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.[1] 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.[2] The Edison purportedly represented "a Holy Grail in the field of microfluidics."[3] Theranos was going to revolutionize healthcare and change the world. Instead, Holmes is serving a prison sentence for conspiracy and fraud.[4] 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"

[1] *See* Press Release, Securities and Exchange Commission, Theranos, CEO Holmes, and Former President Balwani Charged with Massive Fraud (Mar. 14, 2018), https://www.sec.gov/news/press-release/2018-41 [perma.cc/AH7G-C6UB].

[2] Rachel Kraus, *Theranos screwed up legit blood test innovations for everybody*, MASHABLE (Mar. 20, 2019), https://mashable.com/article/hbo-theranos-elizabeth-holmes-documentary-edison-failures [https://perma.cc/N9U7-XB33]

[3] JOHN CARREYROU, BAD BLOOD: SECRETS AND LIES IN A SILICON VALLEY STARTUP 286 (2018).

[4] Erin Griffith, *Elizabeth Holmes Is Sentenced to More Than 11 Years for Fraud*, N.Y. TIMES (Nov. 18, 2022), https://www.nytimes.com/2022/11/18/technology/elizabeth-holmes-sentence-theranos.html [perma.cc/JA4X-9AK7].

considerations.[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.[6] TrueAllele falls into a relatively new category of software systems known as probabilistic genotyping software (PGS).[7] PGS systems interpret DNA samples too old, trace, or complex to parse with traditional DNA technology.[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.[9] Even so, TrueAllele has never undergone peer review or validation testing independent of its developers.[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.[11]

[5] CARREYROU, *supra* note 3, at 252–53.

[6] *Casework,* CYBERGENETICS, https://www.cybgen.com/products/casework/ [perma.cc/F4B7-5CED] (last visited Oct. 24, 2023).

[7] *Id.*

[8] *See* Michael D. Coble & Jo-Anne Bright, *Probabilistic Genotyping Software: An Overview,* 38 FORENSIC SCI. INT'L: GENETICS 219, 221 (2019).

[9] PRESIDENT'S COUNCIL OF ADVISORS ON SCI. AND TECH., FORENSIC SCI. IN CRIM. CTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS (2016) [hereinafter PCAST Report]; *Casework, supra* note 6.

[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.

[11] People v. Wakefield, 107 N.Y.S.3d 487, 495–96 (2019).

[3] 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.[12] Commentators blamed Silicon Valley's "move fast and break things" investment ethos for enabling Theranos's deceit,[13] but for antithetical reasons, the U.S. legal system is also vulnerable to admitting shoddy, trade-secret-guarded science at staggering costs.[14] 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.[15] Court rooms, particularly in criminal law, are thus rife with unsupported "junk science" technologies as fallacious as the Edison.[16] 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).

[13] Elizabeth Ruzzo, *8 reasons 'move fast and break things' doesn't work for health care companies*, STAT (Dec. 17, 2021), https://www.statnews.com/2021/12/17/8-reasons-move-fast-break-things-doesnt-work-for-health-care-companies/ [perma.cc/GRQ8-HX2D].

[14] *See, e.g.*, Jim Hilbert, *The Disappointing History of Science in the Courtroom,* 71 OKLA. L. REV. 759, 812 (2019) (describing the role of precedent in preserving scientifically baseless bite mark evidence in courts); Paul C. Giannelli, *Forensic Science:* Daubert*'s Failure,* 68 CASE W. RSRV. L. REV. 869 *passim* (2018) [hereinafter Giannelli, Daubert*'s Failure*] (listing various methodologies long considered admissible before being demonstrated unreliable). *See generally* M. CHRIS FABRICANT, JUNK SCIENCE AND THE AMERICAN CRIMINAL JUSTICE SYSTEM (2022) (detailing the history and notable examples of unreliable science in American courts).

[15] James Clayton, *Elizabeth Holmes: Has the Theranos scandal changed Silicon Valley?,* BBC (Jan. 3, 2022), https://www.bbc.com/news/technology-58469882 [perma.cc/C9ER-MUKA] (describing an investment system based on trust); *Understanding Stare Decisis,* ABA (Dec. 16, 2022), https://www.americanbar.org/groups/public_education/publications/preview_home/understand-stare-decisis/ [perma.cc/7HAP-5H73] (defining *stare decisis* and its implications); Aliza B. Kaplan & Janis C. Puracal, *It's Not a Match: Why the Law Can't Let Go of Junk Science,* 81 ALB. L. REV. 895, 898 (2018) (explaining how precedent enshrines unreliable science).

[16] *See, e.g.*, Giannelli, Daubert*'s Failure*, *supra* note 14, *passim*.

[4] 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[17] 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.[18] *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.[19] 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.

[5] 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

[17] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593–94 (1993) (establishing the "*Daubert* standard" for admissibility of expert evidence). *See also infra* notes 131–39 and accompanying text.

[18] *See infra* Part II.D.

[19] *See infra* Part III.D.

convictions.[20]

[6] Part II describes the legal standard for scientific evidence and expert testimony, and how TrueAllele has historically fared under them.[21] 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.[22] 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.[23] Finally, it describes TrueAllele's prior admissibility history under *Daubert* and other standards in both state and federal courts.[24] While extensive scholarship illustrates the prevalence of unreliable "junk science" amidst what Erin Murphy calls traditional, "first generation" forensic technologies,[25] 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.[26]

[7] 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.[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;[28] second, because Maryland is one of only two states known to this author where judges have excluded TrueAllele evidence at any level;[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,[30] analysis under Maryland law is relevant to the supermajority of states who apply even just the original *Daubert* factors.[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,[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

[27] *See infra* Part III.

[28] Rochkind v. Stevenson, 471 Md. 1, 1 (2020); *see infra* Part III.B.

[29] *See infra* Part II.D.

[30] *See infra* Part II.B, examining TrueAllele's failure to satisfy six out of the ten *Daubert-Rochkind* factors.

[31] *See infra* Part III.C.

[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

[33] Jaya Lakshmi Bukyya et al., *DNA Profiling in Forensic Science: A Review*, 4 GLOB. MED. GENETICS 135, 135–36 (2021).

[34] *Id.* at 135.

[35] *Id.* at 136.

[36] *Id.* at 136.

[37] Maryland v. King, 569 U.S. 435, 435 (2013); George M. Dery III, *Can a Distant Relative Allow the Government to Access Your DNA?*, 10 HASTINGS SCI. TECH. L. J. 103, 139 (2019); Francesco Sessa et al., *Touch DNA,* 9 SCI. REP. 1, 1 (2019).

replication process.[38] 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."[39] 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.[40] Each locus contains two "alleles," which are variations of the DNA inherited from each parent.[41] The most common form of DNA analysis examines loci with alleles composed of repeating groups of base pairs known as "short tandem repeat" markers.[42] 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.[43] 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.[44]

[38] ROYAL SOC'Y OF EDINBURGH, FORENSIC DNA ANALYSIS: A PRIMER FOR COURTS 10, 10 (2017).

[39] *Id.*; *see* JOHN M. BUTLER ET AL., NAT'L INST. STANDARDS & TECH., NISITR 8351-DRAFT, DNA MIXTURE INTERPRETATION: A NIST SCIENTIFIC FOUNDATION REVIEW 21 (2021) [hereinafter NIST Report].

[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.

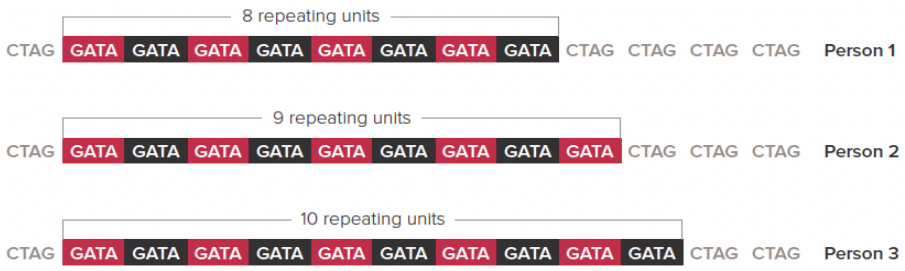
[41] NIST Report, *supra* note 39, at 9.

[42] ROYAL SOC'Y OF EDINBURGH, *supra* note 38, at 10.

[43] *Id.*

[44] *Id.* at 11.

STRs of different lengths of repeating units of four bases (represented by GATA) on a single strand of DNA from three different people at the same locus.



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[11] 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.*

[12] 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.[50] 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.[51] 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.[52] 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.[53] After a laboratory produces DNA profiles and compares them to suspects and/or CODIS, prosecutors and defense attorneys can use the results in court.[54]

B. What is Junk Science?

[13] 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."[55] DNA's broad utility beyond the justice

[50] *See id.* at 13.

[51] *Frequently Asked Questions on CODIS and NDIS*, FED. BUREAU OF INVESTIGATIONS, https://www.fbi.gov/how-we-can-help-you/dna-fingerprint-act-of-2005-expungement-policy/codis-and-ndis-fact-sheet [perma.cc/AJ5P-GW6A] (last visited Mar. 12, 2023).

[52] SARA DEBUS-SHERRILL & MICHAEL B. FIELD, NAT'L CRIMINAL JUSTICE REFERENCE SERV., UNDERSTANDING FAMILIAL DNA SEARCHING: POLICIES, PROCEDURES AND POTENTIAL IMPACT 1–2 (2017), https://www.ojp.gov/pdffiles1/nij/grants/251043.pdf [https://perma.cc/6XJR-P6XL].

[53] ROYAL SOC'Y OF EDINBURGH, *supra* note 38, at 13.

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

[55] Bess Stiffelman, *No Longer the Gold Standard: Probabilistic Genotyping is Changing the Nature of DNA Evidence in Criminal Trials*, 24 BERKELEY J. CRIM. L. 110, 111 (2019).

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.[56]

[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."[57] Junk science poses a special danger in court for two reasons: juries place great weight on scientific-sounding evidence,[58] 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."[59] The

[56] *See* FABRICANT, *supra* note 14, at 96–98.

[57] 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).

[58] Kaplan & Puracal, *supra* note 15, at 898; Andrea Roth, *Trial by Machine*, 104 GEO. L. J. 1245, 1250 (2016) (discussing American "instrument fetishism").

[59] *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).

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

[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.

[62] *See, e.g.,* FABRICANT, *supra* note 14. Chris Fabricant is the strategic litigation director for the Innocence Project, whose strategy includes exonerating individuals incarcerated based on junk science or misapplied forensic science, *see Our Team: M. Chris Fabricant*, INNOCENCE PROJECT, https://innocenceproject.org/team/m-chris-fabricant/ [perma.cc/JH8H-3H8H] (last visited Oct. 24, 2023). *See Misapplication of Forensic Science*, INNOCENCE PROJECT, https://innocenceproject.org/misapplication-of-forensic-science/ [perma.cc/X5NF-FBG3] (last visited Jun. 13, 2023); *see* sources cited *infra* note 65 for the division between admissibility in civil and criminal courts.

standards for scientific evidence.[63] For example, such standards have been used: in federal and state courts,[64] in criminal and civil courts,[65] against both

[63] 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).

[64] Victor E. Schwartz & Cary Silverman, *The Draining of* Daubert *and the Recidivism of Junk Science in Federal and State Courts*, 35 HOFSTRA L. REV. 217, 268–69 (2006).

[65] David L. Faigman, *Admissibility Regimes: The "Opinion Rule" and Other Oddities and Exceptions to Scientific Evidence, the Scientific Revolution, and Common Sense*, 36 SW. U. L. REV. 699, 716 (2008) ("While *Daubert* ostensibly applies in the same way in criminal and civil cases, social scientists have increasingly raised the issue whether courts, in fact, employ *Daubert* more lackadaisically in criminal trials—especially in regard to prosecution evidence"); Peter J. Neufeld, *The (Near) Irrelevance of* Daubert *to Criminal Justice and Some Suggestions for Reform*, 95 AMER. J. PUB. HEALTH S107, S109 (2005) ("[W]hereas civil defendants prevail in their *Daubert* challenges, most of the time criminal defendants almost always lose their challenges to government proffers"); Erica Beecher-Monas, *Reality Bites: The Illusion of Science in Bite-Mark Evidence*, 30 CARDOZO L. REV. 1369, 1370 (2009) ("[D]espite the common goal of accurate factfinding and the common threshold of relevance and reliability, judicial application of gate-keeping standards in civil and criminal trials could not be more different"); Paul C. Giannelli, *The Supreme Court's "Criminal"* Daubert *Cases*, 33 SETON HALL L. REV. 1071, 1111 (2003) [hereinafter Giannelli, *"Criminal"* Daubert *Cases*] (*"Daubert* has evolved into a stringent standard in civil cases. Paradoxically, and perhaps shamefully, this standard has not been consistently imposed in criminal cases"); Erin Murphy, *Neuroscience and the Civil/Criminal* Daubert *Divide,* 85 FORDHAM L. REV. 619, 619 (2016) ("History suggests that, when it comes to proffers of scientific evidence, civil and criminal proceedings are not in fact created equal."); *see also* Giannelli*,* Daubert*'s Failure*, *supra* note 14, at 873 (explaining courts apply 'Daubert-lite' in the criminal context); Jessica G. Cino, *An Uncivil Action: Criminalizing* Daubert *in Procedure and Practice to Avoid Wrongful Convictions*, 119 W. VA. L. REV. 651, 685–86 (2016) (noting judges more frequently admit expert testimony in civil than criminal cases). *Cf.* Seaman, *supra* note 63, at 897–912 (explaining the difficulties in comparing civil and criminal standards due to differences between type of evidence offered, while nonetheless examining types of arson and handwriting testimony offered across both civil and criminal practice to illustrate the divide).

civil plaintiffs and defendants,[66] and against the State and criminal defendants.[67]

[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."[68] 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.

cases.[69] 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.[70] 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.[71] Over the same period, defense counsel did not win a single *Daubert* decision at any level.[72] 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.[73]

[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

[69] *See* Seaman, *supra* note 63, at 894, 896 ("[I]n civil cases, courts seem quite up to the task of evaluating microbiology, teratology, and toxicology evidence . . . Yet when it comes to evaluating the shortcomings of lip prints and handwriting, courts are unable to muster the most minimal grasp of why a standardless form of comparison might lack evidentiary reliability or trustworthiness."); Giannelli, *"Criminal"* Daubert *Cases*, *supra* note 65, at 1073–74 (noting "[i]t is difficult to imagine a federal court in a toxic tort case that would allow a plaintiff's attorney to admit evidence that passed for "science" in a recent fingerprint case . . . How can federal courts demand stringent epidemiological studies in toxic tort cases and then accept such vacuous reasoning in criminal cases?").

[70] *See* Faigman, *supra* note 65, at 716.

[71] *See* Cicchini, *The* Daubert *Double Standard*, *supra* note 67.

[72] *Id.*

[73] *Id.*; *see also* Seaman, *supra* note 63, at 892–93.

government's favor against an indigent person of color."[74] And yet, junk science routinely appears in criminal courts today.[75] 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.[76] 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

[74] FABRICANT, *supra* note 14, at 5, 19. While Fabricant writes based on personal experience, the over-representation of people who are poor and/or a racial minority in the criminal system is well-established: "[r]oughly four out of five criminal defendants are too poor to hire a lawyer and use public defenders or court-appointed lawyers," Richard A. Oppel Jr. & Jugal K. Patel, *One Lawyer, 194 Felony Cases, and No Time*, N.Y. TIMES (Jan. 31, 2019), https://www.nytimes.com/interactive/2019/01/31/us/public-defender-case-loads.html [perma.cc/ZF5D-KHK8]. Black Americans are incarcerated in state prisons across the country at nearly five times the rate of white Americans, and Latinx people are 1.3 times as likely to be incarcerated than non-Latinx white Americans, ASHLEY NELLIS, SENT'G PROJECT, THE COLOR OF JUSTICE: RACIAL AND ETHNIC DISPARITY IN STATE PRISONS 6 (2021). Fabricant also calls forensic science used in criminal cases "poor people science" in recognition of the criminal system's failure to identify unreliable "science" compared to civil law, where more money is at stake, M. Chris Fabricant, *On Junk Science and Poverty,* CRIME READS (Apr. 8, 2022), https://crimereads.com/on-junk-science-and-poverty/ [perma.cc/M6D5-DSNK].

[75] *See generally* Paul C. Giannelli, *Forensic Science: Under the Microscope*, 34 OHIO N.U. L. REV. 315 (2008) [hereinafter Giannelli, *Under the Microscope*] (summarizing methodologies found unreliable under *Daubert*, like bite marks, handwriting, and ballistics).

[76] *See generally* Paul C. Giannelli, *Comparative Bullet Lead Analysis: A Retrospective,* 47 CRIM. L. BULL. 306, 306, 308 (2010) [hereinafter Giannelli, *Comparative Bullet Lead Analysis*] (surveying the downfall of comparative bullet lead analysis); Press Release, FBI, FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review (Apr. 20, 2015), https://www.fbi.gov/news/press-releases/fbi-testimony-on-microscopic-hair-analysis-contained-errors-in-at-least-90-percent-of-cases-in-ongoing-review [perma.cc/YGB9-HV9H] (explaining the FBI's acknowledgement that long-used hair microscopy methodologies are no longer considered valid); Selby, *supra* note 60 (discrediting bite mark evidence); Giannelli, Daubert*'s Failure, supra* note 14, at 889 (summarizing the history of arson investigation science).

traditional "pattern matching" disciplines, including latent fingerprint analysis, firearms analysis, footwear analysis, tire tracks, fiber evidence, document examination, and bloodstain patterns.[77]

[18] Erin Murphy classifies the discredited traditional forensic disciplines as "first generation" forensics.[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.[79] Many first generation forensic techniques, like fingerprinting or bullet groove analysis, are intuitively comprehensible by lay people.[80] In contrast, "second generation" forensic techniques appear in a wider range of cases.[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.[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.[83] Second generation techniques have

[77] NAS REPORT, *supra* note 67 (discussing latent fingerprint analysis, firearm analysis, footwear analysis, tire tracks, fiber evidence, document examination, and bloodstain patterns); PCAST REPORT, s*upra* note 9 (discussing latent fingerprint analysis, firearm analysis, footwear analysis, and document examination).

[78] Erin Murphy, *The New Forensics: Criminal Justice, False Certainty, and the Second Generation of Scientific Evidence*, 95 CAL. L. REV. 721, 726 (2007) [hereinafter Murphy, *The New Forensics*].

[79] *Id.* at 726–28.

[80] *Id.* at 726–27.

[81] *Id.* at 728.

[82] *Id.* at 729.

[83] Murphy*, The New Forensics*, *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.[84] For example, law enforcement officers use surveillance and investigative algorithms to detect individuals at risk of committing mass shootings,[85] detect and initiate responses to gunshots (and,

[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),[86] obtain information from cell phones by mimicking cell towers,[87] remotely scan individual's hard drives for illicit material,[88] and recognize faces.[89] Predictive policing algorithms claim to

[86] *See generally* SOUNDTHINKING, https://www.soundthinking.com/ [perma.cc/R8ET-6BKW] (last visited Nov. 3, 2023). ShotSpotter, recently re-branded as SoundThinking, brands itself as "a public safety technology company that combines transformative solutions and strategic advisory services for sound decision," *id.* The technology has come under intense criticism for its opaque methodology and contribution to over-policing communities of color, *see* Maneka Sinha, *The Dangers of Automated Gunshot Detection*, 5 J. L. & INNOVATION 63, 63–68 (2023) (arguing "ShotSpotter . . . erodes seizure and search protections" and "exacerbates [law enforcement] abuses that have become the unfortunate hallmark of *Terry* encounters"); *see also* Brendan Max, *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 ShotSpotter should play no role in the criminal system due to its flawed testing process and unreliable performance). In at least one Florida case, SoundThinking recordings of conversations have been used as criminal evidence, Brian Fraga, *ShotSpotter recording of street argument raises potential privacy issues*, SOUTH COAST TODAY, https://www.southcoasttoday.com/story/news/crime/2012/01/11/shotspotter-recording-street-argument-raises/49773221007/ [perma.cc/CSB5-B68V] (last updated Jan. 11, 2012, 7:20 AM).

[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, *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, *Stingray Technology, the Exclusionary Rule, and the Future of Privacy: A Cautionary Tale*, 119 W. VA. L. REV. 915, 916–19 (2017); *see also* Spencer McCandless, Note, *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").

[88] *See* Rebecca Wexler, *Life, Liberty, and Trade Secrets: Intellectual Property in the Criminal Justice System*, 70 STAN. L. REV. 1343, 1364–65 (2018) (summarizing privacy issues in *United States v. Ocasio*, where law enforcement accused a defendant of trafficking child pornography after remotely scanning files in his hard drive).

[89] GAO Forensics Report, *supra* note 84, at 3–4; Andrew Guthrie Ferguson, *Facial Recognition and the Fourth Amendment*, 105 MINN. L. REV. 1105, 1110–13 (2021).

predict crimes a week in advance[90] and estimate the chance that a child is at risk of death or abuse.[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.[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.[93]

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

[90] Matt Wood, *Algorithm predicts crime a week in advance, but reveals bias in police response*, UNIV. CHI.: BIOLOGICAL. SCIS. DIV. (June 30, 2022), https://biologicalsciences.uchicago.edu/news/algorithm-predicts-crime-police-bias [perma.cc/ER48-XELN].

[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).

[92] Berkman Klein Forensic Algorithms Report, *supra* note 84, at 13.

[93] *Id.* at 24–26.

[94] *See* GAO Forensics Report, *supra* note 84, at 5, 9–10.

[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., 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).

analysis.[96] 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

[96] *See, e.g.*, Jay Shendure & Hanlee Ji, *Next-Generation DNA Sequencing*, 26 NATURE BIOTECH. 1135, 1135–37 (2008) (discussing various second-generation advances in DNA analysis and sequencing).

[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.[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.[102] These are the types of samples PGS systems, including TrueAllele, were designed to manage.[103]

[22] TrueAllele "utilize[s] statistical genetics, biological models, computer algorithms, and probability distributions to infer possible genotypes and calculate LRs [('likelihood ratios')]."[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.[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.[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

[101] NIST Report, *supra* note 39, at 22.

[102] *See id.* at 23.

[103] *See* Coble & Bright, *supra* note 8, at 221.

[104] NIST Report, *supra* note 39, at 39.

[105] *Id.* at 36–37.

[106] *Id.* at 34–35.

> programs] are looking for names using the entire bag of Scrabble pieces.[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."[108] TrueAllele declined to substantively address PCAST's concerns when expressing a lack of confidence in many PGS promises based on inadequate empirical testing.[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 *People v. Wakefield* case, the company stated that its code is "protected as a trade secret and is only known by two individuals."[110] Accordingly, its disclosure history is dubious.[111]

II. ADMISSIBILITY STANDARDS FOR EXPERT TESTIMONY

A. The Evolution of *Frye* and *Daubert*

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

[107] BRANDON L. GARRETT, AUTOPSY OF A CRIME LAB: EXPOSING THE FLAWS IN FORENSICS 186 (2021).

[108] *Casework*, *supra* note 6.

[109] *See* PCAST, *An Addendum to the PCAST Report on Forensic Science in Criminal Courts* 8 (2017) [hereinafter PCAST Report Addendum]; Letter from Mark Perlin, Chief Sci. & Exec. Officer, Cybergenetics, to John Holdren, Assistant to the President for Sci. & Tech., PCAST (Sept. 16, 2016), https://www.cybgen.com/information/newsroom/2016/sep/files/letter.pdf [perma.cc/837R-AEM9].

[110] People v. Wakefield, 175 A.D.3d 158, 167 (N.Y. App. Div. 2019); *see infra* Part III.A (detailing Perlin's extensive involvement in TrueAllele's validation studies).

[111] *See infra* Part III.B.2.

predecessor *Frye*.[112] The D.C. Circuit Court established the *Frye* standard for expert testimony in 1923, when James Alphonzo Frye appealed his second-degree murder conviction.[113] 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."[114] 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.[115] 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."[116] Mr. Frye's conviction was upheld, and the *Frye* "general acceptance" standard emerged.[117]

[112] Some states automatically admit certain DNA evidence under local statutes, *see, e.g.,* MD. CODE ANN., CTS. & JUD. PROC. § 10-915 (West 2016); DEL. CODE ANN. tit. 11, § 3515 (West 2023); ALASKA STAT. ANN. § 12.45.035 (West 2023); MINN. STAT. § 634.25 (West 2023). In Maryland, DNA evidence admitted subject to CJP & 10-915 does not require a *Daubert* hearing, Phillips v. State, 126 A.3d 739, 742–43 (Md. Ct. Spec. App. 2015) (explaining failure to pass CJP § 10-915 entitles evidence to a *Frye-Reed* hearing). Whether TrueAllele qualifies for automatic admissibility under state statutes exceeds the scope of this paper.

[113] Frye v. State*,* 293 F. 1013 (D.C. Cir. 1923), *superseded by statute,* Fed. R. Evid. 702, *as recognized in* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 587 (1993).

[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.*

[26] Nearly every court in the country adopted the *Frye* standard over the next 50 years.[118] However, evidence law scholars complained that the standard was too permissive and relied too greatly on the adversarial process to weed out "unqualified science."[119] Contradictory *Frye* rulings in different jurisdictions affirmed their suspicions.[120] 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.*[121]

[27] Like *Frye, Daubert* implemented a new standard while precluding certain types of scientific evidence from the court room.[122] The *Daubert* plaintiffs were 19-year-old Jason Daubert, 12-year-old Eric Schuller, and their parents.[123] 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.[124] 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

[118] Reed v. State, 283 Md. 374, 379 (1978).

[119] Hilbert, *supra* note 14, at 772–73.

[120] *Id.*

[121] *Id.* at 774—75, 780.

[122] *See id.* at 770–71, 780.

[123] Natalie Angier, *High Court to Consider Rules On Use of Scientific Evidence*, N.Y. TIMES (Jan. 2, 1993), https://www.nytimes.com/1993/01/02/us/high-court-to-consider-rules-on-use-of-scientific-evidence.html [perma.cc/5FRL-WJTB]; *see also* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 579 (1993).

[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:[133]

1. Whether a theory or technique is scientific knowledge that can be (and has been) tested;[134]
2. Whether the theory or technique has been peer reviewed and/or published;[135]
3. A scientific technique's known or potential rate of error;[136]
4. The existence and maintenance of standards controlling the technique's operation;[137] and
5. The technique's degree of acceptance within a relevant scientific community.[138]

[29] The fifth factor, a technique's degree of acceptance, illustrates the *Daubert* standard's de facto incorporation of *Frye* pursuant to Rule 702.[139] 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.[140] Thus, *Daubert* permitted courts to continue considering general acceptance under Rule 702 as part of a broader

[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.

[142] Rochkind v. Stevenson, 236 A.3d 630, 633 (Ct. App. Md. 2020).

[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.[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.[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).[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.[151] *Rochkind* is an illustrative example of the approach taken by the nineteen other states

[148] J.L. Hill, *The States of* Daubert *after Florida*, LEXVISIO: THE EXPERT WITNESS NEWS, https://www.lexvisio.com/article/2019/07/09/the-states-of-daubert-after-florida [perma.cc/RV4C-X6PL] (last updated Aug. 7, 2023). For criminal cases, Washington, Pennsylvania, New York, and Illinois follow the *Frye* standard or a "*Frye* plus" standard; Virginia, South Carolina, North Dakota, and Nevada follow a unique local standard; the remainder follow *Daubert* or adopted *Daubert* in conjunction with a local standard and are described as "modified *Daubert*" or "*Daubert* plus" states, *id.*; GA. CODE. ANN. § 24-7-702 (West 2023) (describing Georgia's state's reliance on *Daubert* for expert testimony and expert qualifications standards); Rochkind v. Stevenson, 236 A.3d 630, 633 (Ct. App. Md. 2020) (abandoning the *Frye* standard in favor of the *Daubert* factors); *In re* Amends. to Fla. Evid. Code, 278 So.3d 551, 552 (2019) (adopting the *Daubert* standard).

[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).

[150] *See, e.g.*, Schwartz & Silverman, *supra* note 64, at 241; *Rochkind*, 236 A.3d at 650.

[151] *Rochkind*, 236 A.3d at 645.

who follow *Daubert* in conjunction with additional factors.[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.[153]

[33] Maryland's *Daubert-Rochkind* standard encompasses *Daubert* entirely.[154] The first five factors are adopted directly from *Daubert*.[155] The

[152] *See id.* at 650.

[153] *Id.*

[154] *Id.*

[155] *See* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593 (1993).

subsequent five factors are identical to those discussed in the 2000 Rules Committee Advisory Notes for Federal Rule 702.[156] As *Daubert* envisioned, the standard is a balancing test, and "no single factor is dispositive in the analysis."[157] *Daubert-Rochkind* is not exhaustive—rather, it is intended as a flexible starting point for considering expert testimony.[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."[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."[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*.[161]

C. Judicial Discretion and *Daubert* Hearings

[34] So, are judges obligated to hold *Daubert* hearings for forensic algorithms like TrueAllele?[162] *Daubert* puts forth "inconsistent messages"

[156] FED. R. EVID. 702 advisory committee's note to 2000 amendment.

[157] *Rochkind*, 236 A.3d at 651.

[158] *Id.* (citing Kumho Tire Co. v Carmichael*,* 119 S.Ct. 1167, 1171 (1999)).

[159] *Id.* (citing Savage v. State, 455 Md. 138, 184 (2017) (Adkins, J., concurring)).

[160] *Id.* at 652 (quoting United States v. Horn, 185 F.Supp.2d 530, 554 (2002)).

[161] *Id.*

[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.[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.[164] *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 *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."[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."[166] At the same time, *Daubert* rejected the common *Frye* practice of exempting non-novel techniques from admissibility inquiries.[167] *Daubert* explicitly stated that "[a]lthough the *Frye* decision itself focused exclusively on 'novel' scientific techniques, we do not read the requirements of Rule 702 to apply specially or exclusively

[163] *Advisory Committee on Evidence Rules: Conference on Best Practices for Managing* Daubert *Questions*, 88 FORDHAM L. REV. 1215, 1219 (2020) [hereinafter Daubert *Advisory Committee Conference*] (quoting professor Daniel J. Capra at a moderated panel held by Vanderbilt Law School).

[164] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 596 (1993).

[165] Kumho Tire Co. v. Carmichael, 526 U.S. 137, 139 (1999) (citing General Electric Co. v. Joiner, 522 U.S. 136, 143 (1997)).

[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).

[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)); *Kuhmo*, 526 U.S. at 152–53; *see also* Giannelli, *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

[168] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 592 n.11 (1993).

[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.[173] 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.[174] 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?"[175]

[38] Regardless of approach, judges in criminal courts frequently deny *Daubert* hearings for forensic science evidence.[176] The Defense Research Institute published a 1997 paper post-*Daubert* titled "Convincing a Reluctant Judge to Hold a Pretrial *Daubert* Hearing."[177] As the article explains, "some judges may be reluctant [to] hear these issues issue before

[173] Daubert *Advisory Committee Conference*, *supra* note 163, at 1222–226.

[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).

[176] *See* Kronick, *supra* note 175, at 593, 608; *See* Order Allowing Trueallele DNA Results, No. 18-9-4511-58, results at 2 (Cobb Cty. Sup. Ct. Dec. 30, 2021) (explaining that in at least two Georgia courts, judges have taken judicial notice as to the admissibility of TrueAllele results under the *Harper* standard for criminal evidence); *see also* Gregory W. Segal, *Clashing Standards in the Courtroom: Judicial Notice of Scientific Facts*, 51 COLUM. J. L. SOC. PROBS. 523 (2018); Christopher Onstott, *Judicial Notice and the Law's 'Scientific' Search for Truth*, 40 AKRON L. REV. 465, 466 (2007) (examining how judicial notice interacts with the *Daubert* standard).

[177] Thomas W. Lyons, *Convincing A Reluctant Judge to Hold A Pretrial* Daubert *Hearing,* STRAUSS, FACTOR, LAING & LYONS (July 4, 2019), https://www.sfandllaw.com/articles/convincing-a-reluctant-judge-to-hold-a-pretrial-daubert-hearing/ [https://perma.cc/J6FG-PQ5M] (reprinted with permission).

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

[39] Federal Rules of Evidence 103 and 104 also support the argument for a pretrial *Daubert* hearing.[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."[183] Rule 104(c) requires courts to hold a pretrial hearing when "justice so requires,"[184] thus creating an opportunity for attorneys seeking a *Daubert* hearing to argue that the interests of justice *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.[185]

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

[178] *Id.*

[179] *Id.*

[180] *See id.*

[181] *See id.*

[182] *See* Lyons, *supra* note 177.

[183] FED. R. EVID. 103(d).

[184] FED. R. EVID. 104(c)(3).

[185] *See id.* (citing the Advisory Committee's note to the 2011 amendment).

method for granted.[186] Under the *Frye-Reed* standard*, Clemons v. State* indicated a strong preference for pretrial hearings when handling expert testimony:

> Where evidence is subject to challenge under *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.[187]

[41] *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."[188] In *Savage v. State*, the Maryland Court of Appeals relied upon the *Clemons* court's preference for pretrial *Daubert* hearings when

[186] *See* Jodi V. Terranova, *Maryland Adopts* Daubert *Standard for Expert Testimony: Fallout from Jurisprudential Drift*, WILSON ELSER (Sept. 30, 2020), https://www.wilsonelser.com/publications/maryland-adopts-daubert-standard-for-expert-testimony-fallout-from-jurisprudential-drift [https://perma.cc/X5CL-YBM2].

[187] *See* Clemons v. State, 896 A.2d 1059, 1079 n. 6 (Ct. App. Md. 2006); *see also* 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 *Frye-Reed,* it is best practice for courts to address the issue pretrial).

[188] *See Clemons*, 896 A.2d at 1079; *see also* Giannelli, *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

[189] *See* Savage v. State, 455 Md. 138, 170–71, 180 (2017).

[190] *See* Thomas Kiley, Note, State v. Matthews*: Maryland Fails to Measure Up to its New Expert Testimony Standard*, 82 MD. L. REV. 1135, 1135, 1140, 1145–46 (2023).

[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

[196] Rochkind v. Stevenson, 236 A.3d 630, 652 (Ct. App. Md. 2020).

[197] *See Rochkind*, 236 A.3d at 632–33, 647, 652.

[198] *See* Montgomery Mut. Ins. Co. v. Chesson, 923 A.2d 939, 946–47 (2007); *see also* Savage v. State, 455 Md. 138, 171 (2017).

[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 . . .").

courts.[200] TrueAllele also appears most commonly in criminal cases.[201] Since most criminal prosecutions occur in state courts, admissibility issues generally arise in state rather than federal trial courts.[202] Most states, including Maryland, do not publish the majority of their intermediate or trial court decisions in reporters.[203] Consequently, Lexis and Westlaw do not carry most state trial decisions.[204]

[45] 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.[205]

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[200] FED. R. EVID. 702 advisory committee's note to 2000 amendment.

[201] *See TrueAllele® Admissibility*, CYBERGENETICS, https://www.cybgen.com/information/admissibility/page.shtml [https://perma.cc/DZ6B-9NX8] (last visited Nov. 7, 2023) (showing TrueAllele's tracking of its own admissibility in forty domestic and international criminal cases).

[202] *See Comparing Federal & State Courts*, U.S. COURTS, https://www.uscourts.gov/about-federal-courts/court-role-and-structure/comparing-federal-state-courts [https://perma.cc/PXF6-TK9C] (last visited Jan. 20, 2024).

[203] *See* MD. R. 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).

[204] *See State Trial Courts and Their Reporters*, DEPAUL U. COLL. L., https://libguides.depaul.edu/c.php?g=253629&p=1691145 [https://perma.cc/84K5-PMFM] (last updated Apr. 4, 2023, 4:09 PM).

[205] Emma Copley Eisenberg, *Public Records, Astronomical Price*, SLATE (Mar. 22, 2017, 10:34 AM), https://slate.com/news-and-politics/2017/03/outrageous-trial-transcript-fees-are-bad-for-defendants-journalists-and-democracy.html [https://perma.cc/Z5PH-FFXB] (explaining the economics around expensive court reports).

For instance, the trial transcript for *Georgia v. Gibbs,* including the *Daubert* hearing concerning TrueAllele, totals $1,646.10.[206]

[46] Given these difficulties, considering TrueAllele's admissibility history according to Cybergenetics, TrueAllele's developer, is helpful.[207] Cybergenetics hosts an "admissibility" page on its website cataloging 39 cases where TrueAllele faced an admissibility hearing in a U.S. court.[208] Cybergenetics does not claim the list is exhaustive (and as will later be discussed, it is not).[209] 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.[210]

[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.[211] Most admissibility challenges arose in state trial courts.[212] In federal trial courts, cases arose in

[206] 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).

[207] *See infra* Table 1 [hereinafter TrueAllele Admissibility Table] (referencing information gathered from *TrueAllele Admissibility*, *supra* note 201).

[208] *Id.*

[209] *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).

[210] *See id.*

[211] TrueAllele Admissibility Table, *supra* note 207.

[212] *Id.*

Pennsylvania, Louisiana, and Georgia.[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.[214] Out of the thirty-nine U.S. cases, only six trial court admissibility findings were affirmed by a higher court.[215] Intermediate appellate courts affirmed trial court admissibility findings in Florida (under *Frye*), Pennsylvania (under *Frye*), and Tennessee (under *Daubert*).[216] Ultimate courts similarly affirmed trial court admissibility findings in Nebraska (under *Daubert*), New York (under *Frye*), and Georgia (under its local standard, *Harper*).[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.[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.[219] In Georgia, all ten prior admissibility challenges allowed TrueAllele results pursuant to its local, now-overruled *Harper* standard.[220] Georgia abandoned the *Harper* standard

[213] *Id.*

[214] *Id.*

[215] *Id.*

[216] TrueAllele Admissibility Table, *supra* note 207.

[217] *Id.*

[218] *Id.*

[219] *Id.*

[220] *Id.*

in 2022 in favor of *Daubert*, and no Georgia state court has yet heard a TrueAllele challenge under *Daubert.*[221] 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.[222] 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.[223]

[49] 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.[224] 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.[225] However, through word of mouth, I discovered another case excluding TrueAllele results: in 2022, a Louisiana state trial court excluded the

[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).

[222] TrueAllele Admissibility Table, *supra* note 207; Rochkind v. Stevenson, 236 A.3d 630, 644 (Ct. App. Md. 2020).

[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

[226] Writ Granted in Part; Denied in Part; Stay Lifted, State v. Biscoe, No. 22-532, 2022 La. App. 5 Cir. WL 17075820, at *1–2 (Nov. 11, 2022).

[227] *Id.*

[228] TrueAllele Admissibility Table, *supra* note 207.

[229] *Id.*

[230] *Id.*

[231] *Id.*

[232] *See About the U.S. Court of Appeals*, U.S. COURTS, https://www.uscourts.gov/about-federal-courts/court-role-and-structure/about-us-courts-appeals [https://perma.cc/LEM9-4SAV] (last visited Nov. 7, 2023).

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.

[235] *See Publications*, CYBERGENETICS, https://www.cybgen.com/information/publication/page.shtml [https://perma.cc/CF8P-4XK5] (last visited Nov. 12, 2023).

[236] *See* Rochkind v. Stevenson, 236 A.3d 630, 652 (Ct. App. Md. 2020).

could thus carry strong precedential value.[237] 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.[238]

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.[239] *Daubert-Rochkind* considers "whether a theory or technique has been subjected to peer review and publication."[240] 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.[241]

[54] The TrueAllele validation studies frequently referenced in litigation are not properly peer reviewed because of Perlin's extensive involvement.[242] Perlin has authored nearly every study on TrueAllele since

[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 Cybergenetics 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.[243] 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."[244] Beyond PCAST, concern regarding conflicts of interest in scientific research is a widely held ethical consideration for most major research organizations.[245]

[55] Although Cybergenetics touts "over three dozen" TrueAllele validation studies, as of 2020, only eight were actually published in peer-reviewed journals.[246] 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."[247] NIST adopted even stronger language: "A study isn't complete until it's been published."[248]

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

[243] *See id.*; *see generally* Daniel P. Mooney, *The Rise of Probabilistic Genotyping Causing the Fall of DNA Evidence*, MD. STATE BAR ASS'N (Sept. 21, 2022), https://www.msba.org/the-rise-of-probabilistic-genotyping-causing-the-fall-of-dna-evidence/ [https://perma.cc/4VJS-VHXE].

[244] PCAST Report, *supra* note 9, at 79.

[245] *See, e.g., Conflicts of Interest*, RESPONSIBLE CONDUCT OF RESEARCH, https://ori.hhs.gov/education/products/columbia_wbt/index.html (last visited Nov. 3, 2023); *see also* David B. Resnik, *Conflicts of Interest in Scientific Research Related to Regulation or Litigation*, 7 J. PHIL. SCI. L. 1, 10 (2007).

[246] Mark Perlin, Chief Sci. and Exec., Cybergenetics, GAO Answers (Perlin) 2 (Mar. 11, 2020), https://www.cybgen.com/information/newsroom/2020/jun/GAO_Perlin.pdf [https://perma.cc/F3AB-JDWZ] [hereinafter GAO Answers].

[247] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593 (1993).

[248] NIST Report, *supra* note 39, at 15.

seven.[249] The sole published validation study not listing Perlin as an author instead thanked him for his "helpful comments and guidance."[250] 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.[251]

[57] Finally, the secrecy surrounding TrueAllele's source code draws its "peer-reviewed" articles into question regardless of Perlin's involvement.[252] *Daubert* focuses "solely on [the] principles and methodology [of technologies], not on the conclusions that they generate."[253] 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."[254] TrueAllele is exactly that type of proprietary algorithm.[255] Without subjecting the code to peer review, any external peer reviewer must base their conclusions on incomplete information.[256] Whether due to secret source code or Perlin's involvement, the dearth of legitimate peer-reviewed

[249] GAO Answers, *supra* note 246, at 3, 8.

[250] Susan A. Greenspoon et al., *Establishing the Limits of TrueAllele® Casework: A Validation Study*, 60 J. FORENSIC SCI. 1263, 1276 (2015).

[251] *See Meet the Founders*, CYBERGENETICS, https://www.cybgen.com/company/meet-the-founders/ [https://perma.cc/5KNB-BL97] (last visited Nov. 1, 2023).

[252] *See infra* Part III.B.

[253] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 595 (1993).

[254] FED. JUD. CTR., REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 787 (3rd ed. 2011).

[255] Eli Siems et al., *Trade Secrecy and Innovation in Forensic Technology*, 73 HASTINGS L. J. 773, 777 (2022).

[256] *See infra* Part III.B.

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] Until

[257] *See id.*

[258] FED. R. EVID. 702 (citing the Advisory Committee's note to 2000 Amendment).

[259] Christian Chessman, *A 'Source' of Error: Computer Code, Criminal Defendants, and the Constitution*, 105 CAL. L. REV. 179, 216–17 (2017); *see generally Free TrueAllele® screening of your DNA evidence data,* CYBERGENETICS, https://cybgen.com/support/free-screening/ [https://perma.cc/FR9V-G883] (last visited Nov. 3, 2023).

[260] *See* Chessman, *supra* note 259, at 217; *see also* Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593 (1993).

[261] *See TrueAllele® Transparency*, CYBERGENETICS, https://www.cybgen.com/support/transparency/ [https://perma.cc/7L4S-V4V9] (last visited Jan. 28. 2023); *TrueAllele® Source Code*, CYBERGENETICS, https://www.cybgen.com/information/sourcecode/page.shtml [https://perma.cc/HWE9-HJ8N] (last visited Jan. 27, 2023).

[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] Cybergenetics 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."[263] This option generates enough confidence for some.[264] However, the currently available testing without source code is not sufficient to satisfy *Daubert*.[265] From a software development perspective, "The only way to completely understand how—and whether—a program

[263] Katherine Kwong, *The Algorithm Says You Did It: The Use of Black Box Algorithms to Analyze Complex DNA Evidence*, 31 HARV. J. L. TECH. 275, 292 (2017); David Kravets, *Secret source code pronounces you guilty as charged*, ARS TECHNICA (Oct. 17, 2015, 8:00 AM), https://arstechnica.com/tech-policy/2015/10/secret-source-code-pronounces-you-guilty-as-charged/ [https://perma.cc/YWE3-BBBH] (quoting Perlin's endorsement of empirical testing and his statement that he himself does not examine source code to determine a DNA program's reliability).

[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").

[265] *See* Chessman, *supra* note 259, at 216–17.

works is by reading the program's source code."[266] Structural errors can hide in PGS source code and escape detection despite extensive empirical testing.[267] 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.[268] 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.[269]

[60] One forensic scholar compares learning about a software program by watching it run to learning about automobiles by watching a car drive.[270] 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 [https://perma.cc/69B6-HJMP] (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.

[268] *See, e.g.*, Statement Relating to STRmix™ Miscodes, STRMIX (Mar. 18, 2016), https://www.strmix.com/assets/STRmix/STRmix-PDFs/Statement-relating-to-STRmix-miscodes-180316.pdf [https://perma.cc/F6VJ-PMRN].

[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.[271] Chessman lists structural errors in software that only source code can reveal, including: accidental errors,[272] faulty software updates to legacy code,[273] inadvertent or intentional bias,[274] conditional processes that do not trigger as expected,[275] concurrent processes that interfere with one another,[276] flawed self-diagnostics tools,[277] and the ever-looming threat of "unknown unknowns."[278]

[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.[279] 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.

[279] *See generally MATLAB*, MATHWORKS, https://www.mathworks.com/products/matlab.html [https://perma.cc/73NC-ARVV] (last visited Feb. 23, 2023); People v. Wakefield, 175 A.D.3d 158, 172, 186 (N.Y. App. Div. 2019) (noting that Perlin claims TrueAllele's code is so long and complex that it would take a single person more than eight years to read it).

[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."[280] The same logic applies under *Daubert-Rochkind'*s testability factor.

[62] 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.[281] 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.[282] CheckFrequencyForRemoval operated in "ways users wouldn't necessarily be aware of."[283] Even more troubling, the function's methodology contradicted sworn testimony and peer-reviewed works on FST.[284] No amount of prior empirical testing had revealed the faulty function despite FST's application in over a thousand cases between 2011

[280] State v. Pickett, 466 N.J. Super. Ct. 270, 323–24 (2021).

[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).

[282] Jeanna Matthews et al., ASSOCIATION FOR COMPUTING MACHINERY, *The Right to Confront Your Accusers: Opening the Black Box of Forensic DNA Software*, Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society (2019).

[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.[285] 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."[286]

[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.[287] In 2015, an Australian laboratory discovered a miscode in STRmix that impacted its LRs.[288] The laboratory subsequently submitted updated LRs for twenty-three cases.[289] Although the media exaggerated the error, which STRmix described as minimal rather than outcome determinative, the incident offers a critical reminder that PGS

[285] Kirchner, *Thousands of Criminal Cases in New York*, *supra* note 269 (noting that ProRepublica successfully obtained and publicized the source code in 2017, prompting an independent study regarding the quantitative impact of the CheckFrequencyForRemoval function); *see ProPublica/NYC-DNA-Software*, GITHUB, https://github.com/propublica/nyc-dna-software [https://perma.cc/HNU6-YQ6M] (last visited Mar. 12, 2023).

[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).

[287] *Access to STRmix Software by Defence Legal Teams, supra* note 266; *Summary of miscodes,* STRMIX (May 23, 2018, 9:00 AM), https://strmix.com/news/summary-of-miscodes/?acceptCookies=63ea71f82a871 [https://perma.cc/X8XA-WKRN] (making mis-codes and fixes publicly available).

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

[289] Health Support Queensland, *RTI #3386 – STRmix Miscoding Error,* DEPT. HEALTH, https://www.health.qld.gov.au/__data/assets/pdf_file/0029/633368/dohdl1617012.pdf [https://perma.cc/469Q-2DVG] (last visited Mar. 12, 2023).

errors may impact LRs, which *can* be outcome determinative in court.[290] 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."[291]

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.[292] 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.[293] Cybergenetics' website now states that TrueAllele's source code is available to defense attorneys pursuant to judicial order,[294] but two past

[290] David Murray, *Queensland authorities confirm 'miscode' affects DNA evidence in criminal cases,* COURIER MAIL (Mar. 20, 2015, 10:00 PM), https://www.couriermail.com.au/news/queensland/queensland-authorities-confirm-miscode-affects-dna-evidence-in-criminal-cases/news-story/833c580d3f1c59039efd1a2ef55af92b [https://perma.cc/SAG2-QYRB] (sensationalizing the STRmix miscode).

[291] *Statement Relating to STRmix™ Miscodes, supra* note 268.

[292] Dean DeChiaro, *Convicted by software? Not so fast, says California lawmaker,* ROLL CALL (July 14, 2020, 6:00 AM), https://rollcall.com/2020/07/14/convicted-by-software-not-so-fast-says-california-lawmaker/ [https://perma.cc/WG2Q-2D7V].

[293] Wexler, *supra* note 88, at 1358–59; People v. Wakefield, 175 A.D.3d 158, 167 (N.Y. App. Div. 2019).

[294] TrueAllele Admissibility Table, *supra* note 207.

protective orders,[295] combined with the experience of defense experts,[296] 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.[297] 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.[298] 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.[299] 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.[300] Since testing source code printed on a piece of paper is impossible, the approved protective order offers only the illusion of expanded access.[301] Perlin might as well be offering to whisper the source

[295] Protective Order, Virginia v. Watson, 2021 Va. App. LEXIS 87 (2021) (No. FE-2019-279) [hereinafter *Watson* Disclosure Order], https://www.cybgen.com/information/sourcecode/Watson2020VAa.pdf [https://perma.cc/9438-KFDC]; Protective Order, New Jersey v. Pickett, 246 A.3d 279 (2021) (No. 17-07-470) [hereinafter *Pickett* Protective Order], https://www.cybgen.com/information/sourcecode/Pickett2021NJb.pdf [https://perma.cc/8CAK-H6NR].

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

[297] *Watson* Disclosure Order, *supra* note 295; *Pickett* Protective Order, *supra* note 295, at 15.

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

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

[300] *Id.*

[301] *See generally id.*

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.[302] 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.[303] 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.[304] Perlin has repeatedly denied defense teams use of this metaphorical magnet.[305]

[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."[306] While Perlin made *some* of TrueAllele's code available, he omitted portions of the source code,[307] including software "dependencies" TrueAllele relies upon to run,[308] "build instructions" that function like a blueprint for the

[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.*

[306] *Id.*; United States v. Ellis, No. 19-369 (W.D. Pa. Dec. 20, 2021) Special Master Hr'g Tr. 14 [hereinafter Ellis Special Master's Hearing I].

[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 omissions, 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]

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[309] *Id.* at 121.

[310] *Id.* at 83.

[311] *Id.*

[312] United States v. Ellis, No. 19-369 (W.D. Pa. Dec. 23, 2021) Special Master Hr'g Tr. 56, 73 [hereinafter Ellis Special Master's Hearing II].

[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.*

[69] 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.[318] 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

[70] TrueAllele also fails *Rochkind*'s analytical gap factor because Cybergenetics refuses to meaningfully release the source code.[319] *Rochkind* adopted *Daubert*'s consideration for "whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion"[320] upon recognizing Maryland's jurisprudential drift towards *Daubert*.[321] 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."[322]

[71] 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.[323] Although the Court found the neuropsychologist's qualification methodologies reliable, it held that "we are unable to conclude

[318] *Id.*

[319] *Id.*

[320] Rochkind v. Stevenson, 236 A.3d 630, 650 (Ct. App. Md. 2020).

[321] *Id.*

[322] Blackwell v. Wyeth, 971 A.2d 235, 253–55 (2009) (adopting Joiner's analytical gap analysis in General Electric Co. v. Joiner, 522 U.S. 136, 146 (1997)).

[323] Savage v. State, 166 A.3d 183, 202 (Md. 2017).

that [the expert] adequately 'connected the dots' between the empirical foundation…and [his] ultimate opinions."[324]

[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.[325] MCMC emerged during World War II and retains widespread scientific recognition for its use in a variety of fields.[326] TrueAllele employs MCMC methods to help factfinders determine issues far removed from mathematics, like whether someone is a killer, a rapist, or a thief.[327] 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.[328]

[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.[329] 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.*

[329] Harvey Brown & Melissa Davis, *Eight Gates for Expert Witnesses: Fifteen Years Later*, 52 HOUS. L. REV. 1, 267 n.1595 (2014).

empirical foundations and its results.[330] "[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."[331] 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."[332] Error rates as a concept are incompatible with the primary statistics generated by TrueAllele and other PGS: the likelihood ratio (LR).[333] 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.[334] 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.").

[331] General Electric v. Joiner, 522 U.S 136, 146 (1997).

[332] Rochkind v. Stevenson, 236 A.3d 630, 650 (Ct. App. Md. 2020).

[333] *See* Mark Perlin, *DNA Matters: How to Use the Likelihood Ratio*, FORENSIC MAG. (May 28, 2021), https://www.forensicmag.com/3425-Featured-Article-List/576342-How-to-Use-the-Likelihood-Ratio/ [https://perma.cc/CAS9-5QZH]; K. Slooten, *Likelihood Ratios and the (Ir)relevance of Error Rates*, 44 FORENSIC SCI. INT'L: GENETICS 1, 3 (2019), https://pubmed.ncbi.nlm.nih.gov/31670022/ [https://perma.cc/AM2Z-64U2] ("the concept of error does not apply to the likelihood ratio").

[334] NIST Report, *supra* note 39, at 4.

range.[335] Perlin also describes suspect testing practices to determine error rates for TrueAllele as a system.[336] 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

[75] TrueAllele has not demonstrated adequate empirical testing to measure the fitness of its LRs for use in casework.[337] Empirical testing means gathering information based on direct observation, and is also known as "ground truth" evidence.[338] 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.[339] 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.[340] 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."[341] 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.[342]

[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.[343] 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)."[344] For this reason, PCAST ultimately concluded that insufficient testing supported PGS system reliability when faced with more than three contributors.[345]

[77] NIST explored factor space coverage data newly available between 2016 and 2021.[346] Its conclusion? Little had changed.[347] 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

[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."[348] Likewise, "contributor genotypes or degree of allele sharing is rarely provided" for internal validation studies.[349]

[78] Perlin's comments offer little confidence that TrueAllele will face expanded empirical testing in the future.[350] 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."[351] 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.[352] 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.[353] 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.*[354] Perlin's conclusions lack sufficient factor space coverage and rely on crime scene rather than known ground truth samples.[355] As for evaluating the fitness of an LR, developing an error rate for a system requires empirical testing with known ground truth samples.[356] "Ground-truth requires knowing the correct answer before testing is performed and *therefore is not possible* with samples arising from crime-scene evidence."[357]

[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.[358] 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.[359]

[354] *See, e.g.*, State v. Simmer, 935 N.W.2d 167, 176 (Neb. 2019).

[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.

[81] 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.[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.[361] Through a combination of insufficient factor spread coverage, a disinterest in further empirical testing, and use of crime scene samples, *Daubert-Rochkind*'s error rate factor favors excluding TrueAllele.

E. TrueAllele's Failure Under the Development Purpose Factor

[82] *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.[362] Under this factor, both TrueAllele's development history and Perlin's interest in using DNA to serve law enforcement raise serious reliability concerns.[363]

[83] The development purposes factor considers "whether experts are proposing to testify about matters growing naturally and directly out of research they have conducted independent of the litigation, or whether they have developed their opinions expressly for purposes of testifying[.]"[364] As

[360] NIST Report, *supra* note 39, at 59.

[361] *Id.*

[362] Rochkind v. Stevenson, 236 A.3d 630, 650 (Ct. App. Md. 2020); Mooney, *supra* note 243, at 78–80.

[363] *See* Mooney, *supra* note 243, at 78–80; *see also* Mark Perlin, *Threshold,* SoundCloud (2011), https://soundcloud.com/markperlin/threshold [https://perma.cc/F2V5-R7LS] [hereinafter Perlin, *Threshold*].

[364] *Rochkind*, 236 A.3d at 650.

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[.]"[365]

[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.[366] TrueAllele's historical development suggests that Perlin shaped the growth of Cybergenetics specifically to develop opinions for criminal cases.[367] 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."[368] "Backlogs" are the accumulated DNA tests state and local forensic labs need to process for the purposes of litigation.[369] Today, the only fields Cybergenetics lists among its services are related to litigation and law enforcement: prosecution, defense, investigation, innocence, crime lab complementor,

[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] Mooney*, supra* note 243, at 78–80.

[367] *Id.*

[368] *History,* CYBERGENETICS, https://www.cybgen.com/company/history/ [https://perma.cc/XDW4-J2FW] (last visited Nov. 2, 2023).

[369] U.S. Dep't. Just. Off. Just. Programs, *OJP Fact Sheet: The DNA Backlog*, OPJ (Nov. 2011), https://www.ojp.gov/sites/g/files/xyckuh241/files/archives/factsheets/ojpfs_dnabacklog.html [https://perma.cc/PX2M-2WL8].

and retail theft.[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.[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.[372] Choice lyrics include:

> I rather would use TrueAllele®
> Interpret DNA for real
> Let the evidence reveal
> Thugs who slash and shoot and steal.[373]

And:

> Science should let numbers talk
> Not let perpetrators walk
> Who can count the victims lost

[370] *Services*, CYBERGENETICS, https://www.cybgen.com/services/ [https://perma.cc/QK3K-F29F] (last visited Nov. 2, 2023).

[371] Perlin, *Threshold*, *supra* note 363; *see also* Mark Perlin, Overcoming DNA Stochastic Effects Presentation at the Northeastern Ass'n of Forensic Sci. 2010 Annual Meeting (Nov. 10, 2010), https://www.cybgen.com/information/presentations/2010/NEAFS/Perlin_Overcoming_DNA_stochastic_effects/page.shtml [https://perma.cc/RKJ7-44FX].

[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.

[373] Perlin, *Threshold*, *supra* note 363; Consider: "Thug today is a nominally polite way of using the N-word." All Things Considered, *The Racially Charged Meaning Behind the Word 'Thug',* NPR (Apr. 30, 2015), https://www.npr.org/2015/04/30/403362626/the-racially-charged-meaning-behind-the-word-thug [https://perma.cc/473S-DUKQ].

To criminals who've not been caught.[374]

And finally:

Draw a threshold throw away
The evidence from DNA
Release a killer who should stay
In prison till his dying day.[375]

[86] 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.[376] Thus TrueAllele's *Daubert* inquiry cannot be divorced from Perlin's interest in using DNA for law enforcement and crime reduction.

F. TrueAllele's Failure Under the General Acceptance Factor

[87] When *Rochkind* adopted *Daubert*, Maryland rejected *Frye-Reed*'s general acceptance standard as an "imperfect proxy for reliability."[377] Under *Daubert-Rochkind,* "General acceptance remains an important consideration in the reliability analysis, but it cannot remain the *sole* consideration."[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

[374] Perlin, *Threshold*, *supra*, note 363.

[375] *Id.*

[376] Chessman, *supra* note 259, at 192 ("Inadvertent biases . . . are regular features of computer programs.").

[377] Rochkind v. Stevenson, 236 A.3d 630, 648–49 (Ct. App. Md. 2020).

[378] *Id.* at 647.

a judgment about it."[379] Courts decline to find general acceptance for scientific methodologies that are subject to "widespread disagreement" or a "genuine controversy."[380] 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.[381] As noted, today and at the time, Perlin claimed that TrueAllele could reliably evaluate samples far beyond these parameters.[382] PCAST also called for more studies, "*not associated with the software developers*" to investigate PGS reliability limits.[383]

[89] Five years later, NIST concluded that "publicly available information continues to lack sufficient details needed to independently assess reliability."[384] 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]."[385] While open to the possibility that further, publicized research could increase reliability evaluations, NIST concluded that current proficiency testing for

[379] Blackwell v. Wyeth, 408 Md. 575, 586 (Ct. App. Md. 2009).

[380] Wilson v. State, 370 Md. 191, 210–11 (Ct. App. Md. 2002).

[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 needs 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.*

[387] Maneka Sinha, *Radically Reimagining Forensic Science*, 73 ALA. L. REV. 879, 884 (2022).

[388] PCAST Report, *supra* note 9, at 2; Eric Lander et al., *PCAST Releases Report on Forensic Science in Criminal Courts*, OBAMA WHITE HOUSE (Sept. 20, 2016, 5:59 AM), https://obamawhitehouse.archives.gov/blog/2016/09/20/pcast-releases-report-forensic-science-criminal-courts [https://perma.cc/WT4G-XNSU].

[389] *About NIST*, NIST, https://www.nist.gov/about-nist [https://perma.cc/TV5V-U4Q4] (last updated Jan. 11, 2022).

[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.[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.[393] STRmix levied similar criticism towards the NIST report but increased its data transparency in response.[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."[395]

[92] Law enforcement agencies have similarly questioned the PCAST report.[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.[397] Lynch declined to recognize

[392] Institute of Environmental Science and Research Ltd., *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].

[393] John Buckleton, *Comments on the PCAST Report to the President* (Sept. 1, 2016), https://johnbuckleton.files.wordpress.com/2016/09/comments-on-the-pcast-report-to-the-president-forensic-science-in-criminal-courts-ii.pdf [https://perma.cc/59EC-Q7MJ]; Letter from Mark Perlin, *supra* note 109.

[394] Institute of Environmental Science and Research Ltd., *supra* note 392.

[395] *NIST launches wasteful study that undermines science and justice*, CYBERGENETICS (Oct. 5, 2017), https://www.cybgen.com/information/newsroom/2017/oct/NIST-launches-wasteful-study-that-undermines-science-and-justice.shtml [https://perma.cc/AZC4-H628].

[396] Gary Fields, *White House Advisory Council Report is Critical of Forensics Used in Criminal Trials,* WALL STREET J., https://www.wsj.com/articles/white-house-advisory-council-releases-report-critical-of-forensics-used-in-criminal-trials-1474394743 [https://perma.cc/5M7J-G5Y6] (last updated Sept. 20, 2016, 4:25 PM).

[397] *Id.*; Sinha, *Radically Reimagining Forensic Science*, *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."[398] Both the DOJ and its investigatory arm, the FBI, accused PCAST of ignoring "numerous published research studies."[399] However, when PCAST invited them to submit any disregarded papers, the DOJ conceded that it had "no additional studies for PCAST to consider."[400] 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.[401] He leveled no evidence for bias other than a consulting author's affiliation with the Innocence Project.[402]

[93] 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.[403] There is also reason to suspect bias from law enforcement and prosecution: TrueAllele, like most forensic disciplines, is primarily a carceral tool supporting law

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

[399] FBI, *Comments On: President's Council of Advisors on Science and Technology REPORT TO THE PRESIDENT,* FBI.GOV (Sept. 20, 2016), https://www.fbi.gov/file-repository/fbi-pcast-response.pdf/view [https://perma.cc/9FVM-QEEA]; Dep't of Just., *Justice Department Publishes Statement on 2016 President's Council of Advisors on Science and Technology Report,* JUSTICE.GOV (Jan. 13, 2021), https://www.justice.gov/opa/pr/justice-department-publishes-statement-2016-presidents-council-advisors-science-and [https://perma.cc/2KGY-2JRQ].

[400] PCAST Report Addendum, *supra* note 109, at 3.

[401] Letter from Michael A. Ramos, President, Nat'l Dist. Att'ys Ass'n, to President Barack Obama (Nov. 16, 2016), http://www.ciclt.net/ul/ndaajustice/PCAST/NDAA%20PCAST%20Response%20FINAL.pdf [https://perma.cc/EMN3-ANLU].

[402] *Id.*

[403] Wilson v. State, 370 Md. 191, 210–11 (Md. 2002).

enforcement.[404] Perlin once reported that only 10% of the cases he consulted on were for defense and the remaining 90% for prosecution.[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.[406] It is telling that PCAST remains uncontroversial among academics and scientists.[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.[408]

IV. CHALLENGING TRUEALLELE UNDER *DAUBERT* BENEFITS DEFENDANTS AND COMBATS JUNK SCIENCE

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

[404] Sinha, *Radically Reimagining Forensic Science*, *supra* note 387, at 887.

[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].

[406] Sinha, *Radically Reimagining Forensic Science*, *supra* note 387 at 921.

[407] *Id.* at 920–21.

[408] *Id.* at 883.

[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.").

[410] Easton, *supra* note 409, at 7.

once it is introduced to jurors.[411] Despite *Daubert*'s invocation of the "crucible of courtroom cross examination,"[412] studies indicate that cross-examination is a poor engine of truth for scientific and technical evidence.[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.[414] Even unsuccessful *Daubert* challenges against TrueAllele can shield attorneys from ineffective assistance of counsel claims[415] and preserve the issue for appeal.[416] Each of these premises helps justify the resource-intensive process inherent to understanding (let alone challenging) a proprietary algorithm like TrueAllele.[417]

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[411] David H. Kaye, *How* Daubert *and Its Progeny Have Failed Criminalistics Evidence and a Few Things the Judiciary Could Do About It*, 86 FORDHAM L. REV. 1639, 1651 (2018) (noting the "special rhetorical and persuasive power" of scientific evidence); Katherine L. Moss, *The Admissibility of TrueAllele: A Computerized DNA Interpretation System*, 72 WASH. & LEE L. REV. 1033, 1051–52 (2015) ("Persuasive statistics usually carry an immense weight with a jury.").

[412] Neufeld, *supra* note 65, at S109.

[413] Jacquelin Austin Chorn & Margaret Bull Kovera, *Variations in Reliability and Validity Do Not Influence Judge, Attorney, and Mock Juror Decisions About Psychological Expert Evidence*, 43 L. & HUM. BEHAV 1, 3–4.

[414] *See 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.").

[415] Michael D. Cicchini, Daubert *Strategies for the Criminal Defense Bar*, 2021 U. ILL. L. REV. 97, 100 (2021). *But see* Mark Loudon-Brown, *Garbage In, Garbage Out: Revising Strickland as Applied to Forensic Science Evidence*, 34 GA. ST. L. REV. 893, 895, 903, 909 (2018) (arguing the prejudice should be presumed under *Strickland*'s ineffective assistance of counsel standard when reviewing courts find an attorney performed deficiently to combat forensic science evidence).

[416] Schwartz & Silverman, *supra* note 64, at 263.

[417] Cicchini, *Daubert Strategies for the Criminal Defense Bar*, *supra* note 414, at 100; Schwartz & Silverman, *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.[418] Considerable evidence demonstrates that defense attorneys are often reluctant to challenge complex scientific evidence,[419] and they generally avoid topics related to math and science.[420] 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.

[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.[421] 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.[422] *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.[423]

[97] And yet, as discussed above, *Daubert* has historically failed to stem the flow of junk science into criminal courts.[424] 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.

[98] 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

[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.[425] Murphy also included two tactics this Article endorses: more extensive pretrial hearings and more rigorous application of the *Frye* and *Daubert* standards.[426] 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.[427]

[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.[428] True to Murphy's prediction, most forensic science reforms seem to perpetuate rather than extinguish the introduction of faulty forensic science in criminal courts.[429] 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."[430] 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.[431]

[100] In response, Sinha offers an abolition-based framework for re-imagining the forensic system entirely.[432] 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[.]"[433]

[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"[434] 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,"[435] there is no reason to believe that the factors allowing faulty science to convict poor defendants

[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,[436] and rigorously applying the due process standard at sentencing.[437] While narrower in scope than the reform framework Sinha suggests, *Daubert* challenges remain indispensable for individual clients facing technologies like TrueAllele.[438]

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.[439] 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.[440] It is *still* not admissible without sufficient proof of reliability.[441] "[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).

[438] *See* Ria David, *TrueAllele Casework ruled admissible in Ohio* Daubert *challenge*, BUSINESSWIRE (Oct. 22, 2014, 9:15 AM), https://www.businesswire.com/news/home/20141022005529/en/TrueAllele-Casework-ruled-admissible-in-Ohio-Daubert-challenge [https://perma.cc/9U9R-3Z9V].

[439] *See supra* Part III.A–F.

[440] *See* Cory Stieg, *What Exactly Was The Theranos Edison Machine Supposed To Do?*, REFINERY29 (Mar. 12, 2019 12:25 PM), https://www.refinery29.com/en-us/2019/03/224904/theranos-edison-machine-blood-test-technology-explained [https://perma.cc/N83G-Y2R3].

[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."[442]

[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.[443] 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.[444] 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.[445] 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.[446]

[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[.]"[447] Under *Daubert's* reliability standard, the judge's gatekeeping role "inevitably on occasion will prevent the jury from learning of authentic insights and innovations."[448] 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.

[448] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 597 (1993).

insight and innovation and end up using "science" to legitimize prosecutions rather than advance justice.[449] 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.

[449] Sinha, *Radically Reimagining Forensic Science*, *supra* note 387, at 956.

Table 1: TrueAllele's Admissibility in U.S. Courts						
	State	**Admitted?**	**System**	**Court**	**Standard**	**Year**
Georgia						
U.S. v. Gibbs	GA	Y	Federal	Northern District Trial Court	Daubert	2019
State v. Sewell	GA	Y	State	Floyd County Trial Court	Harper	2019
State v. Session	GA	Y	State	Cobb County Trial Court	Harper	2021
State v. Nundra	GA	Y	State	South Georgia Circuit Trial Court, aff'd by Georgia Supreme Court (Ultimate Court)	Harper	2019, 2023
State v. Garner	GA	Y	State	Western Judicial Circuit Trial Court	Harper	2021
State v. Day	GA	Y	State	Tifton Judicial Circuit Trial Court	Harper	2019
State v. Das	GA	Y	State	Western Judicial Circuit Trial Court	Harper	2021
State v. Byers	GA	Y	State	Dekalb County Trial Court	Harper	2022
State v. Baugh and Howell	GA	Y	State	Coweta County Trial Court	Harper	2019
State v. Battle	GA	Y	State	Ben Hill County Trial Court	Harper	2019
State v. Bah	GA	Y	State	Douglas Judicial Circuit Trial Court	Harper	2019
Louisiana						
State v. Chesterfield and Nicholas	LA	Y	State	East Baton Rouge Parish Trial Court	Daubert	2014
State v. Houston	LA	Y	State	Jefferson Parish Trial Court	Daubert	2017
State v. Russ	LA	Y	State	East Baton Rouge Parish Trial Court	Daubert	2019

U.S. v. Johnson	LA	Y	Federal	Eastern District Trial Court	Daubert	2021
State v. Lewis, Major, and Parker	LA	Y	State	Orleans Parish Trial Court	Daubert	2022
State v. Tabb	LA	Y	State	Fifth District Trial Court	Daubert	2022
State v. Dyson	LA	Y	State	Fifteenth Judicial District	Daubert	2023
Indiana						
State v. Wade	IN	Y	State	Monroe County Trial Court	Daubert	2016
State v. Forest	IN	Y	State	Vanderburgh County Trial Court	Daubert	2016
State v. Coalter	IN	Y	State	Perry County Trial Court	Daubert	2017
State v. Glazebrook	IN	Y	State	Monroe County Trial Court	Daubert	2018
Pennsylvania						
Commonwealth v. Foley	PA	Y	Cth.	Indiana County Trial Court, aff'd by Pennsylvania Superior Court (intermediate court)	Frye	2009
U.S. v Anderson	PA	Y	Federal	Middle District of Pennsylvania Federal Trial Court	Daubert	2023
Maryland						
State v. Jones	MD	N	State	Montgomery County Trial Court	Daubert	2021

State v. Harvin	MD	Y	State	Baltimore City Trial Court	Daubert	2021
New York						
People v. Wakefield	NY	Y	State	Schenectady County Trial Court, aff'd by NY Supreme Court (Ultimate Court)	Frye	2015, 2022
People v. Wilson	NY	Y	State	Chemung County Trial Court	Frye	2019
Nebraska						
State v. Simmer	NB	Y	State	Douglas County Trial Court, aff'd by Nebraska Supreme Court (Ultimate Court)	Daubert	2018, 2019
Massachusetts						
Commonwealth v. Bartlett	MA	Y	State	Plymouth County Trial Court	Daubert	2016
Florida						
State v. Daniels	FL	Y	State	Palm Beach County Trial Court, aff'd by Fourth District Court of Appeals (Intermediate Court)	Frye	2018, 2021
California						
People v. Langston	CA	Y	State	Kern County Trial Court	Kelly-Frye	2013
South Carolina						
State v. Aiken	SC	Y	State	Beaufort County Trial Court	Jones	2015
Tennessee						
State v. Watkins	TN	Y	State	Davidson County Trial Court, aff'd by Tennessee Court of Criminal	Daubert	2018, 2021

				Appeals at Nashville (Intermediate Court)		
State v. Powell	TN	Y	State	Stewart County Trial Court	Daubert	2021
Virginia						
Commonwealth v. Brady	VA	Y	Cth.	Colonial Heights County Trial Court	Spencer	2013
Ohio						
State v. Shaw	OH	Y	State	Cuyahoga County Trial Court	Daubert	2014
State v. Mathis	OH	Y	State	Cuyahoga County Trial Court	Daubert	2018
Washington						
Washington v. Fair	WA	Y	State	King County Trial Court	Frye	2017