EVIDENCE THEORY AND THE NAS REPORT ON FORENSIC SCIENCE

Michael S. Pardo*

INTRODUCTION

The report of the National Academy of Sciences on the current state of forensic science in the United States is a remarkable document.[1] In comprehensive detail, it exposes a number of troubling and sometimes scandalous problems with forensic science evidence. Some of these problems are economic: for example, many crime labs are severely underfunded and face large backlogs of cases.[2] Some of the problems are political: many forensic experts operate as an arm of law enforcement or the prosecution in a manner that creates potential biases and prejudices, rather than as independent scientists.[3] Some of the problems are legal: despite evidentiary rules that are meant to weed out expert testimony that has not been shown to be reliable, courts do not appear to be requiring that all forensic expertise meet this standard.[4] Finally, many of the problems are with the forensic science itself: with the exception of DNA evidence, there is a lack of peer-reviewed studies or other credible evidence establishing the scientific validity of most forensic science;[5] nor is there much evidence demonstrating exactly how reliable many forensic techniques are in practice.[6] And there is widespread divergence regarding the types of training, certification, and controls on the methodologies and protocols of those who process and testify about forensic-science evidence.[7] According to the NAS Report, the current state of forensic

---

* © 2010 Michael S. Pardo, Associate Professor, University of Alabama School of Law. My thanks to Daniel Medwed for inviting me to participate in this symposium and to Dean Ken Randall and the Alabama Law School Foundation for generous research support.

[1] NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD (2009), *available at* http://ag.ca.gov/meetings/tf/pdf/2009_NAS_report.pdf [hereinafter NAS REPORT]. My page citations are to the pre-publication copy of the report.

[2] *Id.* at 1-2, 2-3 to -5.

[3] *See id.* at S-6 n.8, 2-19.

[4] *Id.* at 3-17. Moreover, there are additional problems with the manner in which forensic science is presented in court. These problems include the conclusory manner in which testimony is often presented and the certainty with which conclusions are given. *See, e.g.*, *id.* at 3-15 to -16.

[5] *Id.* at S-5 to -6 ("[T]here is a notable dearth of peer-reviewed, published studies establishing the scientific bases and validity of many forensic methods.").

[6] *See, e.g.*, *id.* at 3-16. These are distinct problems. One problem has to do with *the quality of the evidence*; the other has to do with *our knowledge* of the quality of the evidence. Even evidence of not great quality may be useful in litigation settings so long as it is probative and the fact-finder understands how much weight to give it. The primary problem with many forensic-science techniques appears not necessarily to be that they are unreliable; rather, the problem is that their reliability is uncertain.

[7] *Id.* at S-4 to -6.

science poses a threat to effective, efficient, and accurate law-enforcement investigation (including national security) as well as to innocent defendants who may be wrongfully convicted on the basis of such evidence.[8]

In addition to documenting these problems, the NAS Report calls for widespread reform. One common theme running through the report is that legal doctrine—primarily, the law of evidence—cannot fix the problems diagnosed in the report and that reform must focus on the forensic science practices themselves and the juridical evidence they produce.[9] These reforms include creating an independent agency to oversee forensic science (the "National Institute of Forensic Science"); establishing best practices; establishing standardized terminology, measurements, and reporting procedures; developing accreditation procedures and ethical codes; increasing funding for education and training; and conducting research into the scientific foundations of the various forensic techniques and research into the potential biases and prejudices of practitioners, among others.[10] Other participants in this symposium are better qualified than I am to assess the feasibility as well as the likely successes and failures of these recommendations on their own terms, and I will leave this analysis to them. My focus will be on the relationships between current theoretical accounts of evidence (and the proof process more generally) and current forensic science evidence as described by the NAS Report. My hope is that the interaction between high-level evidence theory and the intensely practical issues raised by the NAS Report will help to illuminate both.

Aside from any theoretical insights this interaction may provide, its practical significance should not be underestimated. Although the NAS Report is surely right that legal doctrine cannot solve all of the problems identified, legal doctrine and the courts applying it need not sit idly by, replicating the status quo, waiting for forensic science reforms to take hold. The justification of doctrinal changes or applications by courts will depend upon a well-justified conceptual foundation of the legal proof process.[11] Providing this conceptual foundation is the domain of

---

[8] *Id.* at S-3 ("Further advances in the forensic science disciplines will serve three important purposes. First, further improvements will assist law enforcement officials . . . to identify perpetrators with higher reliability. Second, further improvements . . . should reduce the occurrence of wrongful convictions . . . . Third, any improvements . . . will undoubtedly enhance the Nation's ability to address the needs of homeland security."). The NAS Report also documents a number of problems with, and suggests reforms for, medical examiner and coroner offices throughout the country. *See id.* at 9-1 to -21.

[9] *Id.* at 1-14 ("In short, judicial review, by itself, is not the answer.").

[10] *Id.* at S-14 to -24.

[11] This justification will also depend on accurate empirical information. Any theoretical or conceptual project in this area must, of course, be informed by the best available empirical evidence of the proof process. On the relationship between theoretical and empirical investigations in the law of evidence, see generally Ronald J. Allen & Brian Leiter, *Naturalized Epistemology and the Law of Evidence*, 87 VA. L. REV. 1491, 1503 (2001) (arguing that "[e]xisting attempts to make theoretical sense of the evidentiary process have inadequately attended to their empirical adequacy and, in addition, have fairly systematically run afoul of the two constraints of epistemology").

evidence theory. Reflecting on forensic science in light of evidence theory will thus help to illustrate potential options for doctrinal changes and potential applications of current doctrine, as well as illustrate potential ways in which these changes and applications may be justified in light of the goals and functions of the proof process. Or so I will attempt to demonstrate.

Rather than focus on the details of any one type of forensic science, I will focus on a general problem underlying many forensic techniques: evidence purporting to link a defendant to a particular crime scene when there is uncertainty regarding the reliability of technique to establish the link or uncertainty regarding the validity of the science underlying the technique. Given the way this problem is framed, I will focus most of my analysis on the use of forensic evidence by the prosecution as purportedly inculpatory evidence, but, aside from a few differences I will point out along the way, many of the considerations will also apply to defense evidence. My primary conclusion is that, in light of evidence theory, many of the problems with forensic science described in the NAS Report ought to be dealt with at the sufficiency-of-the-evidence stage rather than at the admissibility stage. Doing so will require courts to develop a more robust sufficiency jurisprudence for criminal cases. I will briefly sketch how such a development may proceed in light of the theoretical issues discussed.

Part I provides a brief outline of evidence theory. Part II discusses forensic science in light of the theoretical issues discussed in Part I, focusing on the general problem of forensic evidence of unknown probative value purporting to link a defendant to a crime. Part III argues that a sufficiency response may be better justified than an admissibility response and sketches how such a response may proceed in a theoretically justified manner.

I. A BRIEF OUTLINE OF EVIDENCE THEORY

Theoretical accounts in the law of evidence are primarily epistemological in nature.[12] They are "epistemological" in the broad sense that they aim to either justify or to reform evidentiary rules or practices in light of their tendencies to produce true (factually accurate) outcomes or produce false (factually erroneous) outcomes. These accounts are also "epistemological" in the more narrow sense that the truth-conducive or truth-thwarting tendencies of evidentiary rules are typically evaluated based on the likely effects they will have on the rational evaluation of evidence by juries and judges. In short, legal fact finders are epistemic agents whose inferences and conclusions about evidence may be more or less justified and which the law may or may not endorse based upon the epistemic warrant of the inferences and conclusions. Although epistemic considerations largely drive evidence policy, the choices among evidentiary arrangements (with varying

[12] *See generally* Michael S. Pardo, *The Field of Evidence and the Field of Knowledge*, 24 LAW & PHIL. 321, 359 (2005) (describing three different intersections between epistemology and evidence law).

epistemic consequences) must ultimately be defended in terms of political morality.[13]

Not all evidence theory is concerned with these questions about truth, errors, rationality, and epistemic justification, but a great deal of it is (at least implicitly), and it is the part on which I shall focus and to which I shall refer as "evidence theory." Although evidentiary arrangements may at times be justified on other grounds, these considerations will typically provide necessary, if not sufficient, conditions for just legal judgments.[14]

The law of evidence and the theory underlying it serve these epistemic functions by regulating the proof process at both the macro level and the micro level. The macro level involves evaluations of whether evidence as a whole proves—or is at least sufficient for a reasonable fact finder to conclude that it proves—the elements of a claim or an affirmative defense. The law operates at this level by assigning the burden of proof to one party and adopting a decision rule (such as "preponderance of the evidence," "clear and convincing," or "beyond a reasonable doubt"). The burden of proof and the decision rules function to distribute the potential errors between the parties in a justified manner. For example, the preponderance-of-the-evidence rule applicable in most civil cases is meant to distribute the risk of error roughly evenly among the parties,[15] while the beyond-a-reasonable-doubt rule in criminal cases is meant to skew the risk of error against the prosecution and in favor of criminal defendants.[16]

---

[13] *See* Michael S. Pardo, *The Political Morality of Evidence Law*, 5 INT'L COMMENTARY ON EVIDENCE 1, 16–30 (2007), *available at* http://www.bepress.com/ice/vol5/iss2/art1 (reviewing ALEX STEIN, FOUNDATIONS OF EVIDENCE LAW (2005)) (arguing that "morally justified evidence law . . . lies . . . in deeper epistemic waters"). Evidentiary arrangements that are not the best from an epistemic perspective may nevertheless be better justified in terms of political morality. For example, the beyond-a-reasonable-doubt standard may create more overall errors than the preponderance standard, but it is justified in criminal cases based on the relative costs of false acquittals and false convictions. In general, however, the practices better justified epistemically will also be the ones better justified in terms of political morality. This is so because truth is a necessary condition for the application of justice. *See* WILLIAM TWINING, RETHINKING EVIDENCE: EXPLORATORY ESSAYS 76 (2d ed. 2006) ("Establishing the truth . . . is a necessary condition for achieving justice in adjudication; incorrect results are one form of injustice.").

[14] *See* TWINING, *supra* note 13.

[15] *See, e.g.*, Grogan v. Garner, 498 U.S. 279, 286 (1991) (noting "the preponderance-of-the-evidence standard results in a roughly equal allocation of the risk of error between litigants"); Herman & Maclean v. Huddleston, 459 U.S. 375, 390 (1983) (quoting Addington v. Texas, 441 U.S. 418, 423 (1979)) ("A preponderance-of-the-evidence standard allows both parties to 'share the risk of error in roughly equal fashion.'"); *In re* Winship, 397 U.S. 358, 371 (1970) (Harlan, J., concurring) ("In a civil suit between two private parties for money damages, for example, we view it as no more serious in general for there to be an erroneous verdict in the defendant's favor than for there to be an erroneous verdict in the plaintiff's favor.").

[16] *See, e.g.*, Addington v. Texas, 441 U.S. 418, 423–24 (1979) ("In the administration of criminal justice, our society imposes almost the entire risk of error upon itself. This is

One possibility at the macro level is for the law of evidence not to regulate it. In other words, this would allow fact finders in each case to decide for themselves when the evidence warrants a conclusion that a disputed fact has been proven. This would allow them, in effect, to distribute the risk of error among the parties as they see fit. The Supreme Court has rejected this approach as a general matter[17] and has declared in particular that the decision rule in criminal cases of "beyond a reasonable doubt" (BARD) is constitutionally required.[18] Although the decision rules potentially help to solve one problem—distributing the risk of error in a socially desirable manner—they may achieve this goal while still leaving much to be desired epistemically. Consider two extreme examples: the risk of error under the preponderance rule could be approximated in civil cases by deciding cases with a coin flip, and if BARD is interpreted to incorporate something like Blackstone's ratio (i.e., ten false acquittals for every false conviction),[19] then this risk of error could be approximated with an eleven-sided die or any other random procedure that made it ten times as likely the defendant would win.

The upshot of the examples is that the number and types of *accurate* outcomes matter, too.[20] The decision rules distribute the risk of error *based on a rational assessment of the evidence* because a rational assessment of the evidence will produce more accurate outcomes. What is troubling about the examples is that they prevent the parties who *ought* to win from producing evidence showing they ought to win, thereby reducing the risk of an erroneous and adverse outcome. By producing favorable evidence, each side may reduce the risk of an adverse judgment,[21] and fact finders have more information on which to decide given the residual uncertainty. In short, the epistemic focus on the proof process is not just on the decision rules but on the evidentiary base upon which decisions are made in light of these rules.

---

accomplished by requiring under the Due Process Clause that the state prove the guilt of an accused beyond a reasonable doubt.").

[17] *See* Santosky v. Kramer, 455 U.S. 745, 757 (1982) (noting that the Supreme Court "has never approved case-by-case determination of the proper standard of proof for a given proceeding" and finding that "[s]ince the litigants and the fact-finder must know at the outset of a given proceeding how the risk of error will be allocated, the standard of proof necessarily must be calibrated in advance").

[18] *See, e.g.*, *In re* Winship, 397 U.S. at 364 (noting that "the reasonable-doubt standard is indispensible" to due process).

[19] 4 WILLIAM BLACKSTONE, COMMENTARIES *352 ("[I]t is better that ten guilty persons escape, than that one innocent suffer.").

[20] *See generally* Larry Laudan & Harry D. Saunders, *Re-Thinking the Criminal Standard of Proof: Seeking Consensus About the Utilities of Trial Outcomes*, 7 INT'L COMMENT. ON EVIDENCE 1, 19–33 (2009), *available at* http://www.bepress.com/ice/vol7/iss2/art1 (arguing that "the desirable standard of proof . . . depends both on actual consequences . . . and on . . . society's evaluation of the gains and losses associated with those consequences"); Ronald J. Allen & Larry Laudan, *Deadly Dilemmas*, 41 TEX. TECH L. REV. 65, 75–80 (2008) (discussing the problems of analysis regarding legal errors).

[21] The evidence provided by the party who does not deserve to win, given the underlying events, may be misleading or truth-thwarting evidence.

This takes us, finally, to the micro level of the law of evidence. One possibility at this level is to allow each party—who presumably best know their respective cases—to present whatever evidence they wish. One constraint on such a free-proof system, however, is the requirement that evidence must be relevant to the disputed issues. It is hard to argue against such a requirement given that logically irrelevant evidence ought, by definition, to have no bearing on a rational evaluation of whether a fact has been proven. Moreover, some parties under a free-proof system may have an incentive to introduce irrelevant evidence to confuse the issues and/or stall the proceedings.

At the micro level, from an epistemic perspective, the more relevant evidence the better.[22] In general, evidence is relevant if it makes a disputed fact appear more or less likely.[23] The more of it presented to a fact finder, the better the evidentiary base on which legal decisions will be made. Thus, as a matter of evidence policy, the exclusion of relevant evidence requires a separate justification. These justifications fall into four categories: (1) economic, (2) other policy goals, (3) jury control, (4) party control. First, relevant evidence may have only minimal probative value in proving the disputed fact, or may be cumulative of other evidence, or may otherwise not be worth the costs of receiving it.[24] Second, relevant evidence may sometimes be excluded to serve other non-epistemic purposes.[25] The two other categories are meant to provide epistemic rationales for the exclusion of relevant evidence. Third, relevant evidence may be excluded if fact finders will "overvalue" the evidence to such an extent that it will detract from rather than aid a rational evaluation of the evidence as a whole, or will otherwise distract them from this function.[26] Finally, relevant evidence may be excluded if doing so will induce parties to present better evidence instead.[27]

The foregoing is relatively uncontroversial. Less understood, and perhaps more controversial, is how the macro-level and micro-level issues interact. Two related issues will highlight the complexity. First, in addition to attempting to improve the evidentiary base on which decisions are made, micro-level rules may also shift the risk of error between the parties (perhaps frustrating or amplifying

---

[22] *See* TIMOTHY WILLIAMSON, KNOWLEDGE AND ITS LIMITS 189 (2000) (discussing this epistemic principle); Alvin I. Goldman, *Quasi-Objective Bayesianism and Legal Evidence*, 42 JURIMETRICS J. 237, 253–60 (2002). This is not to deny that it may be quite difficult to determine whether particular evidence is relevant or not in the context of a particular case.

[23] FED. R. EVID. 401.

[24] FED. R. EVID. 402–03.

[25] FED. R. EVID. 407–11.

[26] FED. R. EVID. 403.

[27] *See* FED. R. EVID. 1001–1008 (requiring original evidence unless other conditions of trustworthiness are satisfied); *see also* Dale A. Nance, *Naturalized Epistemology and a Critique of Evidence Theory*, 87 VA. L. REV. 1551, 1555–56 (2001) (discussing the role of exclusionary rules in incentivizing parties to present better evidence in court).

the risks imposed by the macro-level proof rules).[28] For example, a rule that excludes evidence that would otherwise typically be presented by one side (e.g., the prosecution) may shift more risk onto that side and away from the other side (e.g., defendants), while a rule routinely admitting that evidence may shift the risk of error in the other direction. Second, given this interaction, an asymmetrical application of micro-level rules may be justified by the fact that, as an empirical matter, a decision rule is failing to achieve its desired effect in distributing errors among the parties. For example, if BARD is known to be producing too many false convictions (as compared to false acquittals), then an asymmetrical micro-level rule (either of admission or exclusion) that shifts more risk away from defendants and onto the prosecution may be justified on that ground—and vice versa if the reverse were true.[29] A priori there is no reason to prefer one evidentiary arrangement over another in terms of where it distributes the risk of error (micro and macro), but evidence theory must attend to the ways these levels interact.[30]

This sketch of the basic structure of the evidentiary proof process still leaves open a number of conceptual issues. Most significantly, we still need some conception of what makes evidence relevant, how to measure probative value, and when evidence as a whole is sufficient to satisfy the decision rules. Within evidence theory, two competing conceptions speak to these issues. The first is a probabilistic conception. Under this conception, relevance and probative value can be evaluated based on the likelihood of a disputed fact of consequence given the particular item of evidence, typically measured as a cardinal probability between zero and one.[31] Likewise, under this conception, decision rules are typically

---

[28] For a comprehensive discussion of how micro-level evidence rules shift the risk of error, see ALEX STEIN, FOUNDATIONS OF EVIDENCE LAW 133–40, 183–97, 225–38 (2005).

[29] Michael S. Pardo, *On Misshapen Stones and Criminal Law's Epistemology*, 86 TEX. L. REV. 347, 372–73 (2007) (reviewing LARRY LAUDAN, TRUTH, ERROR, AND CRIMINAL LAW: AN ESSAY IN LEGAL EPISTEMOLOGY (2006)).

[30] *See id.*; *see also* Raphael M. Goldman & Alvin I. Goldman, *Review of* Truth, Error, and Criminal Law: An Essay in Epistemology *by Larry Laudan*, 15 LEGAL THEORY 55, 59–60 (2009) (noting that a desirable risk-of-error allocation may be achieved by a combination of evidentiary rules rather than just the decision standard); Frederick Schauer, *Can Bad Science Be Good Evidence? Lie Detection, Neuroscience and the Mistaken Conflation of Legal and Scientific Norms*, 95 CORNELL L. REV. (forthcoming 2010) (manuscript at 20 n.57, on file with author) (same). For a recent argument that the standards for scientific testimony in criminal cases ought to asymmetrically favor defendants, see CHRISTOPHER SLOBOGIN, PROVING THE UNPROVABLE: THE ROLE OF LAW, SCIENCE, AND SPECULATION IN ADJUDICATING CULPABILITY AND DANGEROUSNESS 143–44 (2007).

[31] *See* Richard O. Lempert, *Modeling Relevance*, 75 MICH. L. REV. 1021, 1025–26 (1977) (explaining how the Bayes' Theorem and regret matrices may be used to analyze evidentiary rules). Under this conception, the probative value of evidence may be expressed as a "likelihood ratio," that is, the likelihood of receiving the evidence given that the disputed fact for which it is offered is *true* compared with the likelihood of receiving the evidence given that the disputed fact is *false*. *Id.* For a critique of the likelihood-ratio

assigned cardinal probabilities (e.g., 0.5 for preponderance and 0.91 for BARD), and evidence is sufficient to satisfy the decision rule when the probative value of the evidence as a whole surpasses the decision rule.[32]

The second conception is explanatory.[33] Under this conception, relevance and probative value may be evaluated based on whether and how well a disputed fact, if true, would explain particular items of evidence.[34] Likewise, under this conception, decision rules may be explicated in terms of how well each side's theory explains the evidence.[35] For example, consistent with the error-distribution goals of the decision rules, the preponderance rule is satisfied when the best available explanation of the evidence and events under dispute supports the party with the burden of proof.[36] Likewise, the BARD rule is satisfied when the

---

model of probative value, see Ronald J. Allen & Michael S. Pardo, *The Problematic Value of Mathematical Models of Evidence*, 36 J. LEGAL STUD. 107, 111–14 (2007).

[32] *See* Michael L. DeKay, *The Difference Between Blackstone-Like Error Ratios and Probabilistic Standards of Proof*, 21 LAW & SOC. INQUIRY 95, 125–26 (1996); David Hamer, *Probabilistic Standards of Proof, Their Complements and the Errors that are Expected to Flow from Them*, 1 U. NEW ENG. L.J. 71, 73 (2007); David H. Kaye, *Clarifying the Burden of Persuasion: What Bayesian Decision Rules Do and Do Not Do*, 3 INT'L J. EVID. & PROOF 1, 1–2 (1999); Erik Lillquist, *Recasting Reasonable Doubt: Decision Theory and the Virtues of Variability*, 36 U.C. DAVIS L. REV. 85, 149–50 (2002); Neil Orloff & Jery Stedinger, *A Framework for Evaluating the Preponderance-of-the-Evidence Standard*, 131 U. PA. L. REV. 1159, 1159–60 (1983).

[33] *See* Ronald J. Allen & Michael S. Pardo, *The Problematic Value of Mathematical Models of Evidence*, 36 J. LEGAL STUD. 107, 135–38 (2007); Michael S. Pardo, *Second-Order Proof Rules*, 61 FLA. L. REV. 1083, 1102–05 (2009); Michael S. Pardo & Ronald J. Allen, *Juridical Proof and the Best Explanation*, 27 LAW & PHIL. 223, 233–42 (2008). The subsequent sections will rely on this conception; these articles provide detailed arguments for why the explanatory account itself explains the proof process at the macro and micro levels better than probabilistic accounts.

[34] This conception relies on the notion of "inference to the best explanation" (or the inferential process of abduction), a notion best known in the philosophy of science. *See* Gilbert H. Harman, *The Inference to the Best Explanation*, 74 PHIL. REV. 88, 88–91 (1965); *see generally* PETER LIPTON, INFERENCE TO THE BEST EXPLANATION 1 (2d ed. 2004) (providing an explanation of the model of Inference to the Best Explanation); Paul R. Thagard, *Evaluating Explanations in Law, Science, and Everyday Life*, 15 CURRENT DIRECTIONS PSYCHOL. SCI. 141, 141–43 (2006) (discussing a "theory of explanatory coherence" to explain how people consider competing explanations). A number of general criteria determine whether one explanation is better than another (e.g., consistency, simplicity, coherence with background beliefs, consilience, and the absence of ad hoc premises, and so on), but this determination will depend on the context and details of particular cases as well as on the goals of decision makers. For further discussion, see Pardo & Allen, *Juridical Proof and the Best Explanation*, *supra* note 33, at 229–33.

[35] *See* Pardo, *supra* note 33, at 1102–05; Pardo & Allen, *Juridical Proof and the Best Explanation*, *supra* note 33, at 233–42 (explaining how explanatory proof works at trial).

[36] Assuming that the better of two explanations is more likely to be true, then this rule will serve the error-allocation and -distribution functions underlying the preponderance rule

prosecution offers a plausible explanation of guilt and there is no plausible explanation consistent with innocence.[37]

It should be noted that these conceptions, and the conceptual issues in evidence theory more generally, are related to—but distinct from—the empirical questions of how jurors actually draw inferences and decide cases.[38] The best model regarding these empirical questions is the "story model," where jurors impose a narrative structure on the evidence, organize the evidence into coherent versions of events through their background knowledge about analogous situations, generalize about the world in the general, and make assumptions about gaps in the evidence.[39]

Finally, however, it should be noted that this empirical information by itself cannot answer the conceptual questions posed by evidence theory. For example, the story model cannot tell us when evidence is sufficient to satisfy a decision rule, when a jury verdict is unreasonable, or how to measure probative value.[40] Evidence theory also places normative constraints on the empirical process: for example, a process of selecting the best story among those offered by each side in a criminal case would allocate an unjustified risk of error onto defendants.[41]

II. FORENSIC SCIENCE AND EVIDENCE THEORY

The NAS Report documents several problems with the current state of forensic science. For purposes of current criminal litigation, the most serious

---

better than a probabilistic rule. *See* Pardo & Allen, *Juridical Proof and the Best Explanation*, *supra* note 33, at 235, 261–62.

[37] Assuming the quality of an explanation is a good indicator of its likely truth, then this rule will serve the error-allocation and -distribution functions underlying the BARD rule. *See* Pardo, *supra* note 33, at 1105; Ronald J. Allen & Michael S. Pardo, *Probability, Explanation, and Inference: A Reply*, 11 INT'L J. EVID. & PROOF 307, 316–17 (2007).

[38] Theoretical accounts must be empirically informed. *See* Allen & Leiter, *supra* note 11, at 1503–37.

[39] *See* Nancy Pennington & Reid Hastie, *A Cognitive Model of Juror Decision Making: The Story Model*, 13 CARDOZO L. REV. 519, 523–25 (1991). According to the story model, jurors formulate and choose among narratives based on criteria such as coverage, coherence, and uniqueness. *Id.*; *see also* NEIL VIDMAR & VALERIE P. HANS, AMERICAN JURIES: THE VERDICT 135 (2007) ("Many subsequent studies . . . have lent support to the basic assumptions of the story model and expanded on its implications.").

[40] For example, if the probative value of evidence were just what any individual jury thought it was, then this would render Federal Rule of Evidence 403 largely unintelligible (how could evidence be misleading or confusing or unfairly prejudicial if the only relevant criterion for probative value is what jurors think it is?). Moreover, sufficiency-of-the-evidence reviews would not make sense because it would be up to juries to determine for themselves what is sufficient. In other words, summary judgment, judgments as a matter of law in civil cases, and sufficiency challenges in criminal cases, which all turn on what "reasonable" juries could conclude, would not be possible. *See* Pardo, *supra* note 33, at 1097–99.

[41] For further discussion of this point, see *id.* at 1102–05.

general issue appears to be the following: "With the exception of nuclear DNA analysis . . . no forensic method has been rigorously shown to have the capacity to consistently, and with a high a degree of certainty, demonstrate a connection between evidence and a specific individual or source."[42]

We may call this the "identity" problem, and it underlies many of the uses of forensic science evidence in criminal proceedings: fingerprints, hair, bite marks, ballistics, handwriting, shoe prints, and tire tracks, among others. We may state the identity problem generally and schematically in the following way: we have some evidence (E) and some forensic science technique (FS) such that the combination of E and FS renders it more or less likely that the defendant is the source of E (and thus more or less likely that the defendant is guilty). The reason the identity problem is a *problem* is because in most cases we simply do not know how much more or less likely the combination of E and FS makes it that the defendant is the source.

The NAS Report responds to this problem by proposing recommendations that aim at improving the precision and reliability of the techniques as well as discovering more information *about* the precision and reliability of the techniques.[43] The report states that improving these techniques will improve the ability of law enforcement to identify true perpetrators of crime and "should reduce the occurrence of wrongful convictions."[44] The report also notes that the probative value and hence the admissibility of forensic science evidence depends on the precision and reliability of these techniques, suggesting, consistent with *Daubert* and Federal Rule of Evidence 702,[45] that evidence must cross some "threshold of evidentiary value" for it to be admitted into court.[46]

Faced with the world described by the NAS Report, courts in criminal cases have two different avenues for potential doctrinal responses to the coming challenges to forensic science. One avenue, and the one most discussed in the report, is at the micro level.[47] The second avenue is at the macro level.

At the micro level, one response would be to exclude the evidence unless and until the precision and reliability of the techniques have been demonstrated to a sufficient degree. This could be done under current doctrine under a more rigorous (and perhaps more faithful) application of *Daubert* and Federal Rule of Evidence 702,[48] or perhaps under Federal Rule of Evidence 403. This response, however,

---

[42] NAS REPORT, *supra* note 1, at S-5.

[43] *Id.* at S-10 to -24.

[44] *Id.* at S-3

[45] *Id.* at ch. 3.

[46] *Id*. at 5-37.

[47] *See id.* at ch. 3. For a discussion of the micro-level issues the NAS Report might raise in both *Daubert* and *Frye* jurisdictions, see Jules Epstein, *The NAS Report: An Evidence Professor's Perspective*, http://ssrn.com/ abstract=1436650 (last visited June 1, 2010).

[48] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 589–95 (1993) (imposing "reliability" standard on the admissibility of expert testimony, and providing criteria for assessing "reliability" such as whether a technique can be tested, has been

raises a number of potential problems in light of evidence theory. First, let us begin with relevance. Only if a forensic technique is no better than a coin flip is it irrelevant. Assuming this is not the case (at least with regard to most of these techniques),[49] then the evidence should presumptively be admitted unless there is some other reason to exclude it. The two possible epistemic reasons for doing so are because the fact finder will significantly overvalue it (jury control) or because it will induce the proponent to introduce better evidence (party control).[50]

Jury-control considerations may be particularly salient in this context given the aura of reliability (and perhaps infallibility) surrounding science in our culture. But, as documented in the NAS Report, much of the problem here may have more to do with *how* forensic experts testify and *to what* they testify, rather than the fact that this type of evidence is introduced.[51] Moreover, although far from conclusive, empirical evidence appears to support the competence of jurors in evaluating complex evidence.[52] Thus, there are reasons to think (at least until there is good empirical evidence to the contrary) that jurors, once apprised of the many known and unknown limitations of the techniques,[53] can give it proper weight in the

---

subjected to peer-reviewed study, has known error rates, has standards controlling its operations, and is accepted in the relevant scientific community); *see also* Kuhmo Tire Co., Ltd. v. Carmichael, 526 U.S. 137, 141 (1999) (holding that *Daubert* also applies to non-scientific expert testimony); Gen. Elec. Co. v. Joiner, 522 U.S. 136, 146 (1997) (concluding that courts can assess expert conclusions as well as techniques under *Daubert*); FED. R. EVID. 702 (requiring that expert testimony must be based on sufficient facts or data along with reliable principles and methods, applied reliably to the facts of the case). Despite previously admitting forensic science, jurisdictions that employ the "general acceptance" standard, may also attempt to screen such evidence by concluding that it is no longer generally accepted in the scientific community, by redefining the relevant scientific community, or by concluding that it would not be helpful to the fact-finder. *See* Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923).

[49] If a technique is no better than random, then it should be excluded on relevance grounds. Many forensic techniques purport to provide relevant evidence based on the fact that they rely on similarities in patterns between evidence found at crime scenes and evidence related to defendants. *See* Michael J. Saks & Jonathan J. Koehler, *The Coming Paradigm Shift in Forensic Identification Science*, 309 SCIENCE 892, 892 (2005).

[50] Even if minimally relevant, the evidence may also be excluded based on the excessive costs of producing it. FED. R. EVID. 403.

[51] *See* NAS REPORT, *supra* note 1, at 1-11. The NAS Report's discussion of the education of potential experts also provides a nice model for the kinds of information an expert should be able to explain to judges and juries: "the [expert] should learn what to measure, the associated population statistics (if appropriate), biases and errors to avoid, other threats to the validity of the evidence, how to calculate the probability that a conclusion is valid, and how to document and report the analysis." *Id.* at 8-1.

[52] For a survey of the literature, see VIDMAR & HANS, *supra* note 39, at 177–80.

[53] This knowledge may come from either explaining the technique and why its results are likely to be valid or through evidence indicating that the technique has been tested empirically and has been sufficiently validated (even if the expert cannot explain *why* it is valid). For an illuminating discussion of this distinction, see Jennifer L. Mnookin, *Of Black Boxes, Instruments, and Experts: Testing the Validity of Forensic Science*, EPISTEME 343

context of individual cases. And from an epistemic perspective, other things being equal, the more relevant evidence—generally understood and roughly properly weighed—the better. Likewise, the party-control rationale does not necessarily warrant exclusion. The exclusion of much current forensic science evidence may induce the development of more precise and reliable techniques. But, and the NAS Report documents, there are plenty of reasons and incentives to continue with this development regardless of whether current evidence is excluded.[54] And exclusion may produce great epistemic costs by excluding probative evidence (assuming it could be accurately presented and evaluated).

Nor is it clear that systematically excluding non-DNA forensic science would reduce erroneous judgments as a whole or types of errors (including false convictions). We do know that in a large percentage of known wrongful convictions the prosecution introduced forensic science evidence against the defendant.[55] But we do not know the extent to which this evidence caused these verdicts.[56] More importantly, it is not clear what the systemic consequences might be should this evidence be routinely excluded. A number of perverse possibilities exist. Perhaps prosecutors may try to convict the same number defendants with *worse* evidence—worse epistemically but better persuasively—perhaps leading to more false convictions.[57] Or perhaps prosecutors will select and prosecute a different class of defendants based on a greater perceived likelihood of conviction but, again, based on worse evidence, perhaps also increasing false convictions. And, of course, it may also lead to a great deal of more false acquittals, placing dangerous criminals back on the street.[58] Assuming appropriate constraints can be placed on how the evidence is presented and that the evidence is generally understood by fact finders,[59] the epistemic considerations underlying evidence

---

(2008). As a general matter, these limitations may be more apparent to juries and judges when expert testimony serves an educational function, rather than one of pure deference. *See* Ronald J. Allen & Joseph S. Miller, *The Common Law Theory of Experts: Deference or Education?* 87 NW. U. L. REV. 1131, 1133–41 (1993).

[54] These include, for example, more accurate and efficient law-enforcement investigations and national-security interests.

[55] For example, according to a study of 200 wrongful convictions, some type of forensic-science evidence was introduced by the prosecution in 113 of the cases. *See* Brandon L. Garrett, *Judging Innocence*, 108 COLUM. L. REV. 55, 81 (2008).

[56] For example, we do not know how many juries would have convicted anyway based on the remaining evidence. And, even if the evidence did play a causal role, we do not know the answer to the counter-factual question of what evidence the prosecution might have introduced instead if the forensic evidence were excluded.

[57] As a general matter, the exclusion of even weak scientific evidence may lead to adverse epistemic consequences if non-scientific evidence relied on in its place is worse. *See* Schauer, *supra* note 30, at 15–25.

[58] This possibility arises from the fact that exclusion may further shift the risk of error onto the prosecution. And, given the utilities of true verdicts (acquittals and convictions), these costs cannot be ignored by simply focusing on the ratio of errors. *See supra* note 20 and accompanying text.

[59] *See supra* notes 51, 53 and accompanying text.

theory appear to counsel against the systematic exclusion of the evidence. This, of course, is not to deny the very real dangers presented by placing this problematic evidence before juries or judges. *Daubert* itself mentions "traditional and appropriate means" to deal with the dangers of "shaky but admissible evidence"—"[v]igorous cross-examination, presentation of contrary evidence, and careful instructions on the burden of proof."[60] The adversarial process itself, however, as the NAS Report notes, is not enough. But it is also not the only other doctrinal option. More detailed macro-level doctrine is also possible. The idea of "careful instructions on the burden of proof" points in the direction of such macro-level considerations but does not go far enough. Better jury instructions on BARD in general or connecting the forensic science with BARD in particular would be desirable.[61]

Also, more importantly, the development of a more robust sufficiency-of-the-evidence jurisprudence would help considerably to cabin the dangers posed by current forensic science evidence.[62] In cases in which otherwise weak evidence is coupled with weak or otherwise problematic forensic science evidence, courts should dismiss cases based on insufficient evidence or overturn convictions. This option would also, for reasons explored more fully in the next Part, respond to the dangers with forensic science in a manner more consistent with the epistemic goals of the proof process.

III. FORENSIC SCIENCE, BARD, AND SUFFICIENCY OF THE EVIDENCE

As a matter of doctrine, the relevant standards regarding burdens of proof, decision rules, and sufficiency of evidence are already in place and of constitutional significance. The prosecution must prove each element of the offense beyond a reasonable doubt,[63] and due process requires that every conviction must be supported by sufficient evidence such that "after viewing the evidence in the light most favorable to the prosecution, any rational trier of fact could have found the essential elements of the crime beyond a reasonable doubt."[64] In theory, the combination of these standards provides a solid doctrinal foundation to respond to the dangers created by "shaky but otherwise admissible" forensic science. Moreover, this foundation provides a potential response that better accords with the epistemic goals elucidated by evidence theory.

---

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

[61] I explore potential jury instructions in light of evidence theory in Pardo, *supra* note 33, at 1107–10. For a thoughtful recent discussion by a federal judge on the difficulties raised by current BARD instructions in criminal trials, see Dean D. Pregerson, *Reasonable Doubt About Reasonable Doubt*, Aug. 4, 2009, DAILY JOURNAL, www.dailyjournal.com.

[62] *See* Richard D. Friedman, *Squeezing* Daubert *out of the Picture*, 33 SETON HALL L. REV. 1047, 1048 (2003) (arguing that sufficiency standards may provide a more appropriate response to problems with expert testimony than admissibility standards).

[63] *In re* Winship, 397 U.S. 358, 361, 364 (1970).

[64] Jackson v. Virginia, 443 U.S. 307, 317–19 (1979); *see* FED. R. CRIM. P. 29.

These goals include reducing errors (or types of errors) and allocating the risk of error among the parties. Assuming that forensic science evidence is relevant and properly understood and evaluated,[65] macro-level rules will better align decision-making with these goals than a micro-level response. At the macro level, in any given case, three situations are possible: (1) the non-forensic-science evidence is sufficient to support a conviction; (2) the forensic science evidence in combination with the other evidence is insufficient; or (3) the forensic evidence pushes the totality of the prosecution evidence across the sufficiency line. In each situation, the forensic evidence improves the evidentiary base upon which decisions are made. In the second situation, even in the case of a conviction, problematic forensic evidence will be neutralized by overturning the verdict.

In the first situation, a conviction was already warranted anyway, and so problematic forensic evidence did no harm—indeed, it improved the evidentiary base, perhaps solidifying an already epistemically warranted judgment.[66] The third situation is the most important and controversial. But if the macro-level rules are well designed in allocating the risk of error, then admission of the evidence is appropriate because it will allow for more accurate applications of the macro-level rules. In other words, adding in this additional relevant evidence will provide more information about on which side of the sufficiency line the case belongs.[67] By contrast, a purely micro-level response will not further these goals. In each of the above three situations, it will reduce the evidentiary base on which decisions are made. Moreover, in situation two, it will not necessarily do anything to prevent convictions based on the other evidence.[68] And in situation three, the reduced evidentiary base will provide less accurate information about on which side of the sufficiency line the case belongs—frustrating the goals of the macro-level rules.[69]

---

[65] *See supra* notes 51, 53.

[66] Note that in this situation, the forensic evidence may still have played a *causal* role in the outcome—but if the other evidence is sufficient, it is not clear how this can be a problem *epistemically*. And if the other evidence by itself is not sufficient, then it is one of the other two situations described above.

[67] Reducing the evidentiary base in this way might be justified if the decision rule were not doing enough to distribute the risk of error. *See supra* notes 29–30 and accompanying text. Under such an argument, increasing the risk of total errors would be justified because doing so would better allocate the risk of error among the parties. This, however, does not appear to be an argument currently being made about forensic-science evidence—for this rationale would apply regardless of the quality of the forensic evidence, and regardless of whether jurors understood its correct probative value, while the arguments for exclusion of forensic evidence typically depend on the poor quality of the evidence or the tendency of jurors to overvalue it.

[68] Of course, we can employ both macro- and micro-level rules in tandem. *See, e.g.*, Friedman, *supra* note 62, at 1047–48 (arguing for macro-level rules for expert testimony along with asymmetric micro-level rules). At least in theory, in situations like situation three, micro-level rules may not be necessary if the macro-level rules are operating appropriately.

[69] *See supra* notes 67–68. Situation one is complicated because, one on hand, excluding the forensic evidence will weaken the evidentiary base upon which the decision

Unfortunately, in practice, macro-level doctrine has largely failed to serve these epistemic goals. Although, the BARD instructions play *some* role in jury decision making,[70] they are vague, poorly understood, and epistemically problematic in their focus on subjective belief states rather than on objective qualities of the evidence.[71] The sufficiency standard is also without much bite. In Brandon Garrett's study of 200 wrongfully convicted defendants, for example, 60 raised sufficiency challenges, and only one was successful.[72] As a general matter, Judge Jon Newman has called for courts to take sufficiency review more seriously, noting that courts overturn convictions on sufficiency grounds "very rarely," and, even then, "they almost never do so by applying, in explicit terms, the 'reasonable doubt' standard."[73] He explains that "on those rare occasions when a federal appellate court accepts a claim that a case should not have gone to a jury, it typically says simply that the evidence is 'insufficient' . . . that there is no evidence to support a necessary element."[74] Indeed, the failures of the doctrine with regard to these macro-level issues may explain much of the concerns regarding admissibility in the criminal context. Admissibility becomes more critical when admissibility decisions are also, in effect, macro-level sufficiency determinations.

The forensic science issues present an important context for courts (and evidence scholars) to develop and improve this macro-level doctrine. This kind of macro-level doctrine is possible, as a brief reflection on the civil context demonstrates. In addition to providing rigorous review on the admissibility of expert testimony, courts in civil cases have developed quite sophisticated sufficiency-review doctrine: summary judgment and judgments as a matter of law.[75] These reviews also depend on what a reasonable or rational fact finder can conclude based on the evidence,[76] and the primary criticism in this context is not

---

will be based; on the other hand, however, given that juries have unfettered power to acquit, it is not necessarily an error if a jury chooses to acquit in the face of sufficient inculpatory evidence (even if they would have convicted with the forensic evidence added).

[70] *See* Lawrence M. Solan, *Refocusing the Burden of Proof in Criminal Cases: Some Doubt About Reasonable Doubt*, 78 TEX. L. REV. 105, 119–32 (1999) (discussing empirical literature on BARD instructions); *see also* Andreas Glöckner & Christoph Engel, *Can We Trust Intuitive Jurors? An Experimental Analysis*, 22–24 (2008), http://ssrn.com/abstract=1307580 (discussing the results of empirical study of the effect of BARD instructions on mock jurors).

[71] *See* LARRY LAUDAN, TRUTH, ERROR, AND CRIMINAL LAW: AN ESSAY IN LEGAL EPISTEMOLOGY 30–47 (2006).

[72] Garrett, *supra* note 55, at 112.

[73] Jon O. Newman, *Beyond "Reasonable Doubt,"* 68 N.Y.U. L. REV. 979, 989 (1993).

[74] *Id.*; *see* Cuellar v. United States, 128 S. Ct. 1994, 2005 (2008) ("[T]he Government failed to introduce any evidence that the reason drug smugglers move money to Mexico is to conceal or disguise a listed attribute of the funds.").

[75] FED. R. CIV. P. 56, 50.

[76] *See* Reeves v. Sanderson Plumbing Prods., Inc., 530 U.S. 133, 149 (2000) ("Under Rule 50, a court should render judgment as a matter of law when 'a party has been fully heard on an issue and there is no legally sufficient evidentiary basis for a reasonable jury to

that the doctrine is feckless. To the contrary, it is that courts are too eager to grant motions for summary judgment or judgment as a matter of law.[77] My point is not to suggest that these areas provide a model for the criminal context to emulate;[78] rather, the point is merely that courts are capable of taking this issue seriously on a grand doctrinal scale.[79] Exactly how such review should proceed depends on the soundness of its theoretical foundation. The following paragraphs sketch how this might proceed in the forensic science context.

Under the explanatory conception of legal proof,[80] the macro-level decision rules (as well as the micro-level issues regarding relevance and probative value) may be articulated based on the explanatory relationships between the evidence and the facts at issue. How ought this play out in the forensic science context? Under the explanatory conception of BARD, a fact is proven when it is part of a plausible explanation of guilt and there is no plausible explanation consistent with innocence.[81] How forensic science fits into this framework will depend, as the NAS Report notes, on the context and details of particular cases.[82] Generally, however, (1) a prosecution case built on weak forensic science will fail to be plausible when there is an absence of (or not much) other evidence rendering the prosecution's explanation plausible, and (2) weak forensic science offered by the prosecution will not by itself render an otherwise plausible defense explanation implausible.[83]

---

find for that party on that issue.'"); Anderson v. Liberty Lobby, Inc., 477 U.S. 242, 250–56 (1986) (explaining that the standard for both motions is whether "there can be but one reasonable conclusion").

[77] *See* Arthur R. Miller, *The Pretrial Rush to Judgment: Are the "Litigation Explosion," "Liability Crisis," and Efficiency Clichés Eroding Our Day in Court and Jury Trial Commitments?*, 78 N.Y.U. L. REV. 982, 1076 (2003).

[78] For criticism of this standard and its applications in the civil context, see Suja A. Thomas, *The Fallacy of Dispositive Procedure*, 50 B.C. L. REV. 759, 769–78 (2009).

[79] Furthermore, courts are capable of taking the issue seriously in light of the details of particular cases. For an example of a court doing so—and doing so consistent with the explanatory analysis presented above—see United States v. Navedo, 443 F. Supp. 2d 431, 434 (W.D.N.Y. 2006) ("[T]here was insufficient evidence at trial to prove beyond a reasonable doubt that defendant *knowingly* possessed the hidden drugs. In fact, the evidence equally supports an inference that defendant *did not know* about the hidden drugs.").

[80] Although I proceed under the explanatory conception, a similar path could be taken under a probabilistic conception. Under this approach, one would need to specify a probabilistic conception of BARD, jury instructions that convey this conception accurately and usefully, and a probabilistic standard for determining when the evidence is sufficient (that is, for when jury conclusions are reasonable).

[81] *See supra* note 37 and accompanying text.

[82] NAS REPORT, *supra* note 1, at 1-6.

[83] Similarly, a defense case built solely on weak forensic evidence may not provide a plausible explanation consistent with innocence. None of these points is meant to suggest that the ability of an expert *to explain the technique* will necessarily be better evidence than evidence that the technique has been tested empirically and has a known error rate. For an

Jury instructions to this effect may better align decision making with the epistemic goals of the proof process.[84] More importantly, courts ought to dismiss a case or overturn a conviction when either of two conditions obtain: (1) a prosecution case relies on weak forensic science and otherwise weak evidence (such that it fails to render the prosecution explanation plausible), or (2) the defense offers a plausible explanation of the evidence that is challenged only by otherwise shaky forensic science.[85] Further generalities may emerge among common-law adjudication along these lines, but this general framework allows for doctrinal development in an epistemically justified manner in light of evidence theory. It allows for proof to proceed in a way that may reduce errors, while maintaining a justified allocation of the risk of errors among the prosecution and defendants, along with also providing a conceptual foundation for courts to place rational constraints on uses of forensic science evidence.

CONCLUSION

The NAS Report recommends a wholesale overhaul of the field of forensic science in the United States. Most of the proposed recommendations for reform focus on activities that take place outside of the courtroom, reforms aimed at improving the quality of the evidence that is used for law enforcement and criminal litigation. In many ways, however, the report invites courts to respond to, and to perhaps improve upon, the ways in which such evidence is admitted and presented currently and in the future. It also invites evidence scholars to develop solid theoretical foundations for possible avenues of response and reform. Toward these ends, I have outlined two general avenues for doctrinal response to problems with forensic science evidence—arguing that macro-level responses in terms of decision rules and sufficiency determinations may provide a more justified response than micro-level admissibility determinations—and I have sketched how such doctrinal reform might proceed in terms of explanatory criteria.

---

illuminating discussion of this distinction, see Mnookin, *supra* note 53. Indeed, the latter evidence may provide jurors with more probative information about the plausibility and strength of the competing explanations of which the forensic evidence may be a part.

[84] *See supra* note 37 and accompanying text. For further discussion of explanation-based jury instructions in light of these goals, see Pardo, *supra* note 33. Explanation-based instructions may also be more intuitive and easier for jurors to implement than those that rely on subjective belief states or probabilities, given that jurors (and people more generally) tend to reason in this manner. *See* VIDMAR & HANS, *supra* note 39, at 137–40; Frank C. Keil, *Explanation and Understanding*, 227 ANN. REV. PSYCH. 227, 247 (2007) ("The processes of constructing and understanding explanations are intrinsic to our mental lives from an early age."); Tania Lombrozo, *The Structure and Function of Explanations*, 10 TRENDS COGNITIVE SCI. 464, 468 (2006) ("The predominance of explanation presents a challenge for approaches to reasoning and inference that focus exclusively on decontextualized statistical evidence.").

[85] These determinations would also provide incentives to develop better evidence, see *supra* note 54, without excluding it in cases in which it epistemically ought to make a difference.