supreme Court of Utah put it best when it acknowledged in the context of memory science that lawyers and judges "tend to comfortably rely upon settled legal precedent and practice, especially when long-settled technical rules are concerned, and to largely ignore the teachings of other disciplines, especially when they contradict long-accepted legal notions."[54]

Judge Harry T. Edwards, one of the authors of the NAS Report, recognized the same resistance to change in his speech at the inaugural meeting of the National Commission on Forensic Science.[55] Judge Edwards rightly recognized that the judiciary's reliance on precedent makes the justice system a poor venue from which to expect forensic reform.[56] Judge Edwards said:

> The judiciary's adherence to the rule of law is another reason why decisions under *Daubert* have not resulted in any meaningful limitations on the admissibility of forensic evidence. In the United States, the rule of law embraces the quest for constancy and predictability, as well as a determination to treat like cases alike. Therefore, even as many judges have recognized that the methods used by fingerprint, ballistics, tool mark, bite mark, handwriting, fire debris, and fiber experts have not been scientifically verified, they have continued to admit questionable and overdrawn testimony from forensic practitioners on the grounds that such evidence has been relied upon in the justice system for many years. Each ill-informed decision becomes a precedent binding on future cases.[57]

The PCAST Report itself recognized that the role of precedent creates an "obvious tension, because many courts admit forensic feature-comparison methods based on long-standing precedents that were set before these fundamental problems were discovered."[58] The authors of the PCAST Report offered a clear resolution from a scientific standpoint: "When new facts falsify old assumptions, courts should not be obliged to defer to past precedents: they should look afresh at the scientific issues."[59] They further recognized authority under the law to depart from precedent: "The Supreme Court has made clear that a court may overrule precedent if it finds that an earlier case was 'erroneously decided and that subsequent events have undermined its continuing validity.'"[60] But the law is still resistant to change.

The resistance to change is not exclusive to courts. Lawyers, even defense lawyers, take comfort in the arms of precedent. Judge Edwards recognized generally that apart from being bound by precedent, "[t]he judicial system is encumbered by judges and lawyers who generally lack the scientific expertise necessary to comprehend and evaluate forensic evidence in an informed manner."[61] That lack of scientific expertise means that the advances in science do not always make their way into the courtroom.

The news is not all bad. Some courts are starting to recognize scientific uncertainty, and some judges are starting to understand the probabilistic nature of many types of forensic evidence. In *Williams v. United States*, Judge Catharine Easterly of the D.C. Circuit discussed in a concurring opinion the improper testimony from a firearms and toolmark examiner who expressed his opinion of a "match" with absolute certainty.[62] Judge Easterly properly recognized, based on the NAS Report, that "there is currently no statistical basis to declare with any degree of certainty that toolmarks on a bullet connect that bullet to a particular gun or 'match' the markings on other bullets fired from that gun."[63] The judge went on to make clear that "[c]ertainty statements such as those elicited by the government in this case are misleading and lack any legitimate utility in criminal trials; they express a solid statistical foundation for individualization that does not currently (and may never) exist."[64]

Other recent decisions echo the same sentiment.[65] In *United States v. Tibbs*, the superior court in the District of Columbia limited the opinions of a firearms examiner after an extensive evidentiary hearing.[66] The court based its ruling "largely on the inability of the published studies in the field to establish an error rate, the absence of an objective standard for identification, and the lack of acceptance of the discipline's foundational validity outside of the community of firearms and toolmark examiners."[67] The court allowed the examiner to testify to a conclusion that the firearm cannot be excluded as the source of the casing, but refused to allow the examiner to opine that the firearm was, in fact, the source.[68]

These cases suggest incremental progress, but the law has a long way to go. Because some of the advances in the state of the science may run contrary to the long-standing and deeply held beliefs by judges and jurors, attorneys need to do more to educate those groups about changes to, and the limits of, the science.

4. The Challenge to Faulty and Misleading Forensics Is Worth the Effort

Because faulty or misleading forensics are the second leading cause of wrongful conviction,[69] challenges to these forensic disciplines are worth the effort. Here is a general framework for the challenge:

A. Foundational Validity v. Validity as Applied

For any type of scientific evidence, there are two broad categories that the evidence must satisfy before it can be admitted in court.

First, is the methodology foundationally valid?

Second, is the methodology valid as applied?

According to the PCAST Report, a method is not "scientifically valid" unless it has both "foundational validity" and "validity as applied."[70] To be "foundationally valid," a method must "be shown, based on empirical studies, to be *repeatable*, *reproducible*, and *accurate*, at levels that have been measured and are appropriate to the intended application."[71] "Foundational validity" is the scientific counterpart to the legal standard for expert testimony under FRE 702, which requires expert testimony to be based on "reliable principles and methods."[72] A method must be "subjected to empirical testing by multiple groups, under conditions appropriate to its intended use."[73] Further, "[s]tudies must … demonstrate that the method is repeatable and reproducible and … provide valid estimates of the method's accuracy … that indicate the method is appropriate to the intended application."[74]

"Validity as applied" requires methods to have reliability in practical application.[75] It is the scientific concept that "correspond[s] to the legal requirement … that [a testifying] expert 'has reliably applied the principles and methods to the facts of the case.'"[76] Two tests must be met: (1) the expert "must have been shown to be capable of reliably applying the method and must actually have done so" and (2) the expert's "assertions about the probative value of proposed identifications must be scientifically valid."[77]

The questions of foundational validity and validity as applied are separate and distinct, and attorneys should consider them each in turn. A method may be neither foundationally valid nor valid as applied, and it should be challenged on both grounds. Alternatively, a method may be foundationally valid, but it may not be valid as applied.

For many of the pattern matching methods, attorneys and judges had long assumed that the first question (foundational validity) had been squarely resolved. Many attorneys and judges assumed that, at some historical point in time, some knowledgeable scientist must have looked at the science and made sure that it was reliable. What is now known (from the NAS Report, the PCAST Report, and many other reports from the scientists themselves) is that foundational validity may not have been established; everyone just assumed that it had been.

B. Faulty Assumptions

One reason that a pattern matching method may not be foundationally valid is because of the assumptions on which the method relies. Every scientific test relies on assumptions. Before the scientific opinion makes it to the jury, it is the job of the attorneys and the court to determine what those assumptions are, whether they are valid, and how changing the assumptions may change the conclusion.

Figuring Out the Assumptions

Figuring out the assumptions behind a forensic opinion may not be an easy task. In many fields of scientific study, the scientist will readily disclose his or her assumptions in order to facilitate peer review — the process of acceptance in the scientific community. Forensic reports in criminal cases, however, do not generally disclose the assumptions on which the opinions rely. Many attorneys have struggled with an adverse forensic witness who carefully crafts his or her testimony to avoid a challenge to the assumptions.

Here are some tips to uncover the assumptions before the witness takes the stand:

1. Hire an expert. As a general rule, attorneys should consult with experts whenever forensics are at issue. The science is constantly changing, and a consulting expert can help the attorney to understand the methodology, craft questions for cross-examination, and distill the important concepts for the judge or jury.

2. Learn the science. Even if the attorney has hired a consulting expert, there is no substitute for learning the science. The consulting expert is an expert on the science, but the attorney is the expert on the facts of the case. The best way to address forensics is by leveraging both the science and the facts.

3. Find the inconsistencies. Do the bench notes match the conclusions in the report? Do the communications between the examiner and the attorney for the other side go beyond what the science can support? What changed from the draft report to the final report?

4. Pay attention to differences in language. Remember that lawyers and scientists speak different languages. There may be subtleties in the examiner's conclusion that seem innocuous to attorneys, but may have meaning to the examiner.

5. Diagram it. Start with the examiner's ultimate conclusion (e.g., the thing from the crime scene "matches" the defendant) and work backward to figure out how she got there. Drawings, decision trees, and flow charts can help to visualize the steps. Then note the places where

the analyst may be connecting dots that cannot be connected, skipping steps in connecting the dots, or relying on the opinions of others that should be explored.

Common Faulty Assumptions for Pattern Matching Methods

Some assumptions are common, but faulty, in pattern matching methods. We focus on three of those common assumptions here.

Common Assumption No. 1: There is only one person in the pool. For many of the pattern matching methods, the examiner assumes that there is only one person in the pool of potential matches. That is, the analyst assumes that the "pattern" is unique such that it matches only one person in the world, to the exclusion of all others. Latent fingerprint analysis can be used to illustrate the point. A latent fingerprint examiner will analyze a latent fingerprint, or impression, from the scene in an attempt to "match" that print to the actual ridge pattern on the suspect's finger. The examiner may identify several characteristics in the impression that the examiner believes to be unique and, if the examiner sees the same characteristics in the suspect's known print, the examiner may declare a match. The examiner, however, is assuming that one would only expect to find those particular characteristics in that particular arrangement in one person in the world.

This testimony that professes to "match" an unknown item of evidence to a specific known source is called "individualization"[78] and has been widely criticized because it purports to entirely eliminate the probability that a different individual might be the source of the evidence. For many of the pattern matching methods, the examiner cannot eliminate that possibility.

Changing this one assumption could have a profound impact on the conclusion of a "match." For example, if the examiner assumes that there could be two people who may have the same set of distinct characteristics, then there exists one other person (besides the suspect) who could have also left the impression at the crime scene. If the examiner assumes that there could be 100 people who may have the same set of distinct characteristics, then there exists 99 other people in the world who also could have left the impression at the crime scene. If the characteristics are not unique at all and could match anyone, then the examiner's opinion that the latent "matches" the suspect makes no difference at all. The opinion is not probative because it does not narrow down the pool of suspects.

In DNA cases, courts have recognized the importance of the statistic that accompanies the opinion of a "match." It is the statistic that gives the match meaning. As one federal court magistrate judge in Ohio recognized in *United States v. Yee*, without that statistic, "the jury does not know what to make of the fact that the patterns match: the jury does not know whether the patterns are as common as pictures with two eyes, or as unique as the Mona Lisa."[79]

For many of the pattern matching methods, there is no statistic that tells the jury whether the match is unique such that it is probative. For attorneys attempting to challenge the opinion of a match, the question is not, "Does this impression match the known?" The better question may be, "How many other people could the impression *also* match?"

Common Assumption No. 2: The pattern at the scene is the same as the pattern on the source. Another common assumption behind pattern matching methods is that the pattern left at the crime scene is the same as the pattern as it appears on the source. The examiner assumes that whoever left the impression at the scene left an exact replica of how that thing appears on the person who left it.

Again, latent fingerprint analysis can be used to illustrate the point. The examiner assumes that the latent fingerprint at the scene is the same as the ridge pattern on the finger that left it. That assumption may be faulty. The quality and quantity of detail in the latent print may be affected by many different factors, including the robustness of the ridge structure, the presence of oil or sweat, the mechanics of touch, and the nature of the surface touched.[80]

Attorneys who have been "printed" know that the officer who takes the print will roll the subject's finger in the black ink and then roll that finger on the ten-print card. The goal is to reduce the amount of distortion in the impression left behind. Criminals do not typically roll their fingers around a crime scene to reduce distortion. Latent fingerprint examiners cannot assume otherwise.

Again, changing this one assumption may have a profound impact on the opinion of a "match." If the examiner assumes that the latent print is distorted in some small but unknown way, the examiner must assume a risk of error that could produce a false positive.

Common Assumption No. 3: Error, if any, would be intentional. In a courtroom, attorneys and judges often assume that an "error" means that someone messed up. The implication is that the examiner acted intentionally or incompetently. In the law, error implies fault.

In science, however, error could also mean an incorrect answer due only to chance — a "coincidental match." No one is at fault; two things just happen to match when we did not expect them to match.

C. What to Do Pretrial, at Trial, or in Postconviction

Here are some of the ways that attorneys can raise the challenges pretrial, at trial, or in postconviction:

1. File motions *in limine*. Pretrial motions to exclude faulty or misleading forensics can be raised under FRE 702, 402, and 403, or the state law equivalent. The proper analysis proceeds under *Daubert*, *Frye*, or the state law equivalent. Be prepared for a pretrial hearing that should include an examination of the other side's expert, testimony from the defense expert to explain the limits of the science, and argument to exclude or limit the expert opinions at trial.

2. Offer an expert. Don't just rely on cross-examination. It may be difficult, if not impossible, to elicit the information necessary to properly educate the court about the limits of the science through an adverse witness.

3. Request a special master. Scientific issues are often complex and may need more specialized attention than the average pretrial hearing that occurs on the morning of trial. Consider requesting a special master to hear from the experts, review the scientific literature, and make a recommendation to the court. The significant progress made in the area of eyewitness identification came as a result of such a hearing before a special master.[81]

4. Offer an *amicus* brief. An *amicus* brief may help to educate the court about the changes in science and the broader policy implications of admitting faulty forensics. Consider seeking out *amicus* support, even at the trial court level.[82]

5. Limit the language of the opinion. Some forensics may be valid for some purposes, but not valid for others. If the opinion is not entirely inadmissible, or if the court declines to exclude it, consider a request to limit the language of the opinion to keep the truly misleading portions out.[83]

Conclusion

Overall, and especially in postconviction, lawyers can remind the court that, by relying on forensic evidence to secure a criminal conviction, the government must necessarily relinquish some measure of finality in that conviction because the state of science is constantly changing.[84] The justice system should not be able to reap the benefits of forensic science without also accepting the risk that future advances in the science will bring current understanding into question.

Notes

1. National Registry of Exonerations, Robert Lee Stinson, http://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3666.

2. National Registry of Exonerations, Philip Scott Cannon, http://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3083.

3. National Registry of Exonerations, Kevin Martin, http://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=4475.

4. National Registry of Exonerations, Stephan Cowans, http://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3127.

5. *See* Craig M. Cooley, *Forensic Science and Capital Punishment Reform: An 'Intellectually Honest' Assessment*, 17 Geo. Mason U. Civ. Rts. L.J. 299, 308 (2007); Erin Murphy, *The New Forensics: Criminal Justice, False Certainty, and the Second Generation of Scientific Evidence*, 95 Cal. L. Rev. 721, 743–44 (2007).

6. Gregory J. Davis, *Forensic Medicine in the 21st Century: A Realistic View of Our Changing Science*, 130 Archives of Pathology & Laboratory Med. 1273, 1273 (2006).

7. *See* Nat'l Research Council, Strengthening Forensic Science in the United States: A Path Forward 4 (2009) [hereinafter NAS Report], https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf; President's Council of Advisors on Sci. and Tech., Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods 25 (2016) [hereinafter PCAST Report], https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_ forensic_science_report_final.pdf.

8. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 587, 113 S. Ct. 2786, 125 L. Ed. 2d 469 (1993).

9. *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923), *superseded by statute*, Fed. R. Evid. 702, *as recognized in Daubert*, 509 U.S. at 587.

10. *Daubert*, 509 U.S. at 589. While the majority of states follow *Daubert*, a minority continue to follow *Frye*. Bruce Kaufman, *States Slow to Adopt Daubert Evidence Rule*, Bloomberg BNA (Apr. 27, 2016), https://www.bna.com/states-slow-adopt-n57982070384/ ("In many of the holdout jurisdictions — including California, New York, New Jersey, Illinois, Maryland, Washington, and the District of Columbia — the standard for admitting expert evidence in courtrooms closely follows the century-old *Frye* test, which was developed for evaluating then-novel polygraph testimony.").

11. NAS Report, *supra* note 7, at 11.

12. *Id.*

13. *Id.* (emphasis in original).

14. *Id.*

15. *Id.*

16. *GE v. Joiner*, 522 U.S. 136, 142, 118 S. Ct. 512, 139 L. Ed. 2d 508 (1997) (quoting *Daubert*, 509 U.S. at 589).

17. *See* N.J. Schweitzer, Communicating Forensic Science 8 (2016), https://www.ncjrs.gov/pdffiles1/nij/grants/249804.pdf.

18. NAS Report, *supra* note 7, at 48.

19. John Alldredge, *The 'CSI Effect' and Its Potential Impact on Juror Decisions*, 3 Themis: Res. J. Just. Stud. & Forensic Sci. 114, 118 (2015).

20. NAS Report, *supra* note 7.

21. *Id.* at 7.

22. PCAST Report, *supra* note 7, at 4.

23. *Id.*

24. NAS Report, *supra* note 7, at 107–08.

25. National Commission on Forensic Science, Scientific Inquiry and Research Subcommittee, *Views of the Commission, Technical Merit Evaluation of Forensic Science Methods and Practices* (June 21, 2016), https://www.justice.gov/archives/ncfs/file/881796/download.

26. *See* National Institute of Science and Technology, The Organization of Scientific Area Committees for Forensic Science (describing different attempts to create or evaluate standards), https://www.nist.gov/topics/organization-scientific-area-committees-forensic-science/osac-standards-and-documents.

27. PCAST Report, *supra* note 7.

28. *Id.* at 1.

29. *Id.*

30. NAS Report, *supra* note 7, at 7.

31. PCAST Report, *supra* note 7, at 26.

32. *See id.* at 7.

33. *See id.* at 88, 118.

34. *See id.* at 1.

35. *Id.*

36. President's Council of Advisors on Science and Technology, An Addendum to the PCAST Report on Forensic Science in Criminal Courts 2 (2017), *available at* https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensics_addendum_finalv2.pdf.

37. *Id.*

38. *Id.* at 3.

39. *Id.* at 3-9.

40. *See, e.g.*, *State v. Raynor*, 189 A.3d 652, 656-60 (2018) *cert. granted in* 193 A.3d 49 (2018) (holding that trial court did not err by refusing the defendant's request for a pretrial hearing on the admissibility of expert opinion on toolmark identification because, according to the court, the science of firearm and toolmark identification was well established and the State had only to establish that the firearm and toolmark evidence was relevant); *State v. Pigott*, 325 P.3d 247 ¶7 (2014) ("[T]he reliability of fingerprint identification has been tested in our adversarial system for over a century and routinely subjected to peer review. The trial court considered all of this in reaching its conclusion that a *Frye* hearing was not needed."); *State v. Lopez-Martinez*, 256 P.3d 896, at*5 (2010) (relying on precedent from 1980 to find that bitemark evidence is sufficiently reliable and, therefore, admissible).

41. *See, e.g.*, *Sixth National Seminar on Forensic Evidence and the Criminal Law*, Pro Bono Net, https://www.probono.net/deathpenalty/calendar/event.284660-Sixth_National_Seminar_on_Forensic_Evidence_and_The_Criminal_Law (last updated 2018); *2020 Making Sense of Science Seminar*, Nat'l Ass'n Criminal Def. Law. (2020), https://members.nacdl.org/event-details?id=d2ffb4cb-1f03-4155-95f6-c1a5338cbcde&reload=timezone (presented annually).

42. *See, e.g.*, Jack D. Roady, Crim. Just., The PCAST Report: A Review and Moving Forward — A Prosecutor's Perspective 9 (2017), https://pdfs.semanticscholar.org/de78/482751756d393d594a1407e4790d45553342.pdf; Jennifer D. Oliva & Valena E. Beety, *Discovering Forensic Fraud*, 112 Nw. U.L. Rev. 121, 123 (2017); Jennifer Friedman & Jessica Brand, *It Is Now Up to the Courts: 'Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods,'* 57 Santa Clara L. Rev. 367, 368 (2017); Eric Alexander Vos, *Using the PCAST Report to Exclude, Limit, or Minimize Experts*, 32 Crim. Just. 15, 15 (2017).

43. *See, e.g.*, Spencer S. Hsu, *White House Science Advisers Urge Justice Dept., Judges to Raise Forensic Standards*, Wash. Post (Sept. 20, 2016), https://www.washingtonpost.com/local/public-safety/white-house-science-advisers-urge-justice-dept-judges-to-raise-forensic-standards/2016/09/19/42475c74-7d13-11e6-beac-57a4a412e93a_story.html?utm_term=.9e7b727cbb75; Christopher Zoukis, *Presidential Commission Criticizes Some Forensic Methods*, Huffington Post, https://www.huffingtonpost.com/christopher-zoukis/presidential-commission-c_b_12234178.html (last updated Dec. 6, 2017); Last Week Tonight with John Oliver (HBO), *Forensic Science*, YouTube (Oct. 2017), https://www.youtube.com/watch?v=ScmJvmzDcG0.

44. *See United States v. North*, No. 1:16-cr-309-WSD, 2017 U.S. Dist. LEXIS 190935, at *8 note 2 (N.D. Ga. Nov. 17, 2017); *United States v. Bonds*, 2017 U.S. Dist. LEXIS 166975, at *5–6. (N.D. Ill., Oct. 10, 2017) (citation omitted); *State v. Allen*, No. 2017 KA 0306, 2017 La. App. Unpub. LEXIS 325, at *5–6 (La. Ct. App. 2017); *Phillips v. State*, 152 A.3d 712, 715 note 3 (Md. 2017) (citations omitted); *Lucas v. Davis*, No. 15cv1224-GPC, 2017 U.S. Dist. LEXIS 69125, at *2, *21 note 8 (S.D. Cal. May 5, 2017) (citations omitted); *State v. Allen*, 2017 La. App. Unpub. LEXIS 325, 2017 WL 4974768, at *3–4 (Nov. 1, 2017); *United States v. Bonds*, 2017 U.S. Dist. LEXIS 166975, 2017 WL 4511061, at *2 (N.D. Ill. Oct. 10, 2017); *Almeciga v. Ctr. for Investigative Reporting, Inc.*, 185 F. Supp. 3d 401, 423, 437 (S.D.N.Y. 2016) (citation omitted); Order at 2, *United States v. Chester*, No. 13 CR 00774 (N.D. Ill., Oct. 7, 2016), ECF No. 875, https://www.theiai.org/current_affairs/20161007_PCAST_Appeal.pdf; *State v. Patel*, No. LLICR130143598S, 2016 Conn. Super. LEXIS 3440, at *17 (Conn. Super. Ct., Dec. 28, 2016); *Motorola, Inc. v. Murray*, 147 A.3d 751, 759 (D.C. 2016) (Easterly, J., concurring); *State v. Romero*, 381 P.3d 297, 304, 305 (Ariz. Ct. App. 2016); *Williams v. United States*, 130 A.3d 343, 347–48 (D.C. 2016); *Gardner v. United States*, 140 A.3d 1172, 1177, 1183 (D.C. 2016) (citations omitted); *Commonwealth v. Perrot*, No. 85-5415, 2016 Mass. Super. LEXIS 3, at *1, *94 (Mass. Super. Ct. Jan. 26, 2016); *Ex Parte Robbins*, 478 S.W.3d 678, 692 (Tex. Crim. App. 2014) (Cochran, J., concurring); *Pigott*, 325 P.3d at 248; *United States v. Johnsted*, 30 F. Supp. 3d 814, 820, 822 (W.D. Wis. 2013) (citations omitted); *United States v. Smallwood*, 456 Fed. Appx. 563, 566 (6th Cir. 2012); *United States v. Otero*, 849 F. Supp. 2d 425, 427 (D.N.J. 2012); *State v. McGuire*, 16

A.3d 411, 433–44 (N.J. Super. Ct. App. Div. 2011); *Jones v. United States*, 27 A.3d 1130, 1137–38 (D.C. 2011); *Rodriguez v. State*, 30 A.3d 764, 767–68 (Del. 2011); *United States v. Watkins*, 450 Fed. Appx. 511, 515 (6th Cir. 2011); *United States v. Hebshie*, 754 F. Supp. 2d 89, 114, 128 (D. Mass. 2010) (citations omitted); *United States v. Cerna*, No. CR 08-0730 WHA, 2010 U.S. Dist. LEXIS 144424, at *18–19 (N.D. Cal. Sept. 1, 2010); *Lopez-Martinez*, 256 P.3d at 896; *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 318, 329 (2009) (citations omitted).

45. *Rosen v. Ciba-Geigy Corp.*, 78 F.3d 316, 319 (7th Cir. 1996).

46. *Bonds*, 2017 U.S. Dist. LEXIS 166975, at *7–8 (citations omitted); *Allen*, 2017 La. App. Unpub. LEXIS 325, at *13, *19–20; *Phillips*, 152 A.3d at 728 (citation omitted).

47. *Daubert*, 509 U.S. at 596 (citations omitted).

48. *See id.* at 593 ("[S]ubmission to the scrutiny of the scientific community is a component of 'good science,' in part because it increases the likelihood that substantive flaws in methodology will be detected.") (citations omitted).

49. Harry T. Edwards, Reflections on the Findings of the National Academy of Sciences Committee on Identifying the Needs of the Forensic Science Community, First Public Meeting of the National Commission on Forensic Science 3 (Feb. 3, 2014), http://www.law.nyu.edu/sites/default/files/EdwardsSpeechtoNCFS.pdf.

50. *Daubert*, 509 U.S. at 590 (quoting Brief for American Association for the Advancement of Science, et al. as Amici Curiae Supporting Respondent 7–8, *Daubert.*, 509 U.S. 579 (1993) (No. 92-102)).

51. *Id.* at 596–97.

52. *See id.* at 597.

53. *See id.* at 597–98.

54. *State v. Long*, 721 P.2d 483, 491 (Utah 1986) (citations omitted).

55. Edwards, *supra* note 49, at 3.

56. *Id.*

57. *Id.*

58. PCAST Report, *supra* note 7, at 143.

59. *Id.* at 144.

60. *See id.*

61. Edwards, *supra* note 49, at 5.

62. *Williams v. United States*, 130 A.3d 343, 351 (D.C. Cir. 2016) (J. Easterly, concurring).

63. *Id.* at 353.

64. *Id.* at 354.

65. *See, e.g.*, *Camm v. Faith*, 2019 US App LEXIS 27252, 2019 WL 4267769, at *21 (7th Cir. 2019) ("But no reasonable investigator would think that a verbal description of blood would be a sufficient basis to make a reliable [high velocity impact spatter] finding. After all, blood spatter science is notoriously unreliable even under the most optimal of circumstances."); *United States v. Johnson*, 2019 U.S. Dist. LEXIS 39590, 2019 WL 1130258, at *35 (March 11, 2019) (discussing the NAS Report and the PCAST Report, and the long history of challenges to the admissibility and scope of toolmark identification evidence); *Ex Parte Chaney*, 563 S.W.3d 239, 258 (Tex. Crim. App. 2018) (recognizing that the science behind bitemark analysis has evolved and accepting the government's agreement to habeas relief on the basis of "actual innocence" because the bitemark evidence that appeared indicative of guilt "no longer proves anything").

66. *United States v. Tibbs*, 2019 D.C. Super. LEXIS 9, at *2 (Sept. 5, 2019).

67. *Id.*

68. *Id.*

69. The Innocence Project estimates that bad forensics contributes to 44 percent of wrongful convictions (https://www.innocenceproject.org/dna-exonerations-in-the-united-states).

70. *Id.* at 4.

71. *Id.*

72. *Id.* at 4–5.

73. *Id.* at 5.

74. *Id.*

75. *Id.*

76. *Id.*

77. *Id.* at 6.

78. NAS Report, *supra* note 7, at 141-42 ("[W]hen a latent print examiner testifies that two impressions 'match,' they are communicating the notion that the prints could not possibly have come from two different individuals.").

79. 134 F.R.D. 161, 181 (N.D. Ohio 1990).

80. NAS Report, *supra* note 7, at 137. *See also* PCAST Report, *supra* note 7, at 61 ("The issue is not whether objects or features differ; they surely do if one looks at a fine enough level. The issue is how well and under what circumstances examiners applying a given metrological method can reliably detect relevant differences in features to reliably identify whether they share a common source.").

81. *See New Jersey v. Henderson*, 27 A.3d 872 (2011). *See also State v. Lawson*, 291 P.3d 673, 685 note 3 (2012) (relying on Special Master's report from *Henderson*, 27 A.3d 872).

82. *See, e.g.*, Federal Rule of Appellate Procedure 29. *See also Hoptowit v. Ray*, 682 F.2d 1237, 1260 (9th Cir. 1982).

83. The Department of Justice issues Uniform Language for Testimony and Reports in several forensic disciplines. *See* Department of Justice, Office of Legal Policy, Forensic Science, Uniform Language for Testimony and Reports, https://www.justice.gov/olp/uniform-language-testimony-and-reports. The ULTRs may be a useful starting point to limit the language of the experts at trial. Attorneys should exercise caution, however, because the ULTRs may still go far beyond what the science can support in some areas.

84. *See Daubert*, 509 U.S. at 590 (quoting Brief for American Association for the Advancement of Science, et al. as Amici Curiae Supporting Respondent 7–8, *Daubert*, 509 U.S. 579 (1993) (No. 92-102)) ("Science is not an encyclopedic body of knowledge about the universe. Instead, it represents a *process* for proposing and refining theoretical explanations about the world that are subject to further testing and refinement."); *see also id.* (quoting Brief for Nicolaas Bloembergen et al. as Amici Curiae 9, *Daubert*, 509 U.S. 579 (1993) (No. 92-102)) ("Indeed, scientists do not assert that they know what is immutably 'true' — they are committed to searching for new, temporary, theories to explain, as best they can, phenomena.").

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