GIVE ME LIBERTY OR GIVE ME THE SOURCE CODE: CHALLENGING A BLACK-BOX COMPUTER ALGORITHM UNDER DAUBERT

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Cite as: Natalie Murphy, Give Me Liberty or Give Me the Source Code: Challenging a Black-Box Computer Algorithm Under Daubert, 30 Rich. J.L. & Tech. 348 (2024).

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“The notion is that the law shouldn’t really change very much — if that was the law yesterday, then it should be the law today, and it’ll be the law tomorrow — but that isn’t how science works at all.”

- Dana Delger

INTRODUCTION

[1] Would you trust an entrepreneur who offered to sell you a truth-telling machine, but refused to tell you how it worked? Elizabeth Holmes persuaded investors to sink $700 million into her health tech company, Theranos, with a simple promise: she had invented a machine that could do the impossible. Holmes claimed her invention, a literal black box called an Edison, could run more than two hundred diagnostic tests in under an hour using only a single drop of blood. The Edison purportedly represented “a Holy Grail in the field of microfluidics.” Theranos was going to revolutionize healthcare and change the world. Instead, Holmes is serving a prison sentence for conspiracy and fraud. The Edisons did what black boxes do best: convert inputs into outputs without revealing how. Theranos did not operate based on proven scientific principles, but a castle of overpromises and lies protected by a moat of so-called “trade secrecy”

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considerations.\textsuperscript{5}

[2] If you were on trial, would you expect a jury to rely on a truth-telling machine whose methodology was a secret? Like Holmes, the technology company, Cybergenetics, asserts a claim made by no other. Cybergenetics insists that its computer program, TrueAllele, can accurately interpret degraded, low-level DNA samples that include genetic material from an unlimited number of individuals.\textsuperscript{6} TrueAllele falls into a relatively new category of software systems known as probabilistic genotyping software (PGS).\textsuperscript{7} PGS systems interpret DNA samples too old, trace, or complex to parse with traditional DNA technology.\textsuperscript{8} Although Cybergenetics claims TrueAllele “handles any number of contributors,” organizations of renowned scientists claim PGS systems cannot reliably interpret samples containing DNA from more than three individuals.\textsuperscript{9} Even so, TrueAllele has never undergone peer review or validation testing independent of its developers.\textsuperscript{10} Cybergenetics’ lead developer reported in 2019 that he has only ever shown TrueAllele’s source code to one other individual, making the program a metaphorical black box in contrast to the Edison’s literal black box.\textsuperscript{11}

\textsuperscript{5} Carreyrou, supra note 3, at 252–53.


\textsuperscript{7} Id.


\textsuperscript{10} See Scientific validation studies, magazine articles, book chapters and more, CYBERGENETICS, https://www.cybgen.com/information/publication/page.shtml [perma.cc/69WZ-AHZW] (last visited Nov. 5, 2023); see infra Part III.A.

\textsuperscript{11} People v. Wakefield, 107 N.Y.S.3d 487, 495–96 (2019).
That fifteen states have admitted TrueAllele results despite these reliability concerns shows the persistent, core flaws in both forensic science and the criminal system at large. Commentators blamed Silicon Valley’s “move fast and break things” investment ethos for enabling Theranos’s deceit, but for antithetical reasons, the U.S. legal system is also vulnerable to admitting shoddy, trade-secret-guarded science at staggering costs. Where Silicon Valley investor cliques make financial decisions based on collective trust rather than complete information, judges swear to honor precedent under stare decisis—ensuring that science is rarely disavowed once accepted in court. Court rooms, particularly in criminal law, are thus rife with unsupported “junk science” technologies as fallacious as the Edison. But instead of people’s money, people’s lives are at stake.

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12 See, e.g., infra notes 74–77 and accompanying text (summarizing various forensic disciplines found unreliable after appearing in court, sometimes for decades).


16 See, e.g., Giannelli, Daubert’s Failure, supra note 14, passim.
How can attorneys facing black-box algorithms like TrueAllele challenge their admissibility in court? This Article argues that TrueAllele clearly fails to meet the Daubert standard for expert testimony, with nearly every factor weighing against the admission of TrueAllele results. Careful and rigorously researched Daubert challenges thus offer a critical opportunity for attorneys to exclude evidence from black-box algorithms like TrueAllele. Indeed, Daubert challenges have recently barred TrueAllele results from both Maryland and Louisiana trial courts. Daubert’s recent adoption in Florida, Georgia, and Maryland also means that at least three states face key opportunities for attorneys to create beneficial precedent statewide through successful Daubert rulings. In sum, TrueAllele’s clear failure to meet the Daubert standard, combined with recent victories in trial courts and new opportunities for litigation amidst shifting state admissibility standards, indicate that attorneys have much to gain from levying well-researched Daubert challenges against TrueAllele.

Contextualized by the history of junk science and TrueAllele’s admissibility record, this Article offers a practical analysis of TrueAllele’s shortcomings under Daubert that attorneys facing forensic algorithms can borrow in many states. Part I answers foundational questions: What is DNA evidence? What is junk science? What is TrueAllele? In addition to explaining the scientific underpinnings for traditional and algorithmic DNA analysis, this section frames junk science as a distinctly criminal law concern, due to the disparate application of identical standards between criminal and civil cases. While TrueAllele has limited application for exoneration cases, the Article understands TrueAllele as primarily a prosecutorial tool, since it is disproportionately used by states to secure

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18 See infra Part II.D.

19 See infra Part III.D.
Part II describes the legal standard for scientific evidence and expert testimony, and how TrueAllele has historically fared under them. It details the distinctions between the older Frye “general acceptance” standard for scientific evidence and the multi-factor Daubert standard, which federal courts adopted in 1993 and has now gained a supermajority in state courts. This section also explores the murky legal standard surrounding judicial discretion to hear pretrial Daubert challenges and uses both federal and Maryland state law to sketch arguments that attorneys seeking such hearings might put forward. Finally, it describes TrueAllele’s prior admissibility history under Daubert and other standards in both state and federal courts. While extensive scholarship illustrates the prevalence of unreliable “junk science” amidst what Erin Murphy calls traditional, “first generation” forensic technologies, juxtaposing TrueAllele’s admissibility with a careful Daubert analysis demonstrates that courts continue to treat more complex “second generation” forensic technologies similarly. However, this admissibility history also highlights three states ripe for influential Daubert challenges: Georgia, Florida, and Maryland.

Part III engages in a comprehensive analysis of TrueAllele’s admissibility under six factors of Maryland’s Daubert-Rochkind standard: (1) peer review and publication, (2) testability, (3) the existence of an analytical gap, (4) known or potential error rate, (5) development purposes,

20 See infra Part I.B.
21 See infra Part II.
22 See infra Part II.A.
23 See infra Part II.C.
24 See infra Part II.D.
25 See infra Part II.B.
26 See infra Part II.D.
and (6) general acceptance.\textsuperscript{27} This Article uses Maryland law as an example for several reasons: first, because Maryland recently replaced the Frye standard with the Daubert-Rochkind standard in 2020;\textsuperscript{28} second, because Maryland is one of only two states known to this author where judges have excluded TrueAllele evidence at any level;\textsuperscript{29} and third, to demonstrate how attorneys must adapt their Daubert arguments to conform to state law. Since Daubert-Rochkind is a “Daubert-plus” standard consisting of ten factors,\textsuperscript{30} analysis under Maryland law is relevant to the supermajority of states who apply even just the original Daubert factors.\textsuperscript{31} Likewise, this section offers arguments relevant to challenging an ever-increasing number of forensic algorithms beyond TrueAllele (particularly other probabilistic genotyping programs) in other states. I conclude that the Daubert standard weighs strongly against admitting TrueAllele results, based on the information currently available. Furthermore, this conclusion has significant implications for numerous states beyond Maryland.

[8] Finally, this Article considers how the practice of bringing individual challenges against TrueAllele interacts with broader efforts to rid the courts of unreliable science. Given Daubert’s demonstrated failure to rid the courts of junk science,\textsuperscript{32} why should attorneys spend their limited time and resources challenging a complex forensic algorithm in individual cases? Can attorneys still work toward systemic change in forensic science given their ethical responsibilities to represent individual clients? How has the conversation about criminal reform versus abolition informed recent

\textsuperscript{27} See infra Part III.

\textsuperscript{28} Rochkind v. Stevenson, 471 Md. 1, 1 (2020); see infra Part III.B.

\textsuperscript{29} See infra Part II.D.

\textsuperscript{30} See infra Part II.B, examining TrueAllele’s failure to satisfy six out of the ten Daubert-Rochkind factors.

\textsuperscript{31} See infra Part III.C.

\textsuperscript{32} See infra Part II.C.
scholarship on forensic science issues? This section raises more questions than it answers and remains open to further scholarship from any criminal defense attorneys seeking to balance immediate fixes with long-term change.

I. DNA AND PROBABILISTIC GENOTYPING IN CONTEXT

A. What is DNA Evidence?

[9] DNA is a molecule widely used for identification purposes.\(^33\) Nearly every cell in the human body contains DNA, each person’s DNA is unique, and (barring meticulous effort) humans leave cells containing DNA nearly everywhere they go.\(^34\) DNA molecules consist of four types of nitrogenous base molecules (abbreviated as A, T, C, and G) arranged into “base pairs” and attached to a backbone of sugar-phosphate.\(^35\) DNA is shaped in a long, twisted strand.\(^36\) In criminal investigations, law enforcement can collect DNA samples from locations ranging from the interior of an arrested suspect’s cheek, to body fluids like blood and semen found at a crime scene, to objects a suspect may have merely touched.\(^37\)

[10] Since DNA constantly replicates in the human body as new cells form, changes in the DNA called “mutations” sometimes arise during the...


\(^{34}\) Id. at 135.

\(^{35}\) Id. at 136.

\(^{36}\) Id. at 136.

replication process. Although much of human DNA is identical between individuals, the variations that mutations introduce mean that “the chances of two human genomes being the same are infinitesimally small.”

Scientists analyzing DNA for forensic purposes examine small areas of an individual’s genome, called “loci” (singular, “locus”) or “DNA markers,” that are likely to be highly variable. Each locus contains two “alleles,” which are variations of the DNA inherited from each parent. The most common form of DNA analysis examines loci with alleles composed of repeating groups of base pairs known as “short tandem repeat” markers. Appropriately, this type of analysis is called “short-tandem repeat” analysis (STR) and distinguishes between individuals based on the number of repeats at each locus. While one individual might have ten short tandem repeats of the base pair GATA at a given locus, a different individual could have only eight repeats of ATAT at the same locus.

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40 Royal Soc’y of Edinburgh, supra note 38, at 10. DNA loci used for forensic purposes ideally have four qualities: (1) highly polymorphic; (2) easy and cheap to characterize; (3) simple to interpret and easy to compare between laboratories; (4) low mutation rate, Bukyya et al., supra note 33, at 137.

41 NIST Report, supra note 39, at 9.

42 Royal Soc’y of Edinburgh, supra note 38, at 10.

43 Id.

44 Id. at 11.
45 Before analysts can examine the alleles at particular loci, they must isolate the DNA molecules from their sample and copy, or amplify, them to develop a large enough sample to analyze.46 Laboratories conduct DNA analyses on samples from crime scenes to produce resulting “DNA profiles” by assigning a number to each locus that describes its structure.47 The numbers are often presented in electropherograms, which are graphs that resemble electrocardiograms used to measure cardiac activity.48 Instead of showing a heart rate, the peaks on electropherograms represent the amount of DNA present at each locus.49

45 Id.

46 Bukyya et al., supra note 33, at 138; NIST Report, supra note 39, at 21–22.

47 See ROYAL SOC’Y OF EDINBURGH, supra note 38, at 19–20.

48 See id.

49 Id.
Forensic technicians develop DNA profiles from DNA samples deposited during the commission of an alleged crime and compare these profiles to those of known suspects. If there are no known suspects, technicians test the DNA profile from the crime scene sample against the FBI’s Combined DNA Index System (CODIS) of DNA profiles from individuals who have been arrested or have prior convictions. Two DNA profiles with the same alleles at each of the 20 autosomal loci examined with modern DNA testing kits are said to be matching. This could mean any of the following: (i) the DNA came from the same individual, (ii) the DNA came from two individuals with the same DNA (like identical twins), or (iii) the match is a false positive. After a laboratory produces DNA profiles and compares them to suspects and/or CODIS, prosecutors and defense attorneys can use the results in court.

B. What is Junk Science?

Courts have long recognized traditional DNA testing as “the gold standard of forensic evidence, heralded for its ability to exonerate the innocent and convict the guilty.” DNA’s broad utility beyond the justice

50 See id. at 13.


53 ROYAL SOC’Y OF EDINBURGH, supra note 38, at 13.

54 Frequently Asked Questions on CODIS and NDIS, supra note 51.

The system has incentivized academics, government scientists, and law enforcement agencies alike to research DNA methodology, and traditional DNA analysis has gained near-universal recognition today thanks to these broad efforts.\footnote{See Fabricant, supra note 14, at 96–98.}

\[14\] If traditional, single-source DNA analysis exemplifies rigorous research conducted in accordance with the scientific method, “junk science” presents its antonym. Maneka Sinha categorizes scientific and technical evidence as junk science when (1) the underlying science itself is inherently unreliable, (2) an otherwise valid method is misapplied to produce faulty results, or (3) forensic examiners exaggerate results.\footnote{Maneka Sinha, Junk Science at Sentencing, 89 GEO. WASH. L. REV. 52, 56–57 (2021). According to Justice Paul Stevens, “an example of ‘junk science’ that should be excluded…as too unreliable would be the testimony of a phrenologist who would purport to prove a defendant’s future dangerousness based on the contours of the defendant’s skull.” General Elec. v. Joiner, 522 U.S. 136, 153 n.6 (1997) (Stevens, P., dissenting) (noting that Stevens refers to admissibility of scientific evidence under the Daubert standard).} Junk science poses a special danger in court for two reasons: juries place great weight on scientific-sounding evidence,\footnote{Kaplan & Puracal, supra note 15, at 898; Andrea Roth, Trial by Machine, 104 GEO. L. J. 1245, 1250 (2016) (discussing American “instrument fetishism”).} and once courts accept a type of evidence, it is difficult to excise even when disproven because judges “almost certainly rely on legal precedent—not science—to make a decision.”\footnote{See Fabricant, supra note 14, at 98; see also Hilbert, supra note 14, at 812 (describing the role of precedent in preserving scientifically baseless bite mark evidence in courts).} The
timeline of *stare decisis* is thus incompatible with the scientific process.\(^{60}\)

[15] While early conversations surrounding junk science have emerged in the civil context,\(^{61}\) the term is now widely associated with the criminal defense bar, due to its disproportionate use against criminal defendants.\(^{62}\) Courts at all levels and types inconsistently apply universal admissibility

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\(^{60}\) Daniele Selby, *Why Bite Mark Evidence Should Never Be Used in Criminal Trials*, INNOCENCE PROJECT (Apr. 26, 2020), https://innocenceproject.org/why-bite-mark-evidence-should-never-be-used-in-criminal-trials/ [perma.cc/2NEY-5ATQ] (“The notion is that the law shouldn’t really change very much — if that was the law yesterday, then it should be the law today, and it’ll be the law tomorrow — but that isn’t how science works at all.”).

\(^{61}\) The term ‘junk science’ gained popularity among conservative politicians surrounding a so-called ‘epidemic’ of toxic tort cases where critics complained questionable science lead to erroneous jury verdicts, Hilbert, *supra* note 14, at 774–75, 780. Conservatives’ obsession with tort reform and the misuse of science in personal injury cases stemmed from the number of massive corporations forced into bankruptcy by tort liability through the 1970s and 80s, FABRICANT, *supra* note 14, at 66–67. Famous litigation examples include the Johns-Manville asbestos cases, Dow Corning’s silicone breast implant cases, and class actions surrounding exploding Ford Pintos and Rely tampons that induced toxic shock syndrome, *id.* Justice Sandra Day O’Connor’s former law clerk Peter Huber released *Galileo’s Revenge: Junk Science in the Courtroom*, “an influential polemic against the evils of ‘jackpot’ personal injury litigation” in 1991, *id.* Through the early 1990s, junk science conversations surrounded civil law and generally avoided criminal defendants and criminal cases, Hilbert, *supra* note 14, at 780.

standards for scientific evidence. For example, such standards have been used: in federal and state courts, in criminal and civil courts, against both A minority of states have explicitly applied different standards to admit expert testimony in criminal versus civil cases, see Julie A. Seaman, *A Tale of Two Dauberts*, 47 GA. L. REV. 889, 892 n.12–13 (2013). New Jersey similarly adopted a standard akin to Daubert for civil cases in 2018 but maintained the earlier Frye standard for criminal cases until 2023, *In re Accutane Litig.*, 234 N.J. 340, 399 (2018); State v. Olenowski, 253 N.J. 133, 139 (2023).


civil plaintiffs and defendants, and against the State and criminal defendants.

[16] Federal courts were the first to establish the judicial “gatekeeper” role for scientific evidence, but in state courts, where the vast majority of criminal cases are tried, attorneys may “ask the doorman nicely to enter, and she should let you pass.” Likewise, the low caliber of evidence admitted in many criminal courts would never see the light of day in civil

66 Murphy, Neuroscience and the Civil/Criminal Daubert Divide, supra note 65, at 627 (“When faced with evidence offered by prosecutors or civil defendants, courts tend to take a generous approach, whereas even the same kind of evidence offered by civil plaintiffs is met with great skepticism.”).

67 See COMM. ON IDENTIFYING THE NEEDS OF THE FORENSIC SCI. CMTY., NAT’L RSCH. COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 11 (2009), https://www.ojp.gov/pdffiles1/nij/grants/228091.pdf [hereinafter NAS REPORT] (“Although it is difficult to get a clear picture of how trial courts handle Daubert challenges, because many evidentiary rulings are issued without a published opinion and without an appeal, the 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.”); Déirdre Dwyer, (Why) Are Civil and Criminal Expert Evidence Different?, 43 TULSA L. REV. 381, 383 (2007) (“the expert evidence of criminal prosecutors is subject to less scrutiny than that of criminal defendants, or than that of civil parties”); Neufeld, supra note 65, at S109 (“[C]riminal defendants almost always lose their challenges to government proffers. But when the prosecutor challenges a criminal defendant’s expert evidence, the evidence is almost always kept out of the trial. This is true in both federal and state courts.”); Faigman, supra note 65. See also D. Michael Risinger, Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?, 64 ALB. L. REV. 99, 99 (2000) (explaining how immediately following Daubert’s adoption in federal courts, empirical studies revealed “civil defendants win their Daubert reliability challenges to plaintiffs’ proffers most of the time, and . . . criminal defendants virtually always lose their reliability challenges to government proffers”); Michael D. Cicchini, The Daubert Double Standard, 2021 MICH. STATE L. REV. 705, 705 (2021) (analyzing a striking case study of 134 Daubert admissibility challenges in Wisconsin, revealing prosecutors won admissibility challenges 100% of the time whereas defense attorneys won admissibility challenges 0% of the time).

68 Schwartz & Silverman, supra note 64, at 266.
Criminal courts routinely admit scientific evidence more lackadaisically (especially when a prosecutor is seeking to admit the evidence) than civil courts, where judges tend to apply significantly more rigor. A recent Wisconsin study revealed that between 2011 and 2021, prosecutors won all 134 admissibility challenges brought across every level of the court system—regardless of case type, expert, or party. Over the same period, defense counsel did not win a single Daubert decision at any level. While defense victories in other states temper the universality of this finding, the record in Wisconsin illustrates a startling tendency: under the same admissibility standard, scientific evidence proffered by the prosecution to secure convictions is routinely admitted while even very similar or identical evidence is excluded when introduced by the accused for defense purposes.

[17] Chris Fabricant, the Innocence Project’s litigation director, describes junk science in relation to the people most often facing it: “it is subjective speculation, masquerading as science, typically tilted in the
government’s favor against an indigent person of color.” And yet, junk science routinely appears in criminal courts today. After decades of use and convictions, methodologies including comparative bullet lead analysis, hair microscopy, bite mark analysis, and various arson investigation techniques have never been established as foundationally valid. A multidisciplinary group of blue ribbon scientists authored the 2009 National Academy of Sciences Report and 2016 President’s Council of Advisors on Science and Technology (PCAST) Forensics Report, which discredited methodologies found unreliable under Daubert, like bite marks, handwriting, and ballistics).


traditional “pattern matching” disciplines, including latent fingerprint analysis, firearms analysis, footwear analysis, tire tracks, fiber evidence, document examination, and bloodstain patterns.\textsuperscript{77}

\[18\] Erin Murphy classifies the discredited traditional forensic disciplines as “first generation” forensics.\textsuperscript{78} Among other defining characteristics, first generation techniques are used in a narrow subset of criminal cases, rarely implicate broad privacy or proprietary concerns, and are not conceptually demanding.\textsuperscript{79} Many first generation forensic techniques, like fingerprinting or bullet groove analysis, are intuitively comprehensible by lay people.\textsuperscript{80} In contrast, “second generation” forensic techniques appear in a wider range of cases.\textsuperscript{81} These techniques often involve proprietary information protected by private companies, and typically result from technically sophisticated and scientifically robust methodologies requiring particularized expertise to interpret.\textsuperscript{82}

\[19\] When Murphy first distinguished between forensic “generations” in 2006, she provided a brief list of second generation techniques, including DNA typing and biometric scanning.\textsuperscript{83} Second generation techniques have

\textsuperscript{77} NAS REPORT, \textit{supra} note 67 (discussing latent fingerprint analysis, firearm analysis, footwear analysis, tire tracks, fiber evidence, document examination, and bloodstain patterns); PCAST REPORT, \textit{supra} note 9 (discussing latent fingerprint analysis, firearm analysis, footwear analysis, and document examination).


\textsuperscript{79} \textit{Id.} at 726–28.

\textsuperscript{80} \textit{Id.} at 726–27.

\textsuperscript{81} \textit{Id.} at 728.

\textsuperscript{82} \textit{Id.} at 729.

\textsuperscript{83} Murphy, \textit{The New Forensics}, \textit{supra} note 78 at 728.
proliferated in the decades since—particularly in the form of complex and often trade-secret protected algorithms that appear at nearly every level of the criminal system. For example, law enforcement officers use surveillance and investigative algorithms to detect individuals at risk of committing mass shootings, detect and initiate responses to gunshots (and,}

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84 See SCI., TECH. ASSESSMENT, & ANALYTICS, U.S. GOV’T ACCOUNTABILITY OFF., GAO-20-479SP, FORENSIC TECHNOLOGY: ALGORITHMS USED IN FEDERAL LAW ENFORCEMENT 3–4 (2020) (describing the use of probabilistic genotyping, latent print analysis, and face recognition by federal law enforcement agencies) [hereinafter GAO Forensics Report]; see also Danielle Kehl et al., Algorithms in the Criminal Justice System: Assessing the Use of Risk Assessments in Sentencing, HARV. L. SCH.: BERKMAN KLEIN CTR. FOR INTERNET & SOC’Y, 2017, at 2, 28 (explaining algorithmic tools “may look like ‘black boxes’ to outsiders and are susceptible to concerns about opacity” and proprietary tools developed for commercial purposes “have both a greater interest in shrouding their products in secrecy in order to remain competitive and more legal tools at their disposal to keep their algorithms away from public scrutiny”) [hereinafter Berkman Klein Forensic Algorithms Report].

85 E.g., Jeff Asher & Rob Arthur, Inside the Algorithm That Tries to Predict Gun Violence in Chicago, N.Y. TIMES (June 13, 2017), https://www.nytimes.com/2017/06/13/upshot/what-an-algorithm-reveals-about-life-on-chicagos-high-risk-list.html [perma.cc/HK65-M3K8] (discussing Chicago’s Strategic Subject List, generated by an algorithm that tries to predict who is most likely to be a perpetrator or a victim in a shooting).
it turns out, record people talking),\textsuperscript{86} obtain information from cell phones by mimicking cell towers,\textsuperscript{87} remotely scan individual’s hard drives for illicit material,\textsuperscript{88} and recognize faces.\textsuperscript{89} Predictive policing algorithms claim to

\begin{itemize}
\item \textsuperscript{86} See generally \textsc{SoundThinking}, https://www.soundthinking.com/ [perma.cc/R8ET-6BKW] (last visited Nov. 3, 2023). ShotSpotter, recently re-branded as \textsc{SoundThinking}, brands itself as “a public safety technology company that combines transformative solutions and strategic advisory services for sound decision,” \textit{id}. The technology has come under intense criticism for its opaque methodology and contribution to over-policing communities of color, see Maneka Sinha, \textit{The Dangers of Automated Gunshot Detection}, 5 J. L. \\& INNOVATION 63, 63–68 (2023) (arguing “\textsc{ShotSpotter} . . . erodes seizure and search protections” and “exacerbates [law enforcement] abuses that have become the unfortunate hallmark of \textit{Terry} encounters”); see also Brendan Max, \textit{SoundThinking’s Black-Box Gunshot Detection Method: Untested and Unvetted Tech Flourishes in the Criminal Justice System}, 26 STAN. TECH. L. REV. 193, 193–94 (2023) (arguing \textsc{ShotSpotter} should play no role in the criminal system due to its flawed testing process and unreliable performance). In at least one Florida case, \textsc{SoundThinking} recordings of conversations have been used as criminal evidence, Brian Fraga, \textsc{ShotSpotter} recording of street argument raises potential privacy issues, \textsc{South Coast Today}, https://www.southcoasttoday.com/story/news/crime/2012/01/11/shotspotter-recording-street-argument-raises/49773221007/ [perma.cc/CSB5-B68V] (last update Jan. 11, 2012, 7:20 AM).

\item \textsuperscript{87} Cell site simulators trick phones within a certain radius into connecting with the device rather than a tower by masquerading as legitimate cell towers, \textsc{Cell-Site Simulators/IMSI Catchers}, ELEC. FRONTIER FOUND., https://www.eff.org/pages/cell-site-simulatorsimsi-catchers [perma.cc/FU5U-WJL3] (last updated Mar. 29, 2023). Secrecy surrounds both the device’s use and methodology. See Shawn Marie Boyne, \textit{Stingray Technology, the Exclusionary Rule, and the Future of Privacy: A Cautioinary Tale}, 119 W. VA. L. REV. 915, 916–19 (2017); see also Spencer McCandless, Note, \textit{Stingray Confidential}, 85 GEO. WASH. L. REV. 993, 996–1000 (2017) (discussing how “some prosecutors... refer to information obtained with stingrays as originating from a ‘confidential source’ when using it in court”).


\item \textsuperscript{89} \textsc{GAO Forensics Report, supra note 84, at 3–4}; Andrew Guthrie Ferguson, \textit{Facial Recognition and the Fourth Amendment}, 105 MINN. L. REV. 1105, 1110–13 (2021).
\end{itemize}
predict crimes a week in advance\textsuperscript{90} and estimate the chance that a child is at risk of death or abuse\textsuperscript{91}. During the parole and pretrial stages of litigation, risk assessment tools and recidivism algorithms augment judicial decisions about whether an individual will face enormous fees or pretrial incarceration.\textsuperscript{92} Similar algorithms work at the post-conviction sentencing stage to determine how long a person should be incarcerated based on their prior life experiences, habits, criminal record, gender, and socioeconomic status—as well as their number of prior police encounters, a factor closely correlated with race.\textsuperscript{93}

\textsuperscript{20} Finally, as is at issue in this paper, second generation algorithmic techniques can automate or supplement first generation techniques, including latent print examination,\textsuperscript{94} ballistic evaluations,\textsuperscript{95} and DNA

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\item \textsuperscript{91} MEDIA FREEDOM & INFO. ACCESS CLINIC, YALE L. SCH., ALGORITHMIC ACCOUNTABILITY: THE NEED FOR A NEW APPROACH TO TRANSPARENCY AND ACCOUNTABILITY WHEN GOVERNMENT FUNCTIONS ARE PERFORMED BY ALGORITHMS 6 (2022).
\item \textsuperscript{92} Berkman Klein Forensic Algorithms Report, \textit{supra} note 84, at 13.
\item \textsuperscript{93} Id. at 24–26.
\item \textsuperscript{94} See GAO Forensics Report, \textit{supra} note 84, at 5, 9–10.
\item \textsuperscript{95} NIBIN is a national database of linked, local ballistics imaging databases. Proprietary algorithms link images of ballistics evidence, like spent casings, to create unique digital signatures for each piece of evidence and find “matches.” Much of the software used is proprietary and comes from a private Canadian corporation, Forensic Technology, Inc., \textsc{William King et al., Opening the Black Box of NIBIN: A Descriptive Process and Outcome Evaluation of the Use of NIBIN and its Effects on Criminal Investigations, Final Report} 2–4 (2013).
\end{itemize}
Beyond the NIST 2021 DNA Mixture Analysis Report, little scholarship has considered the prevalence of traditional junk science in second generation algorithmic techniques. It is uncertain whether the complexity, secrecy, or novelty inherent to second generation techniques, or some other reason, has led to this dearth of literature. This Article seeks to outline how robust Daubert challenges against TrueAllele may serve individual defendants while illustrating a model for rigorously evaluating second generation forensic algorithms, given the historical prevalence of junk science in the criminal system.97

C. What is TrueAllele?

[21] TrueAllele is a software designed to analyze complicated DNA samples using a method called “probabilistic genotyping.”98 Analyzing “single-source DNA,” like a swab from a suspect’s cheek, is relatively uncomplicated and highly accurate.99 However, the analysis becomes more complicated for samples that are degraded, contain DNA from multiple individuals, or both.100 Degraded samples (like very old semen stains) suffer from allele or locus “drop-out” due to broken DNA strands that make the


97 See supra note 87 and accompanying text (discussing the questionable use of “stingray surveillance” techniques and its continued protection by courts); Wexler, supra note 88, at 1421–22 (listing examples of forensic technologies in question, many of which still appear in court: comparative bullet lead analysis, hair microscopy, bite mark analysis, various arson investigation techniques, latent fingerprint analysis, firearms analysis, footwear analysis, tire tracks, fiber evidence, document examination, bloodstain patterns, and more).

98 See Casework, supra note 6.

99 Stiffelman, supra note 55, at 114.

100 Id. at 115.
relevant forensic loci untestable.\textsuperscript{101} DNA in mixed samples (like those collected from a firearm handled by multiple individuals) can only be interpreted by estimating possible genotypes detectable in the sample and determining whether a suspect’s DNA evidence could possibly be included.\textsuperscript{102} These are the types of samples PGS systems, including TrueAllele, were designed to manage.\textsuperscript{103}

[22] TrueAllele “utilize[s] statistical genetics, biological models, computer algorithms, and probability distributions to infer possible genotypes and calculate LRs [(‘likelihood ratios’)].”\textsuperscript{104} LRs are numbers that express a strength of the evidence in favor of one proposition versus an alternative proposition, where each “proposition” is a hypothesized scenario describing whether a suspect contributed to the DNA in a sample.\textsuperscript{105} Unlike traditional DNA approaches, PGS systems purport to mathematically model allele drop-out behavior and peak heights, theoretically allowing the system to weigh each possible genotype using the probability of missing alleles.\textsuperscript{106}

[23] Forensic science scholar and professor Brandon Garrett has emphasized the risks of using PGS to analyze complex, mixed DNA mixtures with a Scrabble metaphor:

[I]f you use an entire bag of Scrabble pieces with letters from the alphabet, it is easy to rearrange the tiles and make out your own name. If you only draw seven tiles, though, the changes are low. …The concern is that, in effect, [PGS

\textsuperscript{101} NIST Report, \textit{supra} note 39, at 22.

\textsuperscript{102} See \textit{id.} at 23.

\textsuperscript{103} See Coble & Bright, \textit{supra} note 8, at 221.

\textsuperscript{104} NIST Report, \textit{supra} note 39, at 39.

\textsuperscript{105} Id. at 36–37.

\textsuperscript{106} Id. at 34–35.
programs] are looking for names using the entire bag of Scrabble pieces.\textsuperscript{107}

[24] TrueAllele, however, claims that it “produce[s] accurate results on previously unsolvable DNA evidence” and has “no artificial limits – [it] handles any number of contributors.”\textsuperscript{108} TrueAllele declined to substantively address PCAST’s concerns when expressing a lack of confidence in many PGS promises based on inadequate empirical testing.\textsuperscript{109} Despite refusing to engage in cross-laboratory or peer-reviewed empirical studies independent of owner and developer Mark Perlin, TrueAllele is notorious for refusing to release its source code even to defendants, and as noted in the 2019 \textit{People v. Wakefield} case, the company stated that its code is “protected as a trade secret and is only known by two individuals.”\textsuperscript{110} Accordingly, its disclosure history is dubious.\textsuperscript{111}

\section{Admissibility Standards for Expert Testimony}

\subsection{The Evolution of Frye and Daubert}

[25] TrueAllele and other algorithmic results face the same admissibility standards as all other scientific evidence: \textit{Daubert}, and sometimes its

\begin{footnotesize}
\textsuperscript{107} \textit{Brandon L. Garrett, Autopsy of a Crime Lab: Exposing the Flaws in Forensics} 186 (2021).

\textsuperscript{108} \textit{Casework, supra} note 6.


\textsuperscript{110} \textit{People v. Wakefield}, 175 A.D.3d 158, 167 (N.Y. App. Div. 2019); \textit{see infra} Part III.A (detailing Perlin’s extensive involvement in TrueAllele’s validation studies).

\textsuperscript{111} \textit{See infra} Part III.B.2.
\end{footnotesize}
predecessor Frye. The D.C. Circuit Court established the Frye standard for expert testimony in 1923, when James Alphonzo Frye appealed his second-degree murder conviction. Although Mr. Frye had already confessed to the killing, he recanted his confession at trial, where defense counsel attempted to demonstrate his truthfulness with a “systolic blood pressure deception test.” The defense expert intended to explain the device’s theory that baseline blood pressure functioned as a proxy for candor, but the trial judge refused to admit testimony on the gadget. On appeal, the D.C. Circuit affirmed the trial court, stating: “[w]hile 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.” Mr. Frye’s conviction was upheld, and the Frye “general acceptance” standard emerged.

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114 Frye, 293 F. at 1013–14; see Hilbert, supra note 14, at 769.

115 See Hilbert, supra note 14, at 769 n.57.

116 Frye, 293 F. at 1013.

117 Id.
Nearly every court in the country adopted the *Frye* standard over the next 50 years. However, evidence law scholars complained that the standard was too permissive and relied too greatly on the adversarial process to weed out “unqualified science.” Contradictory *Frye* rulings in different jurisdictions affirmed their suspicions. Eventually, amidst concerns from conservatives that *Frye* admitted unreliable evidence enabling an “epidemic of toxic tort cases” (and their associated mass payouts and furious business representatives), the Supreme Court established a new standard for expert testimony in *Daubert*.

Like *Frye*, *Daubert* implemented a new standard while precluding certain types of scientific evidence from the court room. The *Daubert* plaintiffs were 19-year-old Jason Daubert, 12-year-old Eric Schuller, and their parents. The boys shared two similarities: both were born with bone deformities in their limbs, and both had mothers prescribed Bendectin for morning sickness while pregnant. The district court granted Bendectin’s manufacturer’s, Merrell Dow Pharmaceuticals, summary judgment motion based on its showing of “extensive published scientific literature” demonstrating “maternal use of Bendectin has not been shown to be a risk

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120 *Id.*

121 *Id.* at 774—75, 780.

122 *See id.* at 770–71, 780.


124 *Id.*; *see also* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 582 (1993).
factor for human birth defects.”\(^{125}\) Although the plaintiffs offered “the testimony of eight other well-credentialed experts” arguing that Bendectin caused birth defects, the court took issue with the fact that their evidence came from animal studies, chemical structure studies, and an unpublished review paper, rather than modern human trials.\(^{126}\) The district court determined that the plaintiffs’ evidence did not meet Frye’s general acceptance standard for expert testimony, and the Court of Appeals affirmed.\(^{127}\) The plaintiffs then petitioned the Supreme Court for writ of certiorari, which the Court granted.\(^{128}\)

[28] The Supreme Court, amidst a public debate surrounding the supposed problem of “junk science” in civil litigation,\(^{129}\) vacated and remanded the Daubert case.\(^{130}\) The Court found that the Federal Rules of Evidence superseded Frye’s general acceptance test and thus Frye should no longer apply in federal trials.\(^{131}\) Instead, the Court envisioned a “flexible” inquiry regarding the scientific validity of an expert’s principles and methodology under Rule 702.\(^{132}\) The Court outlined a non-exhaustive list

\(^{125}\) Daubert, 509 U.S. at 579.

\(^{126}\) Id.

\(^{127}\) Id.

\(^{128}\) Id.

\(^{129}\) Hilbert, supra note 14, at 777; see generally Peter W. Huber, Galileo’s Revenge: Junk Science in the Courtroom (1993) (arguing a crisis-level prevalence of junk science in civil courts).

\(^{130}\) Daubert, 509 U.S. at 580.

\(^{131}\) Id. at 587.

\(^{132}\) Id. at 594–95.
of factors to consider when determining the admissibility of expert testimony:

1. Whether a theory or technique is scientific knowledge that can be (and has been) tested;
2. Whether the theory or technique has been peer reviewed and/or published;
3. A scientific technique’s known or potential rate of error;
4. The existence and maintenance of standards controlling the technique’s operation; and
5. The technique’s degree of acceptance within a relevant scientific community.

[29] The fifth factor, a technique’s degree of acceptance, illustrates the Daubert standard’s de facto incorporation of Frye pursuant to Rule 702. Rather than re-invent the analysis entirely, Daubert envisioned a “flexible” inquiry focusing on “scientific validity and thus the evidentiary relevance and reliability” of expert testimony. Thus, Daubert permitted courts to continue considering general acceptance under Rule 702 as part of a broader

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133 Id. at 593–94.
134 Id. at 593.
135 Daubert, 509 U.S. at 593.
136 Id. at 594.
137 Id.
138 Id.
139 Id.
140 Daubert, 509 U.S. at 594–95.
set of considerations.¹⁴¹ A supermajority of states replaced the Frye standard with the Daubert standard after 1993.¹⁴²

[30] At the federal level, the 2000 Rules Committee Advisory Notes to Rule 702 summarized other common factors federal courts find relevant in determining reliability:

1. Whether experts propose to testify about matters growing naturally and directly out of their own research independent to litigation, or whether they have developed their opinions expressly to testify;¹⁴³
2. Whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion;¹⁴⁴
3. Whether the expert has adequately accounted for obvious alternative explanations;¹⁴⁵
4. Whether the expert is being as careful as he would be in his professional work as a paid litigation consultant;¹⁴⁶
   and,
5. Whether the field of expertise claimed by the expert is known to reach reliable results for the type of opinion the expert would give.¹⁴⁷

¹⁴¹ Id. at 594.
¹⁴³ FED. R. EVID. 702 advisory committee’s note to 2000 amendment (quoting Daubert v. Merrell Dow Pharms., Inc., 43 F.3d 1311, 1317 (9th Cir. 1995)).
¹⁴⁴ Id. (quoting General Electric Co. v. Joiner, 522 U.S. 136, 146 (1997)). Often called the “analytical gap” factor, id.
¹⁴⁵ Id. (quoting Claar v. Burlington N.R.R., 29 F.3d 499 (9th Cir. 1994)).
¹⁴⁶ Id. (quoting Sheehan v. Daily Racing Form, 104 F.3d 940, 942 (7th Cir. 1997)).
¹⁴⁷ Id. (citing Kumho Tire Co. v Carmichael, 119 S.Ct. 1167, 1175 (1999)). Kumho also extended Daubert to apply to non-scientific expert witnesses, id.
B. Maryland’s Daubert-Rochkind Standard

[31] As of 2019, forty-two states follow some version of Daubert in criminal cases, four states continue to follow Frye, and four states follow a unique local standard.\textsuperscript{148} Daubert adoptions have trickled in since the standard emerged in 1993, with Florida, Maryland, and Georgia representing the most recent states to adopt Daubert—in 2019, 2020, and 2022, respectively.\textsuperscript{149} Like many other states, Maryland and Georgia have adopted a modified version of Daubert (termed “Daubert-plus”) and consider the original five Daubert factors in addition to other factors (such as those enumerated under Rule 702).\textsuperscript{150}

[32] For instance, in the 2020 case Rochkind v. Stevenson, Maryland cast off its old Frye-Reed test, a local interpretation of the Frye standard for evaluating expert testimony, in favor of the Daubert standard.\textsuperscript{151} Rochkind is an illustrative example of the approach taken by the nineteen other states


\textsuperscript{149} In re Amends. to Fla. Evid. Code, 278 So.3d 551, 551–52 (2019); Rochkind, 236 A.3d at 652; GA. CODE. ANN. § 24-7-702 (West 2023).

\textsuperscript{150} See, \textit{e.g.}, Schwartz & Silverman, supra note 64, at 241; Rochkind, 236 A.3d at 650.

\textsuperscript{151} Rochkind, 236 A.3d at 645.
who follow *Daubert* in conjunction with additional factors.\textsuperscript{152} The “*Daubert-Rochkind*” standard considers:

1. Whether a theory or technique can be (and has been) tested;
2. Whether a theory or technique has been subjected to peer review and publication;
3. Whether a particular scientific technique has a known or potential rate of error;
4. The existence and maintenance of standards and controls;
5. Whether a theory or technique is generally accepted;
6. Whether experts are proposing to testify about matters growing naturally and directly out of research they have conducted independent of litigation, or whether they have developed their opinions expressly for the purposes of testifying;
7. Whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion;
8. Whether the expert has adequately accounted for obvious alternative explanations;
9. Whether the expert is being as careful as they would be in their regular work outside of their paid litigation consulting; and
10. Whether the field of expertise claimed by the expert is known to reach reliable results for the type of opinion the expert would give.\textsuperscript{153}

Maryland’s *Daubert-Rochkind* standard encompasses *Daubert* entirely.\textsuperscript{154} The first five factors are adopted directly from *Daubert*.\textsuperscript{155}

\textsuperscript{152} See id. at 650.

\textsuperscript{153} Id.

\textsuperscript{154} Id.

subsequent five factors are identical to those discussed in the 2000 Rules Committee Advisory Notes for Federal Rule 702.\textsuperscript{156} As Daubert envisioned, the standard is a balancing test, and “no single factor is dispositive in the analysis.”\textsuperscript{157} Daubert-Rochkind is not exhaustive—rather, it is intended as a flexible starting point for considering expert testimony.\textsuperscript{158} As the Maryland Court of Appeals clarified in State v. Savage, “[a] trial court may apply some, all, or none of the factors depending on the particular expert testimony at issue.”\textsuperscript{159} Although it builds upon long-held federal standards, the Rochkind court emphasized “[t]he shift to Daubert may mean, in a very real sense, that ‘everything old is new again’ with respect to some scientific and technical evidentiary matters long considered settled.”\textsuperscript{160} According to Rochkind, Maryland’s adoption of Daubert is not merely a procedural development but may invite new reliability challenges against expert evidence long considered generally accepted under Frye.\textsuperscript{161}

C. Judicial Discretion and Daubert Hearings

[34] So, are judges obligated to hold Daubert hearings for forensic algorithms like TrueAllele?\textsuperscript{162} Daubert puts forth “inconsistent messages”

\textsuperscript{156} Fed. R. Evid. 702 advisory committee’s note to 2000 amendment.

\textsuperscript{157} Rochkind, 236 A.3d at 651.

\textsuperscript{158} Id. (citing Kumho Tire Co. v Carmichael, 119 S.Ct. 1167, 1171 (1999)).

\textsuperscript{159} Id. (citing Savage v. State, 455 Md. 138, 184 (2017) (Adkins, J., concurring)).

\textsuperscript{160} Id. at 652 (quoting United States v. Horn, 185 F.Supp.2d 530, 554 (2002)).

\textsuperscript{161} Id.

\textsuperscript{162} See, e.g., Schwartz & Silverman, supra note 64, at 260 (highlighting a separate but related issue is whether district courts holding such pretrial hearings have obligation to provide full record, including written findings of fact on rulings for admissibility of exclusion of expert evidence for purpose of appeal). The problem is salient because while appellate courts rarely reverse district courts for failure to hold Daubert hearings, they are most likely to do so when there is no written finding of fact and conclusions supporting admissibility ruling, id.
regarding when trial judges must exercise their gatekeeping powers.\textsuperscript{163} For example, judges must exclude testimony when it is based on unreliable methodologies, but must also send “shaky but admissible evidence” to trial for cross-examination and oral argument before a jury.\textsuperscript{164} \textit{Kumho Tire Co. v. Carmichael} puts determining whether evidence is “shaky but admissible” versus “too shaky to admit” under the trial judge’s discretion: “whether \textit{Daubert}'s specific factors are, or are not, reasonable measures of reliability in a particular case is a matter that the law grants the trial judge broad latitude to determine.”\textsuperscript{165} 

[35] In exercising this discretion, judges must balance the need for hearings in “less usual or more complex cases where cause for questioning the expert’s reliability arises” with their obligation to avoid “unjustifiable expense and delay,” like when “the reliability of an expert’s methods is properly taken for granted.”\textsuperscript{166} At the same time, \textit{Daubert} rejected the common \textit{Frye} practice of exempting non-novel techniques from admissibility inquiries.\textsuperscript{167} \textit{Daubert} explicitly stated that “[a]lthough the \textit{Frye} decision itself focused exclusively on ‘novel’ scientific techniques, we do not read the requirements of Rule 702 to apply specially or exclusively


\textsuperscript{166} Kumho Tire Co., 526 U.S. at 152–53 (explaining that Rule 702 likewise seeks to avoid “unjustifiable expense and delay” as part of its search for “truth” and the “jus[t] determin[ation]” of proceedings. FED. R. EVID. 702).

\textsuperscript{167} See PAUL C. GIANNELLI & EDWARD J. IMWINKELRIED, SCIENTIFIC EVIDENCE § 1-5(D) (3d ed., 1999) (describing how this loophole arose in one of the first ever cases addressing TrueAllele's admissibility, see Commonwealth v. Foley. 38 A.3d 882 (2012)); \textit{Kuhmo}, 526 U.S. at 152–53; see also Giannelli, \textit{Under the Microscope, supra} note 75, at 317.
to unconventional evidence.”168 Post-trial, defendants in appellate courts face a steep “abuse of discretion” standard when questioning a trial court’s decision on whether to hold a Daubert hearing for an expert’s methods.169

[36] In practice, “the complex nature of scientific evidence has created substantial confusion among courts about just where the judge's authority to decide admissibility ends and the jury’s responsibility to assess weight begins.”170 Courts vary considerably on how they define the judge's gatekeeping task under Rule 702 and its state equivalents.171 While most courts hold that whether the expert followed an acceptable methodology is the judge's concern, others sometimes punt methodological issues to the jury.172

[37] Anecdotally, during a conference on best practices for managing Daubert questions, a panel of federal judges on the Advisory Committee on Evidence Rules indicated that judges have adopted highly variable

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169 “Our opinion in Joiner makes clear that a court of appeals is to apply an abuse-of-discretion standard when it “review[s] a trial court's decision to admit or exclude expert testimony. That standard applies as much to the trial court's decisions about how to determine reliability as to its ultimate conclusion. “Otherwise, the trial judge would lack the discretionary authority needed both to avoid unnecessary “reliability” proceedings in ordinary cases where the reliability of an expert's methods is properly taken for granted, and to require appropriate proceedings in the less usual or more complex cases where cause for questioning the expert's reliability arises.” Kumho Tire Co., 526 U.S. at 152 (citation omitted).

170 David L. Faigman et al., Gatekeeping Science: Using the Structure of Scientific Research to Distinguish Between Admissibility and Weight in Expert Testimony, 110 Nw. U. L. Rev. 859, 862 (2016); see also Schwartz & Silverman, supra note 64, at 237, 241 (explaining how unclear language has deterred some courts from acting as proper gatekeepers).

171 Faigman et al., supra note 170, at 859.

172 Id. at 863.
approaches when deciding whether to hold a *Daubert* hearing. Judge Sarah Vance of Louisiana’s Eastern District described conducting extensive independent research into scientific issues prior to holding a hearing, whereas Judge Vince Chhabria from the Northern District of California stated that the undergraduate class, “Physics for Poets,” was his only background in science. Judge John Lee from the Northern District of Illinois considered the question of admissibility versus weight as “less of a bright line and more of a continuum. . . . [M]y guidepost [is]: would a reasonable juror be able to understand the subject matter of the cross-examination to a sufficient degree that they can meaningfully weigh the deficiencies versus the probative value of the testimony?”

Regardless of approach, judges in criminal courts frequently deny *Daubert* hearings for forensic science evidence. The Defense Research Institute published a 1997 paper post-*Daubert* titled “Convincing a Reluctant Judge to Hold a Pretrial *Daubert* Hearing.” As the article explains, “some judges may be reluctant [to] hear these issues issue before

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174 *Id.* at 1223.

175 *Id.* at 1226; *see also* Katie Kronick, *Forensic Science and the Judicial Conformity Problem*, 51 SETON HALL L. REV. 589, 594 (2021) (describing how whether a judge decides to hold a Daubert hearing can be dependent on personality alone).


trial. They will say: ‘Why try the case twice?’\footnote{178} The article’s republication on a firm website in 2019 suggests that the issue persists today.\footnote{179} Recognizing that courts are reluctant to evaluate and potentially exclude technical evidence pretrial, the article emphasizes that \textit{Daubert} expressly allows courts to grant pretrial summary judgment.\footnote{180} Pretrial summary judgment is only an option if there is a pretrial reliability hearing.\footnote{181}

\[39\] Federal Rules of Evidence 103 and 104 also support the argument for a pretrial \textit{Daubert} hearing.\footnote{182} Rule 103(d) provides: “To the extent practicable, the court must conduct a jury trial so that inadmissible evidence is not suggested to the jury by any means.”\footnote{183} Rule 104(c) requires courts to hold a pretrial hearing when “justice so requires,”\footnote{184} thus creating an opportunity for attorneys seeking a \textit{Daubert} hearing to argue that the interests of justice \textit{do} require a hearing. However, Rule 104 provides little other support to argue that trial courts must (or even should) provide a pretrial hearing, and the Advisory Committee Notes indicate that pretrial hearings can be a waste of judicial resources.\footnote{185}

\[40\] Beyond the \textit{Daubert} trilogy and federal rules, Maryland law demonstrates how state-specific inquiries can help clarify when judges should hold \textit{Daubert} hearings versus take the reliability of an expert’s

\footnote{178} Id.
\footnote{179} Id.
\footnote{180} See id.
\footnote{181} See id.
\footnote{182} See Lyons, supra note 177.
\footnote{183} Fed. R. Evid. 103(d).
\footnote{184} Fed. R. Evid. 104(c)(3).
\footnote{185} See id. (citing the Advisory Committee’s note to the 2011 amendment).
method for granted.\textsuperscript{186} Under the \textit{Frye-Reed} standard, \textit{Clemons v. State} indicated a strong preference for pretrial hearings when handling expert testimony:

Where evidence is subject to challenge under \textit{Frye–Reed}, however, the issue should, whenever possible, be dealt with prior to trial. The evidence bearing on whether the challenged evidence is actually the product of a novel scientific technique and, if so, whether that technique is generally accepted in the relevant scientific community will usually be collateral to the substantive issues at trial and may, itself, be inadmissible with respect to those substantive issues. That alone justifies resolving the issue prior to trial. Dealing with the issue pre-trial also avoids delays and diversions at trial that may inconvenience both witnesses and the jury.\textsuperscript{187}

\textsuperscript{[41]} \textit{Clemons} is particularly illustrative in the forensic criminal context because it ultimately excluded testimony based on comparative bullet lead analysis techniques upon finding “several fundamental assumptions underlying the process are not generally accepted by the scientific community.”\textsuperscript{188} In \textit{Savage v. State}, the Maryland Court of Appeals relied upon the \textit{Clemons} court’s preference for pretrial \textit{Daubert} hearings when


\textsuperscript{187} See \textit{Clemons v. State}, 896 A.2d 1059, 1079 n. 6 (Ct. App. Md. 2006); see also \textit{Montgomery Mut. Ins. Co. v. Chesson}, 923 A.2d 939, 946–47 (Ct. App. Md. 2007) (reiterating that where evidence is subject to challenge under \textit{Frye-Reed}, it is best practice for courts to address the issue pretrial).

\textsuperscript{188} See \textit{Clemons}, 896 A.2d at 1079; see also Giannelli, \textit{Under the Microscope}, supra note 75, at 307 n. 4, 313 n. 50.
affirming the exclusion of neuropsychological testimony claiming to elucidate the effects of a defendant’s brain tumor. \(^{189}\)

[42] Though decided under *Frye-Reed*, the logic in *Clemons* retains intuitive appeal under *Daubert-Rochkind*.\(^{190}\) Like expert testimony under *Frye-Reed*, expert testimony under *Daubert-Rochkind* “will [still] usually be collateral to the substantive issues at trial and may, itself, be inadmissible with respect to those substantive issues.”\(^{191}\) Judges must still protect juries from hearing inadmissible evidence; Maryland Rule 104(c) follows the federal Rule 104(c) and states, “[h]earings on preliminary matters shall be conducted out of the hearing of the jury when required by rule or the interests of justice.”\(^{192}\) Judicial economy is always a consideration, meaning that many judges are still likely swayed by the argument that “[d]ealing with [expert testimony admissibility issues] pre-trial also avoids delays and diversions at trial that may inconvenience both witnesses and the jury.”\(^{193}\)

[43] Finally, in response to *Daubert*, some courts have expressed a desire to avoid “grandfathering in” scientific principles that are no longer accepted.\(^{194}\) The courts’ gatekeeping function, in theory, encourages hearings on the admissibility of such evidence.\(^{195}\) *Rochkind* made the


\(^{191}\) *Clemons*, 896 A.2d at 1059, 1079 n. 6.

\(^{192}\) Md. R. Evid. 104(c) (West 2023).

\(^{193}\) *Clemons*, 896 A.2d 1059, 1079 n. 6.; see also Schwartz & Silverman, *supra* note 64, at 259 (noting that holding pretrial hearings “reduces the risk of evidentiary ambush” since it “provides litigants with a preview of the strength of their opponents’ cases,” which may encourage settlement or support a motion to dismiss a weak case on summary judgment).

\(^{194}\) See Kronick, *supra* note 175, at 604.

\(^{195}\) *Id.* at 593, 604.
promise explicit, stating that in Maryland, “everything old is new again”—indicating that even technologies with efficacy taken for granted under Frye-Reed must undergo a Daubert-Rochkind reliability analysis.\(^{196}\) Ultimately, although courts are resistant to change and the law is murky regarding the amount of discretion courts use when determining whether to hold a Daubert-Rochkind hearing, Maryland counsel seeking a hearing may draw upon the Daubert trilogy, the state and federal rules of evidence, and Maryland state law.\(^{197}\) Counsel in similarly situated jurisdictions (like Georgia and Florida) can apply many of the same arguments regarding Daubert’s novelty in their states, and counsel in any jurisdiction should carefully mine state law for precedent favoring pretrial hearings as in Chesson and Savage.\(^{198}\)

D. TrueAllele’s Admissibility History in State Courts

\[44\] So, where have courts admitted TrueAllele evidence under Daubert? Answering this question is complicated by the lack of publicly available trial court decisions on the matter.\(^ {199}\) Daubert designated trial court judges as “gatekeepers to exclude unreliable expert testimony”—meaning that TrueAllele’s admissibility is primarily a question for trial


\(^{197}\) See Rochkind, 236 A.3d at 632–33, 647, 652.


\(^{199}\) See Rebecca Wexler’s summary of encountering a similar problem when researching trade-secret protected technology entering criminal prosecutions in trial courts, Wexler, supra note 88, at 1357. She notes that since Westlaw and Lexis lack comprehensive coverage of state trial court records, her “collection methods necessarily fall short of a comprehensive empirical strategy to quantify trade secret privilege claims in criminal proceedings, but they are the best available.” Id. at 1357. See also, NAS REPORT, supra note 67 (“[I]t is difficult to get a clear picture of how trial courts handle Daubert challenges, because many evidentiary rulings are issued without a published opinion and without an appeal . . .”).

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TrueAllele also appears most commonly in criminal cases. Since most criminal prosecutions occur in state courts, admissibility issues generally arise in state rather than federal trial courts. Most states, including Maryland, do not publish the majority of their intermediate or trial court decisions in reporters. Consequently, Lexis and Westlaw do not carry most state trial decisions.

Without personal knowledge or media attention, it is nearly impossible to locate trial court cases regarding TrueAllele’s admissibility. With knowledge of a relevant trial’s existence, it is possible to order hearing and trial transcripts in lieu of a published decision. However, transcripts are the property of the court reporters who transcribe them and are often prohibitively expensive for independent researchers or public defenders.

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200 Fed. R. Evid. 702 advisory committee’s note to 2000 amendment.


203 See MD. REV. CT. APP. & SPEC. APP. 8-605.1 (West 2023) (showing Maryland’s rule restricting appellate court reporting to “only those opinions that are of substantial interest as precedents” are reported, resulting in most decisions of the Appellate court of Maryland going unreported).


For instance, the trial transcript for *Georgia v. Gibbs*, including the *Daubert* hearing concerning TrueAllele, totals $1,646.10.\footnote{E-mail from Penny Coudriet, Official Court Reporter to Judge J.P. Boulee, U.S. District Court for the District of Northern Georgia, to author (Jun. 21, 2023, 2:54 PM) (on file with author).}

[46] Given these difficulties, considering TrueAllele’s admissibility history according to Cybergenetics, TrueAllele’s developer, is helpful.\footnote{See infra Table 1 [hereinafter TrueAllele Admissibility Table] (referencing information gathered from TrueAllele Admissibility, supra note 201).} Cybergenetics hosts an “admissibility” page on its website cataloging 39 cases where TrueAllele faced an admissibility hearing in a U.S. court.\footnote{Id.} Cybergenetics does not claim the list is exhaustive (and as will later be discussed, it is not).\footnote{See Mark Perlin, Declaration of Mark Perlin, Jan. 2022, https://www.cybgen.com/information/presentations/2022/SCU/Perlin-Innovation-and-transparency-for-reliable-forensic-software/PerlinDeclaration.pdf [https://perma.cc/35Z9-YLLE] (citing the cases from Cybergenetic’s admissibility list in his official declaration to the Commonwealth of Pennsylvania).} However, since the vast majority of admissibility decisions listed occurred in trial court, and such records are not otherwise publicly accessible, the Cybergenetics admissibility log is a critical resource for aggregating relevant cases.\footnote{See id.}

[47] According to the Cybergenetics admissibility page, courts in thirty-eight out of the thirty-nine total cases listed “admitted TrueAllele into evidence” under *Daubert, Frye*, or a local standard.\footnote{TrueAllele Admissibility Table, supra note 207.} Most admissibility challenges arose in state trial courts.\footnote{Id.} In federal trial courts, cases arose in
Pennsylvania, Louisiana, and Georgia.\textsuperscript{213} Georgia state courts admitted TrueAllele pursuant to an admissibility hearing or judicial notice in eleven cases, and Louisiana state courts admitted the evidence pursuant to admissibility proceedings in seven cases.\textsuperscript{214} Out of the thirty-nine U.S. cases, only six trial court admissibility findings were affirmed by a higher court.\textsuperscript{215} Intermediate appellate courts affirmed trial court admissibility findings in Florida (under Frye), Pennsylvania (under Frye), and Tennessee (under Daubert).\textsuperscript{216} Ultimate courts similarly affirmed trial court admissibility findings in Nebraska (under Daubert), New York (under Frye), and Georgia (under its local standard, Harper).\textsuperscript{217} States which affirmed TrueAllele’s admissibility solely in trial courts include: Louisiana, Tennessee, Ohio, Massachusetts, Maryland, and Indiana under Daubert; Washington under Frye; Virginia under the local Spencer standard; South Carolina under the local Jones standard; and California under the local Kelly-Frye standard.\textsuperscript{218}

[48] The log also illustrates that, as states have slowly but steadily adopted the Daubert standard, some states which previously admitted TrueAllele under local standards have not heard admissibility challenges under their newly-adopted Daubert standards.\textsuperscript{219} In Georgia, all ten prior admissibility challenges allowed TrueAllele results pursuant to its local, now-overruled Harper standard.\textsuperscript{220} Georgia abandoned the Harper standard

\textsuperscript{213} Id.

\textsuperscript{214} Id.

\textsuperscript{215} Id.

\textsuperscript{216} TrueAllele Admissibility Table, supra note 207.

\textsuperscript{217} Id.

\textsuperscript{218} Id.

\textsuperscript{219} Id.

\textsuperscript{220} Id.
in 2022 in favor of *Daubert*, and no Georgia state court has yet heard a TrueAllele challenge under *Daubert*. Likewise, a Maryland appellate court admitted TrueAllele evidence, pursuant to a due process hearing and an auto-admissibility statute for DNA evidence, but the state has never affirmed the admissibility of TrueAllele evidence in an appellate court under the *Daubert-Rochkind* standard adopted in 2020. Florida similarly admitted TrueAllele evidence pursuant to *Frye* in 2019, which an intermediate appellate court affirmed following a limited *Daubert* analysis, but the state has not yet heard an admissibility challenge in a trial court under *Daubert* since adopting the standard in 2019.

At the time of this writing, Maryland is the only state in which a trial court has excluded TrueAllele results following an admissibility hearing under any standard. The Cybergenetics list notes that Maryland’s Montgomery County trial court is the sole outlier amidst fifteen total states where TrueAllele has faced an admissibility challenge, as it “did not use TrueAllele evidence” following a *Daubert* admissibility hearing. However, through word of mouth, I discovered another case excluding TrueAllele results: in 2022, a Louisiana state trial court excluded the

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221 See GA. CODE. ANN. § 24-7-702 (West 2023) (referencing the Georgia Supreme Court’s 2023 affirmation of the trial court’s 2019 finding in *Nundra v. State* which only evaluated the case under the *Harper* standard applied by trial court, *Nundra v. State*, 885 Se.2d 790, 802 n.5).


223 TrueAllele Admissibility Table, *supra* note 207; *In re Amends. to Fla. Evid. Code*, 278 So. 3d 551 (Fla. 2019).

224 TrueAllele Admissibility Table, *supra* note 207.

225 *Id.* (stating that while Cybergenetics describes *Daubert* as “not applied” in the Montgomery County case, defense filings and the hearing transcript on file with the author demonstrate a judge ruled to suppress TrueAllele results following an as-applied *Daubert* challenge revealing unreliable application of the technology).
evidence after hearing a pretrial admissibility challenge. 226 Cybergenetics is almost certainly aware of this ruling, given that Cybergenetics’ own chief scientific and executive officers provided “detailed and extensive” information during pretrial hearings. 227 The omission of an exclusionary finding is especially striking because Cybergenetics’ list includes two subsequent district court rulings favoring TrueAllele’s admissibility in 2023—one of them also from Louisiana. 228 That the Louisiana filing remains unlisted offers a reminder of the limitations posed by relying on Cybergenetics to catalog TrueAllele’s admissibility history—not least due to its personal interest in the technology’s success. 229

[50] In sum, Cybergenetics’ admissibility history alone demonstrates that over half of the fifteen states in which courts have heard TrueAllele challenges have only admitted the technology pursuant to a reliability hearing in trial court. 230 Of these eight states, three have not addressed TrueAllele’s admissibility in either their appellate courts (Maryland) or trial courts (Florida and Georgia) since adopting Daubert. 231 Since trial court decisions bind only the parties involved, states courts that have not affirmed TrueAllele’s admissibility in an appellate court or under a newly adopted Daubert challenge are prime candidates for compelling defense challenges. 232 Finally, the Louisiana case demonstrates that TrueAllele’s


227 Id.

228 TrueAllele Admissibility Table, supra note 207.

229 Id.

230 Id.

231 Id.

admissibility story is not yet over, and there may be yet unseen arguments best uncovered by collaborating with local attorneys who may have personal knowledge of TrueAllele’s record in lower court cases that are otherwise difficult to locate.

III. THE DAUBERT-ROCHKIND STANDARD FAVORS EXCLUDING TRUEALLELE EVIDENCE

[51] The Daubert-Rochkind standard favors generally excluding TrueAllele evidence based on the following factors: (1) insufficient peer review, (2) questionable testability, (3) insufficient empirical testing for error rate, (4) development purpose concerns, (5) potential analytical gap, and (6) lack of general acceptance in the scientific community.233 Rigorously evaluating TrueAllele under Daubert-Rochkind thus reveals that the system’s admissibility successes likely do not reflect its reliability but exemplify the criminal system’s historical willingness to admit inadequately examined science for the purpose of securing convictions.234 TrueAllele cannot demonstrate facial reliability based on the information currently available from Cybergenetics, and thus TrueAllele evidence should not be admitted under the Daubert-Rochkind standard.235

[52] This section evaluates TrueAllele under Maryland’s Daubert-Rochkind standard to illustrate how Daubert challenges should incorporate state law beyond the federal standard. Maryland is also notable for its recent adoption of Daubert in 2020.236 No appellate court in Maryland has yet heard a Daubert challenge against TrueAllele, and upcoming decisions

233 See infra Part III.A–F.
234 See supra Part I.B.
could thus carry strong precedential value. However, most of the arguments could be easily adopted by other states using a version of the *Daubert* standard, and most of the reasoning could apply to forensic algorithms beyond TrueAllele.

**A. TrueAllele’s Failure Under the Peer Review and Publication Factor**

[53] *Daubert-Rochkind’s* peer review factor favors exclusion because TrueAllele has never undergone a meaningful peer review process. *Daubert-Rochkind* considers “whether a theory or technique has been subjected to peer review and publication.” Due to TrueAllele developer Mark Perlin’s involvement in every TrueAllele validation study, lack of independently peer-reviewed publications, and the secrecy surrounding TrueAllele’s source code, TrueAllele has not been properly subjected to the peer review and publication process.

[54] The TrueAllele validation studies frequently referenced in litigation are not properly peer reviewed because of Perlin’s extensive involvement. Perlin has authored nearly every study on TrueAllele since

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237 TrueAllele Admissibility Table, *supra* note 207.

238 *See Rochkind*, 236 A.3d at 650–52.

239 *Id.* at 650–52.

240 *Id.* at 650.

241 *See Publications, supra* note 235. Perlin is listed as an author for all but one of the journal articles listed on the Cybergnetics website, *id.*; see also Justin Jouvenal, *A secret algorithm is transforming DNA evidence. This defendant could be the first to scrutinize it.* WASH. POST: LEGAL ISSUES (July 13, 2021, 8:00 AM), https://www.washingtonpost.com/local/legal-issues/trueallele-software-dna-courts/2021/07/12/66d27c44-6c9d-11eb-9f80-3d7646ce1bc0_story.html [https://perma.cc/9TNP-RBSV].

242 *Publications, supra* note 235.
its creation. In reviewing PGS systems including TrueAllele, the PCAST Report emphasized: “Appropriate evaluation of the proposed [PGS] methods should consist of studies by multiple groups, not associated with the software developers, that investigate the performance and define the limitations of programs by testing them on a wide range of mixtures with different properties.”

Beyond PCAST, concern regarding conflicts of interest in scientific research is a widely held ethical consideration for most major research organizations.

[55] Although Cybergnetics touts “over three dozen” TrueAllele validation studies, as of 2020, only eight were actually published in peer-reviewed journals. While Daubert considers publication “but one element of peer review,” the Supreme Court also noted that “submission 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.”

NIST adopted even stronger language: “A study isn’t complete until it’s been published.”

[56] Of these eight published studies, Perlin was listed as an author on


244 PCAST Report, supra note 9, at 79.


248 NIST Report, supra note 39, at 15.
The sole published validation study not listing Perlin as an author instead thanked him for his “helpful comments and guidance.” As the Chief Scientific and Executive Officer of Cybergenetics, Perlin’s involvement in published studies disqualify them as the type of “appropriate validation” envisioned by PCAST and poses an obvious conflict of interest, given his personal stake in TrueAllele’s efficacy.

Finally, the secrecy surrounding TrueAllele’s source code draws its “peer-reviewed” articles into question regardless of Perlin’s involvement. Daubert focuses “solely on [the] principles and methodology [of technologies], not on the conclusions that they generate.” According to the Federal Reference Manual on Scientific Evidence: “[a] peer-reviewed publication needs to describe in detail the method about which the expert plans to testify. . . . A proprietary algorithm used to generate a finding published in the peer-reviewed literature is not adequately supported by that literature.” TrueAllele is exactly that type of proprietary algorithm. Without subjecting the code to peer review, any external peer reviewer must base their conclusions on incomplete information. Whether due to secret source code or Perlin’s involvement, the dearth of legitimate peer-reviewed

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publications regarding TrueAllele weighs heavily against admitting TrueAllele evidence under the peer review factor.

B. TrueAllele’s Failure Under the Testability Factor

[58] Even if TrueAllele had thousands of published, independent, peer-reviewed studies, Daubert-Rochkind’s “testability” factor will favor excluding TrueAllele evidence as long as Cybergenetics maintains black-boxed source code. 257 Daubert’s testability factor refers to “whether the expert’s theory can be challenged in some objective sense … for reliability.” 258 The secrecy currently shrouding TrueAllele’s source code makes meaningful reliability testing impossible because errors can remain hidden in source code despite years of empirical testing. 259 Although testability turns on disclosure of the source code, 260 judges rarely order disclosure. 261 Even where judges have ordered Cybergenetics to disclose TrueAllele’s source code, “the orders have not resulted in more than theatrical access”—meaning that Cybergenetics has not disclosed the code to the extent necessary for independent verification and validation. 262

257 See id.

258 Fed. R. Evid. 702 (citing the Advisory Committee’s note to 2000 Amendment).


262 Zoom interview with Jeanna Matthews, Professor of Comput. Sci., Clarkson Univ. (Apr. 6, 2023).
TrueAllele provides peer reviewers and litigants sufficient source code access, Daubert-Rochkind’s testability factor favors excluding TrueAllele results.

1. TrueAllele May Contain Errors Only Discoverable by Examining Its Source Code

[59] Cybergeneics states that TrueAllele’s source code is irrelevant to reliability testing because prospective clients can run known samples through the system to “look at the math and examine empirical results on real data.” This option generates enough confidence for some. However, the currently available testing without source code is not sufficient to satisfy Daubert. From a software development perspective, “The only way to completely understand how—and whether—a program


264 See, e.g., Stephanie M. Lee, People Are Going To Prison Thanks To DNA Software — But How It Works Is Secret, BUZZFEED NEWS, https://www.buzzfeednews.com/article/stephaniemlee/dna-software-code [https://perma.cc/TQ8F-KPUM] (last updated Mar. 18, 2016, 8:46 PM) (quoting a California crime laboratory director who believes TrueAllele’s empirical testing is sufficient to demonstrate the system “works as expected”); Lauren Kirchner, Where Traditional DNA Testing Fails, Algorithms Take Over, PROPUBLICA (Nov. 4, 2016, 8:00 AM), https://www.propublica.org/article/where-traditional-dna-testing-fails-algorithms-take-over [https://perma.cc/VJC8-2UWJ] (quoting the Idaho Innocence Project’s director who defends TrueAllele’s source code secrecy, saying, “we can test it and see that it works, and that’s what we care about”).

works is by reading the program’s source code." Structural errors can hide in PGS source code and escape detection despite extensive empirical testing. Flawed conditional functions are especially difficult and sometimes impossible to discover without source code since they can lie dormant until activated by a particular set of factors. These risks are not just theoretical: two of TrueAllele’s PGS competitors have faced public controversies surrounding errors and “miscodes,” illustrating the limitations of reliability testing without source code access.

[60] One forensic scholar compares learning about a software program by watching it run to learning about automobiles by watching a car drive. To extend the car metaphor, testing TrueAllele on known samples is like test driving a car with the dashboard obscured. Sure, the car can run, but wouldn’t you like to know if the check engine light is on? What if it’s 70°F

266 Id. at 182; cf. Michael D. Edge & Jeanna Neefe Matthews, Open Practices in Our Science and Our Courtrooms, 38 TRENDS IN GENETICS 113, 114 (2022), https://www.cell.com/trends/genetics/pdf/S0168-9525(21)00271-7.pdf [finding “serious evaluation” of source code “is best performed in conversation with extensive testing,” suggesting reading source code is a necessary but insufficient step given the need for additional testing), with Access to STRmix™ Software by Defence Legal Teams, STRMIX (Apr. 2020), Access to STRmix™ Software by Defence Legal Teams [https://perma.cc/H78W-H4FD](claiming a similar PGS system, STRmix “is best tested by empirical testing…rather than the source code,” although STRmix will release source code to defenses attorneys).

267 See Chessman, supra note 259, at 186.


269 See id. (discussing the two miscodes present in STRmix™ versions up to but not including version 2.0.6); Lauren Kirchner, Thousands of Criminal Cases in New York Relied on Disputed DNA Testing Techniques, PROPUBLICA, https://www.propublica.org/article/thousands-of-criminal-cases-in-new-york-relied-on-disputed-dna-testing-techniques [https://perma.cc/K3LA-WLZT] (last updated Oct. 11, 2018) [hereinafter Kirchner, Thousands of Criminal Cases in New York].

270 Chessman, supra note 259, at 182–83.
on the day you test drive, but the car reliably overheats when the temperature exceeds 90°F—and you live in Texas? Likewise, TrueAllele may appear to run just fine under testing conditions, while the source code contains structural errors that may only be triggered by a specific combination of factors. Chessman lists structural errors in software that only source code can reveal, including: accidental errors, faulty software updates to legacy code, inadvertent or intentional bias, conditional processes that do not trigger as expected, concurrent processes that interfere with one another, flawed self-diagnostics tools, and the ever-looming threat of “unknown unknowns.”

[61] Given the variety of errors that can secretly plague a software system, Perlin’s 2019 claim that only two people have ever viewed his approximately 170,000 lines of MATLAB code raises serious questions regarding its reliability and the discoverability of errors through testing alone. New Jersey’s appellate court agreed, ordering Cybergenetics to disclose the source code for a Frye analysis because: "Without scrutinizing

271 Id. at passim.

272 See id. at 186–89 (including errors in math or typography).

273 Id. at 189–90.

274 Id. at 192–93 (including assumptions that lead to real-world errors).

275 Chessman, supra note 259, at 194.

276 Id.

277 Id. at 195–96.

278 Id. at 196–99.

[TrueAllele’s] software's source code—a human-made set of instructions that may contain bugs, glitches, and defects—in the context of an adversarial system, no finding that it properly implements the underlying science could realistically be made.”

The same logic applies under Daubert-Rochkind’s testability factor.

Concern that hidden errors threaten the reliability of PGS systems transcends mere speculation. New York state protected the source code for its PGS system, the Forensic Statistical Tool (FST), for years before a judge mandated its disclosure to defense in 2016. Upon running an external code review, a team of defense experts identified a hidden function called CheckFrequencyForRemoval that tended to drop evidence helpful to the defendant. CheckFrequencyForRemoval operated in “ways users wouldn’t necessarily be aware of.” Even more troubling, the function’s methodology contradicted sworn testimony and peer-reviewed works on FST. No amount of prior empirical testing had revealed the faulty function despite FST’s application in over a thousand cases between 2011


281 See Kirchner, Thousands of Criminal Cases in New York, supra note 269; Order for Defendant at 1, United States v. Johnson, 2016 U.S. Dist. LEXIS 194411, at *1 (2016).


283 Id.; Kirchner, Thousands of Criminal Cases in New York, supra note 269 (noting that defense expert, Nathan Adams, found the function “dropped valuable data…that could unpredictably affect the likelihood assigned to the defendant’s DNA being in the mixture.”).

284 Matthews et al., supra note 282, at 2.
and 2016. Subsequent source code reviewers noted, “it cannot be overemphasized that the post-validation modification to FST was only publicly acknowledged by [FST’s developer] after FST’s source code was examined in conjunction with independent testing.”

[63] The case of STRmix, which makes source code available to defendants upon request, also demonstrates the persistence of errors as a natural part of the coding process. In 2015, an Australian laboratory discovered a miscode in STRmix that impacted its LRs. The laboratory subsequently submitted updated LRs for twenty-three cases. Although the media exaggerated the error, which STRmix described as minimal rather than outcome determinative, the incident offers a critical reminder that PGS


286 Matthews et al., supra note 282, at 6 (noting that the State’s attorney withdrew the FST results in question prior to the admissibility hearing, and New York City lab abandoned FST in favor of STRmix later that year).


288 Statement Relating to STRmix™ Miscodes, supra note 268.

errors may impact LRs, which can be outcome determinative in court.  

STRmix attributes the small scale of errors, such as the 2015 miscode, to a code that “has been significantly checked by multiple parties, both developers and users” and notes, “this process is possible because of the transparency of our formulations and the multiple diagnostic indicators available with the output.”

2. TrueAllele’s Past Protective Order Terms Limit Source Code Testability

[64] Recent disclosure “victories” remain inadequate. Perlin has argued for decades that trade secrecy law protects TrueAllele’s source code. Cybergenetics went to extensive lengths to protect its source code in 2015, and as noted, Perlin stated in 2019 that only two people had ever viewed the code. Cybergenetics’ website now states that TrueAllele’s source code is available to defense attorneys pursuant to judicial order, but two past


291 Statement Relating to STRmix™ Misscodes, supra note 268.


294 TrueAllele Admissibility Table, supra note 207.
protective orders, combined with the experience of defense experts, cast doubt onto whether Cybergenetics has ever disclosed its source code to the extent necessary for meaningful testing.

[65] The two recent protective orders, in *Virginia v. Watson* and *New Jersey v. Pickett*, mandate terms too restrictive to allow meaningful reliability testing. Rather than allowing experts to view the code in concert with testing, the *Watson* court only allowed defense experts to review source code on a single iPad in its Fairfax, Virginia, office. The *Pickett* court allowed Cybergenetics to limit source code disclosure to mere inspections on a computer without internet access or an ability to copy or transfer the code for external testing. The *Pickett* order permitted defense counsel to request paper copies of select portions of the code, all of which Cybergenetics could challenge, and prohibited translating paper copies into an electronic format. Since testing source code printed on a piece of paper is impossible, the approved protective order offers only the illusion of expanded access. Perlin might as well be offering to whisper the source

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296 Interview with Jeanna Matthews, *supra* note 262.


298 *Watson Disclosure Order*, *supra* note 295.

299 *Pickett Protective Order*, *supra* note 295, at 15.

300 *Id*.

301 *See generally id*. 

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code into the ear of a non-English speaker.

[66] The Watson and Pickett defense teams are not alone in receiving code insufficient to conduct independent validation and verification testing despite disclosure orders. Dr. Jeanna Matthews, a computer scientist and expert witness in multiple TrueAllele cases, stated that the most reasonable way to test TrueAllele’s source code for errors would be to reconstruct the program and run it through a debugger. While detecting coding errors can be like searching manually for a needle in a haystack, a re-constructed program combined with a debugger would be equivalent to using a high-powered magnet to find the needle. Perlin has repeatedly denied defense teams use of this metaphorical magnet.

[67] In Ellis v. U.S., Cybergenetics provided the defense purely “theatrical access” to TrueAllele’s code despite a court order and a protective order crafted so defense could perform “reasonable testing.” While Perlin made some of TrueAllele’s code available, he omitted portions of the source code, including software “dependencies” TrueAllele relies upon to run. “build instructions” that function like a blueprint for the

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302 Watson Disclosure Order, supra note 295; Pickett Protective Order, supra note 295, at 15.

303 Interview with Jeanna Matthews, supra note 262.

304 Id.

305 Id.


307 Ellis Special Master’s Hearing I, supra note 306, at 44–45.

308 Id. at 83.
code, 309 and databases TrueAllele references while operating. 310 With these 
ominations, the source code was not able to run, and the defense team was 
not able to reconstruct the program or run the code through a debugger. 311 Perlin himself admitted that “it would take centuries” for defense experts to 
replicate TrueAllele’s process with the information he provided, and he was 
uncertain if the output in question would even be replicable. 312 After Ellis, 
defense attorneys won a similar disclosure order in a Maryland trial court 
but abandoned their query after extensive litigation because they were “not 
interested in another round of theatrical access.” 313

[68] Although Perlin claims his aversion to source code disclosure is 
rooted in intellectual property concerns, 314 Matthews emphasizes that 
providing source code in a testable format poses no greater intellectual 
property risk than the printed-out code he has already provided following 
protective orders like in Watson and Pickett. 315 There is no valid intellectual 
property interest between what Cybergenetics has previously disclosed, and 
what it needs to disclose to allow defense testing. 316 The only difference is 
the chance that someone will find an error. 317

309 Id. at 121.
310 Id. at 83.
311 Id.
313 Interview with Jeanna Matthews, supra note 262.
314 Ellis Special Master’s Hearing I, supra note 305, at 37.
315 Interview with Jeanna Matthews, supra note 262.
316 Id.
317 Id.
Combined with the *Watson* and *Pickett* protective orders, the difficulties defense attorneys face securing testable code in cases like *Ellis* indicates that Cybergenetics still refuses to disclose code in a way conducive to reliability testing, and judges allow it. Until Cybergenetics increases transparency or Maryland judges begin to order source code disclosure under protective orders that permit meaningful testing, *Daubert*-Rochkind’s testability factor favors excluding TrueAllele evidence.

C. TrueAllele’s Factor Under the Analytical Gap Factor

TrueAllele also fails Rochkind’s analytical gap factor because Cybergenetics refuses to meaningfully release the source code. Rochkind adopted Daubert’s consideration for “whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion” upon recognizing Maryland’s jurisprudential drift towards Daubert. In doing so, Rochkind built upon Maryland’s prior finding that “[a] court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.”

In *Savage v. State*, the court rejected an expert’s testimony upon finding an analytical gap between accepted neuropsychological methodologies and an expert’s testimony regarding the defendant’s cognitive disorder. Although the Court found the neuropsychologist’s qualification methodologies reliable, it held that “we are unable to conclude

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318 Id.
319 Id.
321 Id.
that [the expert] adequately ‘connected the dots’ between the empirical foundation…and [his] ultimate opinions.”

[72] While Savage considered expert testimony where neuropsychological methods constituted the “accepted premise” and “empirical” foundation, TrueAllele relies on widely accepted Markov Chain Monte Carlo (MCMC) statistical sampling methods to solve Bayesian equations. MCMC emerged during World War II and retains widespread scientific recognition for its use in a variety of fields. TrueAllele employs MCMC methods to help factfinders determine issues far removed from mathematics, like whether someone is a killer, a rapist, or a thief. TrueAllele uses MCMC to generate likelihood ratios that help determine whether individuals should go free, or die in prison, or even be executed by the government.

[73] How does TrueAllele do it? How does it bridge the analytical gap between MCMC sampling methods and a suspect’s culpability? That is a trade secret—it is in the black box. Evaluating an analytical gap “necessarily requires reviewing the underlying data,” or in this case, TrueAllele’s source code. Without access to either the source code or peer-reviewed publications from independent authors with access to the source code, no expert can “connect the dots” between TrueAllele’s

324 Id.

325 David W. Bauer et al., Validating TrueAllele® Interpretation of DNA Mixtures Containing up to Ten Unknown Contributors, 65 J. FORENSIC SCI. 380, 381 (2020).

326 Christian Robert & George Casella, A Short History of Markov Chain Monte Carlo: Subjective Recollections from Incomplete Data, 26 INST. MATH. STAT., 102, 103, 08 (2011).

327 Jouvenal, supra note 241.

328 See generally id.

empirical foundations and its results. "[N]othing in either Daubert or the Federal Rules of Evidence require a district court to admit opinion evidence connected to existing data only by the ipse dixit of the expert." As long as source code transparency and empirical testing remain a concern, Daubert-Rochkind’s analytical gap factor favors excluding TrueAllele results.

D. TrueAllele’s Failure Under the Known or Potential Error Rate Factor

[74] Daubert-Rochkind evaluates the reliability of a theory or technique by considering its “known or potential error rate.” Error rates as a concept are incompatible with the primary statistics generated by TrueAllele and other PGS: the likelihood ratio (LR). Instead of using error rates to describe a LR’s reliability, scientists use empirical testing results to evaluate a system’s “fitness” for generating reliable LRs using specific types of data. Two major publicly funded forensics reports from the PCAST and NIST indicate that Cybergenetics has not conducted sufficient empirical testing to assess TrueAllele’s reliability producing LRs beyond a limited

330 Reference Manual on Scientific Evidence, supra note 254, at 787 (“[a] proprietary algorithm used to generate a finding published in the peer-reviewed literature is not adequately supported by that literature.”).


range. Perlin also describes suspect testing practices to determine error rates for TrueAllele as a system. Based on insufficient empirical testing, Daubert-Rochkind’s error rate factor weighs against admitting any TrueAllele Evidence.

1. Empirical Evidence Regarding TrueAllele’s Fitness to Generate Likelihood Ratios Considers Insufficient Factor Space Coverage

TrueAllele has not demonstrated adequate empirical testing to measure the fitness of its LRs for use in casework. Empirical testing means gathering information based on direct observation, and is also known as “ground truth” evidence. Knowing the ground-truth in DNA mixture analyses means knowing, at least (1) how many individuals contributed DNA to the sample, and (2) the identity of each individual. But not all known ground truth empirical studies are created equally; empirical data must have the appropriate “factor space coverage” to be useful for evaluating LR reliability. Testing has appropriate factor space coverage when it considers “the totality of scenarios and associated variables

335 PCAST Report, supra note 9, at 80–81; NIST Report, supra note 39, at 75, 84, 86–87. See also infra Part III.F (criticizing TrueAllele from PCAST and NIST reports).

336 State v. Simmer, 935 N.W.2d 167, 175–76 (Neb. 2019). See supra Parts III(D)(1)–(2) for further analysis.

337 See Ellis Special Master’s Hearing II, supra note 312, at 52.

338 NIST Report, supra note 39, at 10.

339 Id. at 59 (“Empirical assessments of reliability require that the process of interest be tested in ground truth known situations. For DNA mixture interpretation, this means that samples with known genotypes, known number of contributors, known mixture ratios, known degrees of degradation, etc.”).

340 Id. at 91, 95 (suggesting empirically testing “results of LR assessments across a collection of casework-similar, ground-truth known, scenarios” when considering a LR’s fitness).
(factors) that are considered likely to occur in actual casework.” For TrueAllele, this means known ground truth samples including low-level DNA quantities, degraded DNA, a high number of contributors, contributors with various degrees of allele sharing, contributors of different weights, contributors who are related, and so forth.

[76] NIST and PCAST indicate the empirical validation studies Perlin has conducted on TrueAllele do not encompass a wide enough range of factors to evaluate TrueAllele’s LR reliability based on TrueAllele’s advertised lack of limitations. PCAST evaluated the factor space coverage for TrueAllele’s empirical testing in 2016 and reported that “current [PGS] studies have adequately explored only a limited range of mixture types (with respect to number of contributors, ratio of minor contributors, and total amount of DNA).” For this reason, PCAST ultimately concluded that insufficient testing supported PGS system reliability when faced with more than three contributors.

[77] NIST explored factor space coverage data newly available between 2016 and 2021. Its conclusion? Little had changed. After reviewing over sixty PGS validation publications and internal validation data summaries, NIST concluded information pertinent to factor space coverage (like contributor genotypes, degree of allele sharing, and ground truth

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341 Id. at 60.

342 Id.

343 See Ellis Special Master's Hearing II, supra note 312, at 108–09.

344 PCAST Report, supra note 9, at 80.

345 Id. at 82.

346 NIST Report, supra note 39, at 84.

347 See id. at 87.
information) was “not consistently provided.” Likewise, “contributor genotypes or degree of allele sharing is rarely provided” for internal validation studies.

[78] Perlin’s comments offer little confidence that TrueAllele will face expanded empirical testing in the future. When PCAST asked how to best establish TrueAllele’s reliability range, “Perlin contended that empirical testing was unnecessary because it was mathematically impossible for the likelihood ratio approach in his software to incorrectly implicate an individual.” In response to Perlin’s dismissal, PCAST reiterated the importance of empirical testing: “Application of [LRs] requires making a set of assumptions about DNA profiles that require empirical testing. Errors in the assumptions can lead to errors in the results”—and thus the importance of empirical testing. The Cybergenetics website maintains that it can handle unlimited contributors, and a year after the NIST report, Perlin published a study claiming TrueAllele could identify mixtures with up to 10 contributors. Either this claim is untrue, the data is flawed, or both.

2. There is No Reliable Error Rate for TrueAllele as a System

[79] Although traditional error rates do not apply to LRs, Perlin has

348 *Id.* at 88.

349 *Id.*

350 *See* PCAST Report Addendum, *supra* note 109, at 8.

351 *Id.*

352 *Id.* at 8–9.

353 *Casework, supra* note 6; Bauer et al., *supra* note 325, at 380.
engaged in discussions regarding TrueAllele’s error rate as a system. Perlin’s conclusions lack sufficient factor space coverage and rely on crime scene rather than known ground truth samples. As for evaluating the fitness of an LR, developing an error rate for a system requires empirical testing with known ground truth samples. “Ground-truth requires knowing the correct answer before testing is performed and therefore is not possible with samples arising from crime-scene evidence.”

[80] Perlin’s description of the empirical testing for error rates he has done on TrueAllele raises red flags about the legitimacy of his methodology and thus conclusions. As summarized in State v. Simmer, Perlin testified:

First, error rates had been tested through validation studies of large ensembles of “real,” “less pristine” samples from casework to demonstrate how the system works in practice. And second, error rates were tested by the application of information theory to determine the expected distribution of match statistics from one evidence genotype of known composition to “provide information about a sample in a case and what the error rate would be for a particular match statistic.” Of the seven peer-reviewed validation studies, four used laboratory samples of known composition and three drew from less pristine crime scene data.

355 Id. at 175–76, 182.
356 PCAST Report, supra note 9, at 57.
357 NIST Report, supra note 39, at 59 n.17 (emphasis added).
358 See State v. Simmer, 935 N.W.2d at 175-76.
359 Id at 176.
The first step Perlin describes, using “less pristine” casework samples, runs afoul of NIST’s commonsense statement that empirical testing to determine error rates requires samples where the ground truth is known and cannot be done with casework samples.\textsuperscript{360} The three peer-reviewed studies of unknown composition in step two using crime scene data would likewise be insufficient to determine valid error rates.\textsuperscript{361} Through a combination of insufficient factor spread coverage, a disinterest in further empirical testing, and use of crime scene samples, \textit{Daubert-Rochkind}’s error rate factor favors excluding TrueAllele.

\textbf{E. TrueAllele’s Failure Under the Development Purpose Factor}

\textsuperscript{362} \textit{Rochkind}’s sixth factor considers an expert opinion’s “development purposes” and favors excluding TrueAllele results because Cybergenetics appears to have developed TrueAllele expressly for law enforcement and litigation purposes.\textsuperscript{362} Under this factor, both TrueAllele’s development history and Perlin’s interest in using DNA to serve law enforcement raise serious reliability concerns.\textsuperscript{363}

\textsuperscript{364} As

\begin{footnotesize}
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\item \textsuperscript{360} NIST Report, \textit{supra} note 39, at 59.
\item \textsuperscript{361} \textit{Id.}
\item \textsuperscript{362} \textit{Rochkind} v. Stevenson, 236 A.3d 630, 650 (Ct. App. Md. 2020); Mooney, \textit{supra} note 243, at 78–80.
\item \textsuperscript{363} See Mooney, \textit{supra} note 243, at 78–80; \textit{see also} Mark Perlin, Threshold, SoundCloud (2011), \url{https://soundcloud.com/markperlin/threshold} [https://perma.cc/F2V5-R7LS] [hereinafter Perlin, \textit{Threshold}].
\item \textsuperscript{364} \textit{Rochkind}, 236 A.3d at 650.
\end{itemize}
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*Daubert* explained upon remand, “experts whose findings flow from existing research are less likely to have been biased toward a particular conclusion by the promise of remuneration[.]”

[84] While *Daubert* considers the purpose of expert testimony rather than a technology itself, the factor remains relevant since Perlin both developed TrueAllele and typically testifies as an expert on behalf of the state in TrueAllele challenges. TrueAllele’s historical development suggests that Perlin shaped the growth of Cybergenetics specifically to develop opinions for criminal cases. After focusing on medical applications for genetics in the 1990s, “[Cybergenetics] transitioned into forensic analysis, helping to eliminate backlogs and solving the DNA mixture problem.” “Backlogs” are the accumulated DNA tests state and local forensic labs need to process for the purposes of litigation. Today, the only fields Cybergenetics lists among its services are related to litigation and law enforcement: prosecution, defense, investigation, innocence, crime lab complementor,

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365 *Daubert* v. Merrell Dow Pharms., Inc., 43 F.3d 1311, 1317 (9th Cir. 1995). A footnote to the majority opinion stated the factor would not be a substantial consideration for “scientific endeavors closely tied to law enforcement” like DNA fingerprinting, *id.* at 1317 n.5. However, DNA has a myriad of multidisciplinary applications today compared to 1993 and can no longer be clearly considered “closely tied to law enforcement,” see Suliman Khan et al., *Role of Recombinant DNA Technology to Improve Life*, 2016 INT. J. GENOMICS 1, 1–3 (2016).

366 *Id.* note 243, at 78–80.

367 *Id.*


and retail theft.\textsuperscript{370}

\[85\] Perlin’s personal views also raise concern regarding the purpose of his testimony on TrueAllele. In 2011, he wrote and recorded a song called “Thresholds,” denouncing the thresholds at which DNA analysts can conclude that allelic peaks on an electropherogram are not impacted by random variation.\textsuperscript{371} While debating thresholds is valid academic discourse, Perlin’s lyrics betray his interest in using DNA technologies for the purpose of law enforcement and conviction.\textsuperscript{372} Choice lyrics include:

\begin{quote}
I rather would use TrueAllele®
Interpret DNA for real
Let the evidence reveal
Thugs who slash and shoot and steal.\textsuperscript{373}
\end{quote}

And:

\begin{quote}
Science should let numbers talk
Not let perpetrators walk
Who can count the victims lost
\end{quote}


\textsuperscript{372} See generally Joli Bregu et al., Analytical Thresholds and Sensitivity: Establishing RFU Standards for Forensic DNA Analysis, 58 J. FORENSIC SCI. 120, 120, 128 (2013) (describing the merits and drawbacks for different methodologies used to set stochastic thresholds); see also Perlin, Threshold, supra note 363.

To criminals who've not been caught.\textsuperscript{374}

And finally:

Draw a threshold throw away
The evidence from DNA
Release a killer who should stay
In prison till his dying day.\textsuperscript{375}

Perlin’s lyrics demonstrate a clear interest in using forensic DNA to convict and punish. As Perlin is both TrueAllele’s developer and primary expert, the “development purposes” inquiry is especially relevant given the tendency for bias to leak into algorithms.\textsuperscript{376} Thus TrueAllele’s Daubert inquiry cannot be divorced from Perlin’s interest in using DNA for law enforcement and crime reduction.

\textbf{F. TrueAllele’s Failure Under the General Acceptance Factor}

When Rochkind adopted Daubert, Maryland rejected Frye-Reed’s general acceptance standard as an “imperfect proxy for reliability.”\textsuperscript{377} Under Daubert-Rochkind, “General acceptance remains an important consideration in the reliability analysis, but it cannot remain the sole consideration.”\textsuperscript{378} Maryland courts considering whether a theory or technique is generally accepted evaluate “members of the relevant scientific community,” meaning “those whose scientific background and training are sufficient to allow them to comprehend and understand the process and form

\textsuperscript{374} Perlin, \textit{Threshold}, \textit{supra}, note 363.

\textsuperscript{375} Id.

\textsuperscript{376} Chessman, \textit{supra} note 259, at 192 (“Inadvertent biases . . . are regular features of computer programs.”).


\textsuperscript{378} Id. at 647.
a judgment about it.”" Courts decline to find general acceptance for scientific methodologies that are subject to “widespread disagreement” or a “genuine controversy.” Today, skepticism towards TrueAllele from both the PCAST and NIST reports indicates a lack of general acceptance that favors exclusion.

[88] Both reports criticize TrueAllele’s methodology, validation practices, and claims, strongly indicating a genuine controversy and thus lack of general acceptance for TrueAllele. As noted, today and at the time, Perlin claimed that TrueAllele could reliably evaluate samples far beyond these parameters. PCAST also called for more studies, “not associated with the software developers” to investigate PGS reliability limits.

[89] Five years later, NIST concluded that “publicly available information continues to lack sufficient details needed to independently assess reliability.” NIST found available public data from groups like TrueAllele insufficient “to enable an external and independent assessment of the degree of reliability of DNA mixture interpretation practices, including the use of probabilistic genotyping software (PGS) system[s].” While open to the possibility that further, publicized research could increase reliability evaluations, NIST concluded that current proficiency testing for


381 See generally PCAST Report, supra note 9; see generally NIST Report, supra note 39.

382 Casework, supra note 6; Bauer et al., supra note 325.

383 PCAST Report, supra note 9, at 79 (emphasis included in original text).

384 NIST Report, supra note 39, at 6.

385 Id.
PGS systems need to more accurately reflect casework samples.\(^{386}\)

[90] Both PCAST and NIST qualify as the “relevant scientific community” *Blackwell* envisioned: PCAST boasts nearly fifty authors, all “blue-ribbon . . . elite, nationally renowned scientists.”\(^{387}\) The authors specialize in a variety of fields including microbiology, biotechnology, statistics, chemistry, and biochemistry, and together they have evaluated over 2,000 literature publications in the course of their research.\(^{388}\) NIST specializes in the development and use of standards for U.S. science and technology,\(^{389}\) and the authors of the NIST DNA mixtures report specialize in statistical engineering and biomolecular measurement.\(^{390}\) Given TrueAllele’s multidisciplinary approach to DNA interpretation,\(^{391}\) it is difficult to envision bodies more apt than PCAST and NIST to evaluate its reliability.

[91] Despite their credentials and meticulous research, PCAST and NIST encountered criticism from PGS developers, law enforcement agencies, and

\(^{386}\) Id.


\(^{390}\) NIST Report, *supra* note 39, at ii.

\(^{391}\) NIST Report, *supra* note 39, at 39 (“(PGS) systems utilize statistical genetics, biological models, computer algorithms, and probability distributions to infer possible genotypes and calculate LRs[.]”).
prosecutors invested in the practices the reports question.\textsuperscript{392} Perlin and STRmix scientist John Buckleton were the only critics to specifically respond to PCAST’s claims regarding PGS systems, claiming the report did not adequately address all available research on contributor limits for PGS systems, including their self-authored studies.\textsuperscript{393} STRmix levied similar criticism towards the NIST report but increased its data transparency in response.\textsuperscript{394} Perlin did not make any offer to increase transparency, and even prior to the NIST report’s release called the study a “collu[sion]” to “waste taxpayer dollars.”\textsuperscript{395}

[92] Law enforcement agencies have similarly questioned the PCAST report.\textsuperscript{396} Former U.S. Attorney General Loretta Lynch refused to adopt PCAST’s recommendations for the DOJ, claiming that she found the admissibility standards in place sufficient.\textsuperscript{397} Lynch declined to recognize

\textsuperscript{392} Institute of Environmental Science and Research Ltd., \textit{Second Response to NISTIR 8351-DRAFT DNA Mixture Interpretation} (Nov. 8, 2021), https://www.strmix.com/assets/STRmix/STRmix-PDFs/2nd_ESR_response_to_NISTIR_8351_081121.pdf [https://perma.cc/6SXT-WU5P].


\textsuperscript{394} Institute of Environmental Science and Research Ltd., \textit{supra} note 392.


\textsuperscript{397} \textit{Id.}; Sinha, \textit{Radically Reimagining Forensic Science}, \textit{supra} note 387, at 918.
the existence of unvalidated science, failing to respond to the report’s substance since “judicial gatekeeping does not obviate the need for improvement of forensic methods.”

Both the DOJ and its investigatory arm, the FBI, accused PCAST of ignoring “numerous published research studies.” However, when PCAST invited them to submit any disregarded papers, the DOJ conceded that it had “no additional studies for PCAST to consider.” Finally, Michael Ramos wrote to then-President Obama on behalf of the National District Attorney’s Association, issuing a blanket rejection of the findings on similar grounds and claiming bias among PCAST’s authors. He leveled no evidence for bias other than a consulting author’s affiliation with the Innocence Project.

Far from benefitting TrueAllele under the general acceptance factor, criticism of the PCAST and NIST reports constitutes the type of “widespread disagreement” and “genuine controversy” that precludes courts from finding general acceptance for a methodology. There is also reason to suspect bias from law enforcement and prosecution: TrueAllele, like most forensic disciplines, is primarily a carceral tool supporting law

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398 Sinha, Radically Reimagining Forensic Science, supra note 387, at 919.


400 PCAST Report Addendum, supra note 109, at 3.


402 Id.

enforcement.\textsuperscript{404} Perlin once reported that only 10% of the cases he consulted on were for defense and the remaining 90% for prosecution.\textsuperscript{405} Realized or not, prosecutors, law enforcement agencies, and PGS developers share an interest in undermining studies that “might jeopardize convictions” and thus threaten the underpinnings of their livelihoods.\textsuperscript{406} It is telling that PCAST remains uncontroversial among academics and scientists.\textsuperscript{407} While no longer sufficient for admissibility on its own, the general acceptance factor remains especially relevant for cases like TrueAllele, where personal interest can impact reliability assessments.\textsuperscript{408}

\textbf{IV. CHALLENGING TRUEALLELE UNDER DAUBERT BENEFITS DEFENDANTS AND COMBATS JUNK SCIENCE}

[94] For individual clients, successfully ejecting TrueAllele evidence can be outcome determinative,\textsuperscript{409} due to the liberal provisions afforded expert witnesses\textsuperscript{410} and the persuasive power of scientific and technical evidence

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\textsuperscript{404} Sinha, \textit{Radically Reimagining Forensic Science}, supra note 387, at 887.
\footnotesuperscript{405} Mark Perlin, Presentation of Transparency in DNA Evidence to the President’s Council of Advisors on Science and Technology (Nov. 18, 2016), https://www.cybgen.com/information/presentations/2016/PCAST/Perlin-Transparency-in-DNA-evidence/page.shtml [https://perma.cc/5KZN-JZHV].
\footnotesuperscript{406} Sinha, \textit{Radically Reimagining Forensic Science}, supra note 387 at 921.
\footnotesuperscript{407} Id. at 920–21.
\footnotesuperscript{408} Id. at 883.
\footnotesuperscript{409} Schwartz & Silverman, supra note 64, at 260 (“Whether an expert should be permitted to testify is both a complex and vital issue. It is easily outcome determinative[,]”); Stephen D. Easton, “Yer Outta Here!” A Framework for Analyzing the Potential Exclusion of Expert Testimony Under the Federal Rules of Evidence, 32 U. Richmond L. Rev. 1, 5–6 (1998) (“Quite a bit is at stake when judges contemplate whether to allow or exclude expert testimony . . . [A] party often has little chance of success without it.”).
\footnotesuperscript{410} Easton, supra note 409, at 7.
\end{flushright}
once it is introduced to jurors.\textsuperscript{411} Despite \textit{Daubert}'s invocation of the "crucible of courtroom cross examination,"\textsuperscript{412} studies indicate that cross-examination is a poor engine of truth for scientific and technical evidence.\textsuperscript{413} For example, a recent study found that even scientifically strong cross-examinations often evade jurors' comprehension and are thus unlikely to convince them that plainly faulty evidence is unreliable.\textsuperscript{414} Even unsuccessful \textit{Daubert} challenges against TrueAllele can shield attorneys from ineffective assistance of counsel claims\textsuperscript{415} and preserve the issue for appeal.\textsuperscript{416} Each of these premises helps justify the resource-intensive process inherent to understanding (let alone challenging) a proprietary algorithm like TrueAllele.\textsuperscript{417}


\textsuperscript{412} Neufeld, supra note 65, at S109.


\textsuperscript{414} See \textit{id.} at 3 (analyzing an empirical study using mock jurors to find “jurors were largely insensitive to variations in scientific quality [of evidence]. A scientifically informed cross-examination did not improve juror’s sensitivity.”).


\textsuperscript{416} Schwartz & Silverman, \textit{supra} note 64, at 263.

\textsuperscript{417} Cicchini, \textit{Daubert Strategies for the Criminal Defense Bar, supra} note 414, at 100; Schwartz & Silverman, \textit{supra} note 64, at 262.
[95] Not all cases involving TrueAllele evidence will be ripe for *Daubert* challenges: when the defense attorney anticipates a case will resolve short of trial or will ultimately not turn on DNA evidence, she may rightly decline to spend her limited resources opposing scientific evidence pretrial. But in cases where defenders have already determined that TrueAllele evidence is worth challenging, TrueAllele’s demonstrated inability to meet the *Daubert* standard requires that attorneys craft a careful challenge rather than shy away from the subject’s complexity. Considerable evidence demonstrates that defense attorneys are often reluctant to challenge complex scientific evidence, and they generally avoid topics related to math and science. However, defense attorneys who fail to bring robust *Daubert* challenges against TrueAllele for such reasons do so at the peril of their clients.

[96] A properly formatted challenge to TrueAllele under *Daubert* could also present collateral benefits to the criminally accused in general.

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418 Id.

419 Neufeld, *supra* note 65, at S109 (“[D]espite the frequency with which scientific and expert testimony is proffered in criminal cases, there is a dearth of *Daubert* challenges and hearings.”); see Loudon-Brown, *supra* note 415, at 894 (stating that sophisticated-sounding scientific evidence can be “daunting for a defense attorney to confront, particularly one faced with a crushing caseload. It can be tempting to avoid a challenge to a vulnerable forensic science discipline—be it new, novel, or simply recently called into question—when the lawyer reasonably believes that the evidence will be admitted regardless. Worse still, it may seem reasonable to disregard any adversarial challenge to incriminatory science altogether, and to opt instead for a different defense or to encourage a guilty plea. With hundreds of other clients to assist, why invest the time and resources needed to comprehend a new scientific technique sufficiently to cross-examine an expert who has dedicated his or her career to learning the field? . . . Defense challenges to forensics evidence, therefore, are often inconsequential at best or incompetent at worst.”) (citations omitted); *Daubert Advisory Committee Conference, supra* note 163, at 1260.

420 See generally Peter Lee, *Patent Law and the Two Cultures*, 120 YALE L. J. 1, 4, 9, 10 (“As a general matter, lawyers and science don’t mix.”) (“The intersection of law and science is fraught with anxiety.”) (“fewer than ten percent of law students have undergraduate degrees in math, science, or engineering”).
Jurisprudence surrounding TrueAllele is still nascent due to the technology’s relative novelty and admissibility history in only 15 states. Early admissibility decisions under Daubert may carry substantial weight and are likely to influence the decisions that follow. Indeed, the algorithm’s limited use compared to traditional DNA testing methods means that courts could be more likely to consider persuasive authority from other jurisdictions when ruling on TrueAllele issues. Daubert challenges even in lower courts may thus enjoy a broader than usual reach across jurisdictions. If courts tend to determine a technology’s admissibility based on precedent admitting it, so too might they begin to do so based on precedent excluding it. As Katie Kronick argues, judicial peer pressure is such a large factor in admissibility issues that a single judge can shift the tide.

And yet, as discussed above, Daubert has historically failed to stem the flow of junk science into criminal courts. Where do Daubert challenges brought by defense attorneys in individual cases fit into the broader scheme of reform surrounding the admissibility of forensic algorithms? Situating TrueAllele challenges amidst the grim history of attempted forensic reforms can help illustrate.

In 2007, Erin Murphy cataloged various legal and political reforms scholars claimed could improve the quality of scientific evidence in courts: more court-appointed experts; a “complexity exception” for the right to jury trials; increased funding for defense experts; increased attorney training; specialized courts, judges, or juries; and overhauling of the forensic

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421 TrueAllele Admissibility, supra note 201.

422 Moss, supra note 411, at 1070.

423 Kronick, supra note 175, at 642 (“[O]nce a single court deviates from the norm, more will follow. The early challengers to conformity serve as anchors, and other judges can then issue their decisions knowing they are not standing alone.”).

424 Kaplan & Puracal, supra note 15, at 899.
laboratory system. Murphy also included two tactics this Article endorses: more extensive pretrial hearings and more rigorous application of the Frye and Daubert standards. Such reforms would naturally address forensic algorithms like TrueAllele. Murphy concluded:

   Each of these recommendations has its own merits, and if implemented could dramatically improve the quality of scientific evidence in the criminal justice system. Yet they do not address, much less rectify, the particular economy of the criminal justice system, which perpetuates the introduction of faulty forensic science evidence. Instead, the conventional fixes rely upon an outdated view of the nature of forensic evidence, where case-specific review plausibly suffices to ensure the quality of evidence.

[99] In the nearly two decades since the publication of Murphy’s article, some of the potential forensic reforms she found lacking in 2007 have come to fruition, while numerous reports have detailed the continued failings of both first and second generation forensics. True to Murphy’s prediction, most forensic science reforms seem to perpetuate rather than extinguish the introduction of faulty forensic science in criminal courts. In 2022, Maneka Sinha concluded, “even after waves of attempted reforms,

425 Murphy, The New Forensics, supra note 78, at 753, 776–78.

426 See generally id. (discussing the importance of the quality of evidence).

427 See Part II.B. Murphy distinguishes “second generation” forensics as distinct from traditional, first generation forensic disciplines for their technical complexity, widespread use, and implication of private and proprietary information. Id. at 776.

428 Sinha, Radically Reimagining Forensic Science, supra note 387, at 951. See generally PCAST Report, supra note 9 (discussing problems plaguing the forensic sciences); NIST Report, supra note 39 (describing improvements in DNA testing methods); NAS REPORT, supra note 67 (noting the failures of existing agencies in handling the forensic sciences and efforts to strengthen).

429 Murphy, The New Forensics, supra note 78, at 776.
questions about the reliability and validity of forensic methods persist.”

Sinha summarizes:

> [O]ver many years, many varied conventional reform efforts have failed or faltered in improving the forensic system or its enablement of carceral harm. It is not clear that adherence to existing models will succeed any more in the future than they have in the past. Instead, allegiance of existing approaches to reform, though well-intentioned, may reflect an inability to break the mold of dominant thinking.

[100] In response, Sinha offers an abolition-based framework for re-imagining the forensic system entirely. Sinha’s proposed framework requires screening potential reforms, approaching the project “[a]s abolitionists who recognize the unlikelihood of immediate eradication of current carceral structure[.]”

[101] Sinha’s underlying motivations have broader appeal. Whether you believe the label of science is “used as a fig leaf to legitimize prosecutions rather than advance justice” or have simply determined that “[a]nything short of [a] rigorous and consequence-laden analysis . . . will result in an expert-driven mockery of the truth-seeking process,” there is no reason to believe that the factors allowing faulty science to convict poor defendants

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430 Sinha, Radically Reimagining Forensic Science, supra note 387, at 884.

431 Id. at 955.

432 Id. at 938–43 (proposing a three-pronged framework for considering forensic reforms: (1) how well a proposal adheres to core principles of abolition; (2) the purpose for which the forensic method at issue is used; and (3) who uses the method).

433 Id. at 940.

434 Id. at 956.

435 Easton, supra note 409, at 60.
in criminal courts will simultaneously cease tomorrow. Accordingly, attorneys who represent defendants facing questionable scientific methodologies today remain obligated to use the tactics currently at their disposal. Pretrial Daubert challenges are one such tactic in a broader strategy, including techniques beyond the scope of this Article, such as applied challenges, scientifically intelligent cross-examinations, and rigorously applying the due process standard at sentencing. While narrower in scope than the reform framework Sinha suggests, Daubert challenges remain indispensable for individual clients facing technologies like TrueAllele.

CONCLUSION

[102] The Daubert-Rochkind factors strongly indicate that TrueAllele has not proven its reliability to the extent necessary for admission into a court of law. If we must concede TrueAllele exceeds the legitimacy of the Edison (Theranos’s illustrative black box), it does so only because the Edison offered no evidence of its function—biased or otherwise. It is still not admissible without sufficient proof of reliability. “[T]he court room

436 See Chorn & Kovera, supra note 413, at 5.

437 See Sinha, Junk Science at Sentencing, supra note 57, at 81 (describing the minimal admissibility protections for scientific evidence at the sentencing stage and arguing Rule 702 should apply to post-trial proceedings).


439 See supra Part III.A–F.


441 Moss, supra note 411, at 1074–75.
is not the place for scientific guesswork, even of the inspired sort. Law lags
science; it does not lead it.”

[103] While Daubert-Rochkind currently poses a barrier for TrueAllele, it
also holds the key: the peer review factor could favor TrueAllele if
Cybergenetics was willing to subject their technology to independent
reviewers, not including the developers, who conducted empirical testing
with concurrent source code access and reported favorably. TrueAllele
could pass the testability factor by making its source code transparent to
independent testers, even if under protective orders that both assuage
Cybergenetics’ trade secrecy concerns and permit reliability testing. Cybergenetics could satisfy the error rate factor, which hinges on the known
ground truth empirical testing, by conducting more validation tests with
expanded and fully disclosed factor space coverage. TrueAllele’s
development trajectory cannot change, but testimony from experts other
than Perlin combined with the above-mentioned independent evaluations
could help counteract the technology’s legacy.

[104] But unless or until TrueAllele makes changes to demonstrate its
reliability under Daubert, courts must bar TrueAllele for fear of inviting
“subjective speculation, masquerading as science[.]” Under Daubert’s
reliability standard, the judge’s gatekeeping role “inevitably on occasion
will prevent the jury from learning of authentic insights and innovations.”
The legacy of junk science in law indicates that courts too often choose

442 Rosen v. Ciba-Geigy Corp., 78 F.3d 316, 319 (7th Cir. 1996).
443 See supra Part III.A.
444 See supra Part III.B.
445 See supra Part III.C.
446 See supra Part III.D.
447 FABRICANT, supra note 14, at 24–25.
insight and innovation and end up using “science” to legitimize prosecutions rather than advance justice. As many highly particular questions as TrueAllele poses, it is also far from unique in one critical respect: every day, new algorithms enter court rooms and threaten to strip defendants of their liberty and dignity. Carefully argued *Daubert* challenges can force courts to re-examine old assumptions and rigorously evaluate these high stakes technologies—beginning with barring TrueAllele.

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