

THE BITE MARK DENTISTS AND THE COUNTERATTACK ON FORENSIC SCIENCE REFORM

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ABSTRACT

An editorial in a scientific journal by forensic odontologists defending the admissibility of bite mark evidence, *Epidermis and Enamel*, is critiqued. The editorial's primary deficiency is that it fails to address scientific challenges to the reliability and validity of bite mark evidence. The Article first traces the impact of bite mark analysis through two wrongful conviction case examples in Mississippi and Michigan. The Article then reviews the scientific research and reasoning that shows bite mark evidence to be unreliable and to lack scientific support. The critique of *Epidermis and Enamel* shows it to be riddled with logical flaws; failing to critically address scientific analyses showing the unreliability of bite mark analysis; erroneously deflecting criticism of bite-mark (in)accuracy by noting that wrongful convictions often have multiple causes; mischaracterizing social scientific research; falsely claiming that a number of exonerations were not wrongful convictions; being highly defensive; citing the testimonials of supporters; and defaming its critics. The illogical defense of bite mark analysis by forensic odontologists is explained in social psychological terms through the constructs of organizational deviance, groupthink, cognitive dissonance, cognitive bias, and Mercier and Sperber's evolutionary theory of reasoning. We conclude by noting that the resistance to

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scientific challenge by the forensic odontologists in their editorial reflects the rear-guard defensiveness displayed by other forensic analysts and unprogressive prosecutors.

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INTRODUCTION

Controversy over the admissibility of bite mark evidence in criminal prosecutions has generated ample scientific, legal, and popular literature.¹ Perhaps the most curious document to come out of the ongoing debate is a risibly titled editorial, *Epidermis and Enamel: Insights into Gnawing Criticisms of Human Bitemark Evidence* (“*Epidermis and Enamel*”), published in a forensic science journal and authored by eleven forensic odontologists.² The eleven-page editorial article sought to dampen criticism of bite mark evidence generated by a wave of exonerations in which testimony by forensic dentists played a role.³ The article, while acknowledging the exonerations,⁴ offers a shotgun, or perhaps a blunderbuss, blast of defensive arguments rather than a rifle shot that hits the central critique: that bite mark evidence is such an unreliable pattern-comparison or feature-comparison method that courts should rule the technique inadmissible.⁵ The central theme of *Epidermis and*

¹ See Samuel D. Hodge, Jr., et al., *The Growing Controversy Swirling Around Bite Mark Identification*, PRAC. LAW., Aug. 2017, at 33; *infra* Parts I & II.

² See Robert E. Barsley et al., Editorial, *Epidermis and Enamel: Insights into Gnawing Criticisms of Human Bitemark Evidence*, 39 AM. J. FORENSIC MED. & PATHOLOGY 87, 87 (2018). The authors take pains to indicate that the article “is the work product solely of the authors and not of the American Board of Forensic Odontology” and does not represent the views of other organizations. *Id.* at 87. However, they also praise the ABFO for its leading role in improving the reliability of bite mark analysis and note that “ABFO leaders are committed to ongoing discussion to promote appropriate evolution of the field.” *Id.* at 88. Editorials can play important roles in forensic science (as well as in other professional areas). See, e.g., Peter R. De Forest, Editorial, *Proactive Forensic Science*, 38 SCI. & JUST. 1, 2 (1998) (arguing forensic science is a scientific discipline rather than a loose collection of other disciplines).

³ See Barsley et al., *supra* note 2, at 88.

⁴ See *id.*

⁵ See *id.* at 88–89.

Enamel seems to be (it is never clearly asserted) that because wrongful convictions almost always result from a combination of errors generated by a variety of actors,⁶ *and* because “[t]he legal community has an obligation to safeguard against invalid and unreliable testimony,”⁷ *and* perhaps because forensic odontologists have helped to exonerate some of the wrongfully convicted,⁸ *and* because forensic odontologists are taking steps to improve their practices⁹—bite mark analysis should continue to be admissible. A parallel central argument is that while “mistakes have been made in the past” by forensic odontologists “critics ignore the progress made by changes in standards, terminology, and the steps to inhibit bias.”¹⁰ The editorial’s one page review of standards, guidelines, knowledge transfer and education, research, certification, proficiency, and casework, however, does nothing to answer the mounting and powerful scientific evidence showing bite mark evidence to be inherently unreliable.¹¹

Along with this central argument, *Epidermis and Enamel* also argues that erroneous judgments by some forensic odontologists do not represent the professional norm;¹² criticizes its critics by denigrating their motives;¹³ includes testimonials of favorable writers;¹⁴ positions forensic odontology as a “self-correcting” life science;¹⁵ challenges the Texas Forensic Science Commission’s call for a bite mark evidence moratorium;¹⁶ and lists ways in which the bite mark analysis of forensic odontologists is becoming more proficient,¹⁷ while suggesting in passing that bite mark evidence be admitted only in unusual cases.¹⁸ What is most telling about this defense of bite mark analysis is what is missing.¹⁹ *Epidermis and Enamel* offers no

⁶ See *id.* at 89, 91–92.

⁷ *Id.* at 91.

⁸ *Id.* at 88.

⁹ See *id.* at 88, 89.

¹⁰ *Id.* at 87.

¹¹ See *id.* at 94–95; *infra* Part II.

¹² See Barsley et al., *supra* note 2, at 89.

¹³ See *id.* at 88.

¹⁴ See *id.* at 93–94.

¹⁵ *Id.* at 88.

¹⁶ See *id.* at 92–93.

¹⁷ See *id.* at 94–95.

¹⁸ See *id.* at 89. These defenses are analyzed and criticized in Part III.

¹⁹ Compare Michael Saks et al., *Forensic Bitemark Identification: Weak Foundations, Exaggerated Claims*, 3 J.L. & BIOSCIENCES 538, 566 (2016) (explaining that forensic bitemark analysis lacks validity and reliability in court), with Barsley et al., *supra* note 2, at 88 (describing forensic odontology as reliable and useful science in certain criminal cases, and ignoring the accepted issues with validity and reliability of forensic odontology). One thinks of

rejoinder to the substantive criticisms about the scientific basis or reliability of bite mark evidence²⁰ which was raised by the National Research Council's 2009 report on forensic science²¹ or by a major review of the scientific critique of bite mark evidence by Saks et al.²²—both of which are cited in the editorial—or with the critical analysis by the President's Council of Advisors on Science and Technology,²³ which is not cited.²⁴

The spectacularly weak reasoning at the center of *Epidermis and Enamel*, by purportedly self-correcting life scientists,²⁵ along with its often-defensive tone and defamatory criticism of innocence organizations, leads us to explore in greater depth the professional and organizational dynamics and the psychological factors that led this well-educated group into a logical cul-de-sac. Our goal is to understand why some portion of the forensic odontology community arduously resists the findings of critical scientific inquiry, and in so doing, shed some light on rear-guard action against forensic science reform by other forensic examiners and scientists.²⁶

For those familiar with the innocence movement's history, the analogy of prosecutorial resistance to DNA post-conviction testing in the 1990s and 2000s comes readily to mind. Several authors have described the often bizarre lengths to which prosecutors went to block post-conviction DNA testing or to deny the results of exonerating

Sherlock Holmes and "The Adventure of Silver Blaze" in which the dog did not bark. See ARTHUR CONAN DOYLE, *The Adventure of Silver Blaze*, in THE ORIGINAL ILLUSTRATED SHERLOCK HOLMES 185, 197–98 (1997).

²⁰ Compare Barsley et al., *supra* note 2, at 88 (challenging the critics of bite mark identification in forensic odontology), with Saks et al., *supra* note 19, at 566 (discussing the significant unreliability and validity of bite mark identification).

²¹ See COMM. ON IDENTIFYING THE NEEDS OF THE FORENSIC SCI. CMTY., NAT'L RES. COUNCIL, NAT'L ACAD. SCI., STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 173–76 (2009) [hereinafter NRC REPORT], <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf> [<https://perma.cc/2TX3-H6EF>] (in some sources, it is referred to as the NAS Report).

²² See Saks et al., *supra* note 19, at 538.

²³ See PRESIDENT'S COUNCIL OF ADVISORS ON SCI. & TECH., FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS 85–87 (2016) [hereinafter PCAST], https://www.whitehouse.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf [<https://perma.cc/Y4MC-BAHE>].

²⁴ See Barsley et al., *supra* note 2, at 87; PCAST, *supra* note 23. In contrast to *Epidermis and Enamel*, a more sober reaction to bite mark analysis challenges is provided by Richard Souviron & Leslie Haller, *Bite Mark Evidence: Bite Mark Analysis is Not the Same as Bite Mark Comparison or Matching or Identification*, 4 J.L. & BIOSCIENCES 617 (2017), discussed *infra* Part IV.

²⁵ See Barsley et al., *supra* note 2, at 88.

²⁶ See *infra* notes 309–430 and accompanying text.

DNA tests.²⁷ Others went beyond structural and cultural explanations to explore prosecutorial resistance in psychological terms.²⁸ Aviva Orenstein draws on cognitive bias research and explains prosecutorial resistance by the unconscious and non-volitional category of denial, described as “a deeper, more emotional mechanism that our unconscious uses to screen out unpleasant realities and the resultant distressing feelings.”²⁹ As a defense mechanism that masks certain realities which are “too terrible to be true,” denial has the paradoxical quality of being partial because the denier has to know the “terrible” reality at some level.³⁰ “Denial need not be absolute”; it can take the form of minimizing a reality but is always a distortion of truth.³¹ Denial is wrapped up in the denier’s self-identity.³² “That the prosecutor has invested time and energy into proving the prisoner’s guilt and has learned to think of the accused as a bad guy affects the prosecutor’s ability to see mistakes and fosters denial.”³³ The prosecutor’s “impossible” dual role as an advocate and as a minister of justice sets up a psychological bind wherein the “duty to do justice itself inspires denial.”³⁴

²⁷ See Susan Bandes, *Loyalty to One’s Convictions: The Prosecutor and Tunnel Vision*, 49 HOW. L.J. 475, 475–76 (2006); Seth F. Kreimer & David Rudovsky, *Double Helix, Double Bind: Factual Innocence and Postconviction DNA Testing*, 151 U. PA. L. REV. 547, 551 (2002); Daniel S. Medwed, *The Zeal Deal: Prosecutorial Resistance to Post-Conviction Claims of Innocence*, 84 B.U. L. REV. 125, 129–30 (2004). To some degree, the legal and political pressure to pass laws allowing or mandating postconviction DNA testing was the innocence movement’s prime policy objective in the early 2000s, culminating in the federal Innocence Protection Act of 2004 and the eventual passage of a DNA testing law in every state. See Nancy Marion & Marvin Zalman, *Towards a Theory of Innocence Policy Reform*, in *CONTROVERSIES IN INNOCENCE CASES IN AMERICA* 175, 181, 183 (Sarah L. Cooper ed., 2014); Kara Kerker, *Post-Conviction DNA Testing: The Need to Make Post-Conviction DNA Testing an Automatic Constitutional Right*, 8 ARIZ. SUMMIT L. REV. 413, 424–26 (2015); *Access to Post-Conviction DNA Testing*, INNOCENCE PROJECT (Oct. 8, 2019), <https://www.innocenceproject.org/access-post-conviction-dna-testing/> [<https://perma.cc/ZF27-7B65>].

²⁸ See Aviva Orenstein, *Facing the Unfaceable: Dealing with Prosecutorial Denial in Postconviction Cases of Actual Innocence*, 48 SAN DIEGO L. REV. 401, 425–28 (2011). Orenstein summarizes the explanations for prosecutorial resistance developed in prior scholarship: (1) emphasis on finality and concerns with costs; (2) career interests, especially the emphasis on winning cases; (3) maintaining public trust and not disrupting operations; (4) a hyper-adversarial culture; and (5) the personality of people drawn to work as prosecutors. See *id.* at 420–24.

²⁹ *Id.* at 428.

³⁰ *Id.* at 428–30 & n.144.

³¹ *Id.* at 430.

³² See *id.* at 431–32.

³³ *Id.* at 430–31.

³⁴ See *id.* at 432 (drawing in part on Barbara O’Brien, *A Recipe for Bias: An Empirical Look at the Interplay Between Institutional Incentives and Bounded Rationality in Prosecutorial Decision Making*, 74 MO. L. REV. 999, 1001 (2009)).

In a similar vein, Susan Bandes locates the source of prosecutorial denial in the value of loyalty to one's group, which in evolutionary terms is essential for human solidarity and survival.³⁵ In complex societies group loyalty may conflict with other values,³⁶ but in any event "loyalty is shaped and continually reinforced in a social context, through psychological mechanisms," which include both emotional rewards and fears of enforcement mechanisms such as banishment.³⁷ Those who join a group, share its goals, and thrive within it "are likely to internalize and adopt as their own not only the goals of the organization but its internal culture, beliefs, and ways of thinking about problems. Information that threatens this mutually beneficial symbiosis may be warded off at a very early stage in an individual's thought process."³⁸ The complementary psychological categories explicated by Orenstein and Bandes³⁹ may tap into similar neurological and social processes, which in turn help explain irrational thinking or even socially immoral decisions, as less than fully volitional.

To understand how DNA exonerations in the 1990s challenged the worldview and self-image of prosecutors and other criminal justice actors including forensic odontologists, one must enter (or reenter) a world in which the reality that a small percentage—but nevertheless thousands—of innocent people are convicted of felonies every year was inconceivable.⁴⁰ So inconceivable that even reform-oriented criminal defense litigators considered such a scenario to be unreal.⁴¹

³⁵ See Bandes, *supra* note 27, at 481.

³⁶ See *id.* at 481–82, 488.

³⁷ *Id.* at 482.

³⁸ *Id.* at 482–83.

³⁹ See generally *id.* (discussing how the conceptual interpretation of one's loyalty is molded and subsequently reinforced through psychological mechanisms within a social context); Orenstein, *supra* note 28 (analyzing the psychological implications of the prosecutorial self-identity and how it may lead to denial in postconviction cases of actual innocence).

⁴⁰ Estimation of the incidence of wrongful convictions is a difficult and contested matter. See Samuel R. Gross et al., *Rate of False Conviction of Criminal Defendants who are Sentenced to Death*, 111 PNAS 7230, 7230, 7231 (2014). A generally held view among innocence scholars is that an unknown general rate of actual innocence error may run around 2 percent or higher. See *id.* at 7231, 7233; Marvin Zalman, *Qualitatively Estimating the Incidence of Wrongful Convictions*, 48 CRIM. L. BULL. 221, 240 (2012). This understanding has recently been challenged in analyses conducted by legal scholars. See Paul G. Cassell, *Overstating America's Wrongful Conviction Rate? Reassessing the Conventional Wisdom about the Prevalence of Wrongful Convictions*, 60 ARIZ. L. REV. 815, 817 (2018); Paul G. Cassell, *Jurisdiction-Specific Wrongful Conviction Rate Estimates: The North Carolina and Utah Examples*, 60 ARIZ. L. REV. 891, 892 (2018); George C. Thomas III, *Where Have All the Innocents Gone?*, 60 ARIZ. L. REV. 865, 877 (2018). The last word on the subject has probably not been written.

⁴¹ Cf. Michael Meltsner, *Innocence Before DNA*, in WRONGFUL CONVICTIONS AND THE DNA REVOLUTION 14, 15–16 (Daniel S. Medwed ed., 2017) (describing the widespread shock that

But the realization that wrongful convictions occur with regularity led swiftly to new thoughts and policies that upset the complacent world view of many criminal justice actors.⁴² The literary and jurisprudential scholar, Stanley Fish, nicely captures how deeply felt is one's sense of betrayal to a changed world. In the film version of *How to Succeed in Business Without Really Trying*,⁴³ a comedy about the ethical underbelly of the American business world,⁴⁴ the boss's nephew, working in the mail room and expecting nepotistic advancement, cries out "That's not fair!" when the boss declares that promotion will henceforth be based on merit.⁴⁵ On the surface the line is humorous, but Fish digs deeper to ruminate on the way in which high order concepts like fairness are shaped by context and expectations.⁴⁶ The nephew sees the rules of the game he has lived by, in which family relationship is a component of merit, as suddenly changing:

In effect he is reacting just as the elder son in a hereditary monarchy might react were he to be told just before the king died that from now on we're going to do it differently and hold elections. In both cases the disappointment is more than personal; it extends to the overturning of a whole way of life, complete with a tradition, a set of expectations, obligatory routines, normative procedures, in-place hierarchies, and so on. And when a new way of life is forcefully introduced, the sense of betrayal is cosmic, and the terms in which it is expressed are abstract and universal⁴⁷

One might sympathize with people whose expectations, status, and way of life are upended, although responses to such deep changes have also produced ugly reactions that are judged harshly by

Judge Hand's description of the "unreal dream" was, in fact, "a nightmare reality"). For how the realization of wrongful convictions affected the thinking and action of a former prosecutor, see generally MARK GODSEY, *BLIND JUSTICE: A FORMER PROSECUTOR EXPOSES THE PSYCHOLOGY AND POLITICS OF WRONGFUL CONVICTIONS* (2017).

⁴² See Meltsner, *supra* note 41, at 29–30.

⁴³ See STANLEY FISH, *THERE'S NO SUCH THING AS FREE SPEECH, AND IT'S A GOOD THING, TOO* 3 (1994).

⁴⁴ See *id.*

⁴⁵ *Id.*

⁴⁶ See *id.* at 3–4.

⁴⁷ *Id.*

history.⁴⁸ These attempts to plumb the deeper sources of resistance to change, which might include patently unreasoned argument, lead us to seek a deeper explanation of forensic odontologists' resistance to the scientific critique of bite mark analysis.

The arguments of *Epidermis and Enamel* are so transparently weak that we are led to explore the forces that have generated such resistance to forensic science reform. Thus, while we critique *Epidermis and Enamel* as the weakly reasoned polemic that it is, it should be read as part of a larger counter attack by some "industry" forensic scientists against the movement to place the forensic sciences on a more scientific base, to improve the reliability of some feature-comparison disciplines, and where needed, to remove weaker methods from use by prosecutors and courts.

This Article proceeds as follows: Part I, A Tale of Two Forensic Dentists, compares the lurid career of Michael West, a bite mark specialist whose trail of error led to national notoriety,⁴⁹ with speculation about the honest motivations that led a Michigan forensic odontologist, as a stand-in for others, to engage in bite mark analysis. In this section we argue that most mistakes that lead to wrongful convictions, including bite mark analysis, are products of normal human error rather than corrupt motives. Seeing wrongful convictions as the products of systemic error rather than "rotten apples" is a more accurate view of reality, is more likely to generate systemic reforms, and is more likely to convince well-meaning justice professionals that evidence-based changes are beneficial to their professions. Our case study of a Michigan exoneration in which bite mark evidence played a role also provides evidence for criticism of *Epidermis and Enamel's* central thesis.

Part II, A Brief Review of Bite Mark Evidence, sets the foundation for issues related to the bite mark controversy. Criticism of bite mark evidence is one part of the crisis caused by DNA and non-DNA exonerations that led to a paradigm shift in forensic science, a reform

⁴⁸ See ERIC FONER, RECONSTRUCTION: AMERICA'S UNFINISHED REVOLUTION 570–71 (1988). Given rising ideological polarization, we might better say that reactions have been judged harshly by the history of some. The reaction of white Southerners to their status change after the Civil War—the "redemption movement" that overturned Reconstruction, imposed the Jim Crow regime on African Americans, and set American race relations on its well-analyzed and doleful course—had enormously negative consequences on criminal justice. See MICHELLE ALEXANDER, THE NEW JIM CROW: MASS INCARCERATION IN THE AGE OF COLORBLINDNESS 30–32, 35 (2010); FONER, *supra*, at 593–95.

⁴⁹ See John Grisham, *Foreword* to RADLEY BALKO & TUCKER CARRINGTON, THE CADAVER KING AND THE COUNTRY DENTIST: A TRUE STORY OF INJUSTICE IN THE AMERICAN SOUTH, at xi–xii (2018).

movement, and resistance to reform.⁵⁰ This section, similar to a scientific article's literature review, summarizes earlier studies describing how forensic dentistry and court decisions intertwined in the 1970s and 1980s to establish bite mark analysis as an accepted forensic science. This section will be useful to readers unfamiliar with the bite mark and forensic science controversies.

Part III, examining *Epidermis and Enamel*, includes our critical review of the editorial and exposes its weak reasoning and defensive posture.

Part IV, Unreasoned Reasons, offers a speculative explanation of the social and psychological mechanisms behind *Epidermis and Enamel*, based in part on established psychological constructs, including cognitive dissonance, and the evolutionary theory of reasoning advanced by Hugo Mercier and Dan Sperber.⁵¹

Part V, Conclusion: The Counterattack on Reason and Evidence, places the resistance of the forensic odontologists whose analysis we criticize in Part III and who we try to understand in Part IV in the context of other forensic scientists and crime analysts who adhere to methodologies that have been superseded by more scientific and evidence-based methods.⁵²

I. A TALE OF TWO DENTISTS

Of the 200,000 dentists in the United States and Canada, about 100 or fewer are identified as board certified *diplomates* of the American Board of Forensic Odontology (ABFO).⁵³ There are about

⁵⁰ See Michael J. Saks & Jonathan Koehler, *The Coming Paradigm Shift in Forensic Identification*, 309 SCI. 892, 892 (2005). The paradigm shift has been accepted as a present reality by the mid-2010s. See Sue Black & Niamh N. Daeid, *Time to Think Differently: Catalysing a Paradigm Shift in Forensic Science*, PHIL. TRANSACTIONS ROYAL SOC. B, Aug. 5, 2015, no. 20140251, at 3–4; Paul Roberts, *Paradigms of Forensic Science and Legal Process: A Critical Diagnosis*, PHIL. TRANSACTIONS ROYAL SOC. B, Aug. 5, 2015, no. 20140256, at 2.

⁵¹ See HUGO MERCIER & DAN SPERBER, *THE ENIGMA OF REASON: A NEW THEORY OF HUMAN UNDERSTANDING* (2017); Barsley et al., *supra* note 2.

⁵² This issue is explored in regard to arson investigation in EDWARD HUMES, *BURNED: A STORY OF MURDER AND THE CRIME THAT WASN'T* (2019).

⁵³ See C. Michael Bowers, *Review of a Forensic Pseudoscience: Identification of Criminals from Bitemark Patterns*, 61 J. FORENSIC & LEGAL MED. 34, 38 n.28 (2019) [hereinafter Bowers, *Pseudoscience*]; AMERICAN BOARD OF FORENSIC ODONTOLOGY DIPLOMATE INFORMATION (March 2019) [hereinafter ABDO DIPLOMATE INFORMATION], <http://abfo.org/wp-content/uploads/2017/05/ABFO-Diplomate-Information-revised-May-1-2019.pdf> [https://perma.cc/K654-G5X5]. The ABFO “was organized in 1976 and is recognized by the American Academy of Forensic Sciences as a forensic specialty. The ABFO offers board certification to its members.” NRC REPORT, *supra* note 21, at 173. “In 2015, there were 195,722 practicing dentists in the United States.” Bradley Munson & Marko Vujicic, *Number of Practicing Dentists per Capita in the United*

three times as many forensic dentists who are not board certified; also, non-forensically trained dentists may participate in forensic dentistry.⁵⁴ Few odontologists practice this investigative specialty full time.⁵⁵ Before bite mark analysis was added to the forensic odontology toolkit, the unobjectionable practice of identifying deceased persons by linking dental remains to dental records was well established.⁵⁶ How did well-trained practitioners of such a sober and intuitively reliable practice come to accept the questionable practice of bite mark comparison analysis?⁵⁷ In this part we consider

States Will Grow Steadily, AM. DENTAL ASS'N (June 2016), https://mus.edu/che/arsa/HEWCC/HPIBrief_number%20dentists%200616_1.pdf [<https://perma.cc/N4BE-SKQV>].

⁵⁴ In 2004 there were 425 members of the Odontology section of the American Association of Forensic Science compared to 84 ABFO Certified odontologists. See C. MICHAEL BOWERS, *FORENSIC DENTAL EVIDENCE: AN INVESTIGATOR'S HANDBOOK 1* (1st ed. 2004) [hereinafter BOWERS, HANDBOOK]; Dave Altimari & David Owens, *State Agrees on New Trial for Convicted Murderer Swinton, Once a Suspected Serial Killer*, HARTFORD COURANT (June 08, 2017, 6:49 AM), <https://www.courant.com/news/connecticut/hc-hartford-murderer-swinton-new-trial-20170608-story.html> [<https://perma.cc/M5KE-JXYS>] (reporting defense unsuccessful in excluding a dentist from testifying who worked for 25 years for Connecticut state police on grounds that “he wasn’t considered an expert” in forensic odontology).

⁵⁵ “Most people in forensic odontology are practicing dentists, or academics. They don’t make their living doing bite mark analysis,” says Michael Saks, an Arizona State University law professor who studies the role of science in criminal law. “They do it on the side . . .” Radley Balko, *The Path Forward on Bite Mark Matching—And the Rearview Mirror*, WASH. POST (Feb. 20, 2015, 1:57 PM), <https://www.washingtonpost.com/news/the-watch/wp/2015/02/20/the-path-forward-on-bite-mark-matching-and-the-rearview-mirror/> [<https://perma.cc/57ZB-BFXE>] [hereinafter *Path Forward*] (Part 4 of a four-part investigative reporting series on bite mark evidence).

⁵⁶ See *The Controversial History of Bite Mark Analysis*, AM. STUDENT DENTAL ASS'N BLOG (June 15, 2016), <https://www.asdablog.com/the-controversial-history-of-bite-mark-analysis/> [<https://perma.cc/A678-7U8Y>]. Forensic odontology textbooks include chapters on bite mark techniques. See, e.g., BOWERS, HANDBOOK, *supra* note 54, at 67–105 (including a chapter on the techniques for understanding the appearance, characteristics, forensic terminology, and rationale of bite mark analysis in the 21st century). In addition to bite mark analysis, the scientific validity of the aging of a person by analysis of teeth has been questioned. See Brittny Mejia, *Migrant Minor is Held in Adult Detention Facility for Nearly a Year After Dental Exam Found He Was Likely 18*, L.A. TIMES (Oct. 2, 2018, 4:00 AM), <https://www.latimes.com/local/california/la-me-ln-dental-xray-20181002-story.html> [<https://perma.cc/RRQ8-6AM3>].

⁵⁷ See NRC REPORT, *supra* note 21, at 176; *infra* Part II. Bite mark analysis is not the only unreliable forensic practice that was taken, for a while at least, to be based on unimpeachable science; the story of comparative or compositional bullet lead analysis provides a cautionary tale. See Edward J. Imwinkelried & William A. Tobin, *Comparative Bullet Lead Analysis (CBLA) Evidence: Valid Inference or Ipse Dixit?*, 28 OKLA. CITY U. L. REV. 43, 72 (2003); see, e.g., Max M. Houck, *Exquisite Measurements, Erroneous Inferences: Compositional Bullet Lead Analysis*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, 9 (Wendy J. Koen & C. Michael Bowers eds., 2017) (describing how the FBI’s CBLA method made the leap from “exquisite measurement to erroneous interpretation” after an independent review conducted by the National Academy of Sciences found the technique to be “flawed and without scientific basis”); Wendy Koen, *Case Study: James Otto Earhart*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, *supra*, at 4 (explaining how an FBI agent’s CBLA testimony was

the good faith of forensic analysts by examining the work of two forensic odontologists.⁵⁸ Cases of forensic scientists' outright fraud surely grab more headlines and are easier for the public to understand.⁵⁹ The much larger and more pervasive problem, however, is, as stated by Professor Sandra Guerra Thompson, the paradox of the ethical and biased analyst.⁶⁰

Bite mark analysis was probably adopted as a reliable technique in (erroneous) good faith by most odontologists, despite some warning signs.⁶¹ We contrast the flamboyant career of bite mark practitioner Dr. Michael West, whose excesses might exemplify the bite mark analyst for many or mark it as an aberrant practice, with a case study of Dr. Allan Warnick's erroneous bite mark evidence. Warnick, a "normal" odontologist, represents the norm among forensic odontologists, at least in his work style if not in his results.

Michael West's notorious career was marked by flagrant, unsupportable, and at times corrupt practices.⁶² He was identified as a purveyor of "junk science" in *Actual Innocence*, the 2000 book which

not only held out to be "infallible, solid, precise, scientific evidence," but that the agent himself was also "revered" by those participating in the trial).

⁵⁸ The reliability of bite mark evidence is reviewed in greater detail in Part II and a deeper psychological explanation is advanced in Part IV.

⁵⁹ See, e.g., JIM DWYER ET AL., *ACTUAL INNOCENCE: FIVE DAYS TO EXECUTION AND OTHER DISPATCHES FROM THE WRONGLY CONVICTED* 107–25 (1st ed., 2000) (discussing examples of how wrongful conviction cases are so easily picked up by mainstream media and disseminated to the general public); SANDRA G. THOMPSON, *COPS IN LAB COATS: CURBING WRONGFUL CONVICTIONS THROUGH INDEPENDENT FORENSIC LABORATORIES* 35–36 (2015) (explaining how the national publicity surrounding wrongful conviction cases has ousted incompetent criminal laboratories and invalid forensic practices). Forensic fraud takes the forms of performing tests with gross incompetence, lying about credentials, cheating on proficiency tests, tampering with drug evidence to steal drugs, "faking laboratory results, intentionally misinterpreting evidence, and giving flagrantly perjured testimony." *Id.* at 35. Sixty-seven laboratory scandals were identified in twenty-eight states resulting in one-hundred fifteen exonerations. *Id.* at 52–61.

⁶⁰ See THOMPSON, *supra* note 59, at 130–33.

⁶¹ An early survey found the motives that drew people to careers in dentistry included prestige, financial earnings, human service, autonomy, and manual skill. See D.M. More & Nathan Kohn, Jr., *Some Motives for Entering Dentistry*, 66 AM. J. SOC. 48, 48 (1960). We have not discovered a similar article on motivations that draw dentists to forensic odontology. We speculate that prestige, human service, and manual skill will rate high as allures to odontology, that autonomy will rate lower as odontologists will be subject to the control of medical examiners or litigators, and that the financial attraction will depend on the kinds of fees offered for workup and testifying offset by the earnings from their dental practices.

⁶² See Paul C. Giannelli, *Bite Mark Analysis* 26–27 & nn.92–93 (Case Research Paper Series in Legal Studies, Working Paper No. 08-06, Jan. 2008). "A series of cases in Mississippi has made Dr. Michael West a controversial figure." *Id.* at 26. Cases included matching teeth to indentations on a bologna sandwich, which was destroyed; requiring use of photographic evidence leading to reversal of conviction as prejudicial; testifying to bite marks that another expert identified as ant bites; identifying bite marks made three weeks before inspection, contradicted by Dr. Richard Souviron who testified that the wound was not a bite mark, and if it were, was inconsistent with the teeth of alleged biter. See *id.* at 26–27, 27 n. 92.

helped accelerate the innocence movement by bringing it to national attention.⁶³ Wearing yellow goggles and applying a blue laser light, self-labeled the “West Phenomena,” he “claimed to be able to visualize tooth marks, cuts, and scrapes on the skin of crime victims that no one else could see. . . . No one has ever been able to duplicate West’s work.”⁶⁴ West’s career is detailed in *The Cadaver King and the Country Dentist: A True Story of Injustice in the American South*, by *Washington Post* reporter Radley Balko and Mississippi Innocence Project Director Tucker Carrington.⁶⁵ Balko had previously reported on Michael West.⁶⁶

⁶³ See DWYER ET AL., *supra* note 59, at 164; Marvin Zalman, *An Integrated Justice Model of Wrongful Convictions*, 74 ALB. L. REV. 1465, 1491–92 (2011).

⁶⁴ See DWYER ET AL., *supra* note 59, at 163; Mark Hansen, *Out of the Blue*, A.B.A. J., Feb. 1996, at 51.

⁶⁵ See BALKO & CARRINGTON, *supra* note 49. The book is a complex, compound story of two wrongful convictions and exonerations, two forensic scientists, and “a sprawling, complex affair” about the control of death investigations in Mississippi. *See id.* at xiii–xix. Two African American working-class men, Levon Brooks and Kennedy Brewer, were convicted in 1992 and 1995 for murdering their girlfriends’ young daughters, Courtney Smith and Christine Jackson, in nearby Mississippi communities. *See id.* at 157–58, 195. They were exonerated in 2008 by DNA profiling and with the assistance of the Innocence Project. *See* Tucker Carrington, *Mississippi Innocence: The Convictions and Exonerations of Levon Brooks and Kennedy Brewer and the Failure of the American Promise*, 28 GEO. J. LEGAL ETHICS 123, 167–68 (2015). The killer was deranged local man, Justin Albert Johnson, a known drug user and sex offender at the time of the murders, and who was considered as a suspect and rejected. *See* BALKO & CARRINGTON, *supra* note 49, at 4–5, 19–20, 26–27, 31–32. The wrongful convictions were the product of shoddy police work that relied heavily on the assertion of pathologist Dr. Steven Hayne that bruises on the girls were bite marks, and on the analysis of Dr. Michael West. *Id.* at 8–10, 19–20, 22, 32. Hayne and West often worked as a team and the book details their questionable methods, including Hayne’s autopsy caseload, which was far greater than called for by professional standards. *See id.* at 94–95. Far from being a typical wrongful conviction narrative, *The Cadaver King* is a mind-boggling story of how these two driven and unscrupulous actors took advantage of a miserly state’s close to non-existent system for death investigation, corrupt coroners’ offices, and institutional racism, to dominate criminal autopsies in Mississippi. *See id.* at xvii–xix. They became go-to experts by less than critical prosecutors who seemed far more interested in assertions of guilt than the truth. *See id.* at xx. Attempts to reform Mississippi’s death investigation system continuously failed but eventually the egregious work led to West and Hayne being professionally sidelined. *See id.* at 317. The book is based in part on previously published work by Tucker Carrington. *See id.* at xxi; Carrington, *supra*.

⁶⁶ The book’s material on West is based in part on Balko’s 2015 four-part investigative report on bite mark analysis in the *Washington Post*. *See* Radley Balko, *How the Flawed ‘Science’ of Bite Mark Analysis Has Sent Innocent People to Prison*, WASH. POST (Feb. 13, 2015, 10:38 AM), <https://www.washingtonpost.com/news/the-watch/wp/2015/02/13/how-the-flawed-science-of-bite-mark-analysis-has-sent-innocent-people-to-jail/> [<https://perma.cc/LV4A-9S48>] [hereinafter Balko, *Flawed Science*]; Radley Balko, *It Literally Started with a Witch Hunt: A History of Bite Mark Evidence*, WASH. POST (Feb. 17, 2015, 10:57 AM), <https://www.washingtonpost.com/news/the-watch/wp/2015/02/17/it-literally-started-with-a-witch-hunt-a-history-of-bite-mark-evidence/> [<https://perma.cc/V6UR-RVQ2>]; Radley Balko, *Attack of the Bite Mark Matchers*, WASH. POST (Feb. 18, 2015, 5:02 PM), <https://www.washingtonpost.com/news/the-watch/wp>

When West's career as a bite mark specialist bloomed in the tough-on-crime 1980s, the technique had already been accepted by several state courts and had become known to the public through the Ted Bundy serial killer case.⁶⁷ While practicing medicine and working as a forensic odontologist, West engaged in bite mark research, published many articles on the topic, often with Robert Barsley, and testified for the prosecution in the first Mississippi trial where bite mark evidence was introduced (although the defendant was acquitted).⁶⁸ A close look at his work in Levon Brooks's wrongful conviction case shows that his techniques were highly questionable.⁶⁹ He was an assistant coroner,⁷⁰ garnered favorable local news coverage,⁷¹ and sought to insinuate himself in a serial murder case in order to expand his profile.⁷² A sign that West was on shaky ground as a forensic scientist in a corrupt prosecutorial and judicial system was his being called to testify and qualified as an expert in at least a dozen scientific or pattern-comparison categories in which he had little or no training.⁷³ Balko and Carrington opine that "Michael West is either a master bullshit artist or an autodidact for the ages."⁷⁴ His earthy persona made him effective with juries;⁷⁵ he always testified for the prosecution.⁷⁶ In one case he removed a murder victim's fingernails, mounted them on sticks, and claimed to match the fingernails to scratches on the suspect's skin; however, he failed to produce test marks making it impossible to review his conclusions.⁷⁷ Perhaps his worst technique was the practice of pushing dental casts from a suspect onto the skin of a victim where a

/2015/02/18/attack-of-the-bite-mark-matchers-2/ [https://perma.cc/T87C-2JBQ] [hereinafter Balko, *Bite Mark Attack*]; *Path Forward*, *supra* note 55.

⁶⁷ See *infra* note 226 and accompanying text.

⁶⁸ See BALKO & CARRINGTON, *supra* note 49, at 106–07, 108–09. Dr. Barsley is the first named author of *Epidermis and Enamel: Insights into Gnawing Criticisms of Human Bitemark Evidence*. See Barsley et al., *supra* note 2 (the authors are listed alphabetically).

⁶⁹ In that case, West failed to apply a retainer to preserve the shape of skin excised from a deceased and conducted an examination after the body had been embalmed, both errors that distorted the bite mark image. See BALKO & CARRINGTON, *supra* note 49, at 9–10.

⁷⁰ See *id.* at 110. He often mangled or exaggerated his title, including "deputy coroner ranger" and "coroner medical examiner investigator." *Id.*

⁷¹ See *id.* at 110, 113.

⁷² See *id.* at 111–12.

⁷³ These included "bite mark analysis, gunshot reconstruction, wound pattern analysis, pathophysiology, blood stain analysis, gunshot residue, fingernail scratch reconstruction, trace metal analysis, video enhancement, pour pattern analysis, tool mark analysis, and photo enhancement." *Id.* at 111, 112–13.

⁷⁴ *Id.* at 111.

⁷⁵ See *id.* at 114–15.

⁷⁶ See *id.* at 112–13.

⁷⁷ See *id.* at 119.

bite mark, or alleged bite mark, appeared, thus possibly fabricating evidence.⁷⁸

In another case West simply looked at a clean knife in the home of a murder suspect with a good alibi and immediately declared it to be the murder weapon.⁷⁹ He linked the knife to the murder by using ultraviolet light to claim to see impressions the knife handle left on the skin of the suspect's hand purportedly made weeks before;⁸⁰ when he overexposed photographs of the suspect's hands, West made photocopies of the hands and drew the knife's indentations patterns from memory.⁸¹ These techniques are patently absurd, but in every case West would support his assertions of matches, which were almost always admitted into evidence, with his signature phrase: "indeed and without doubt."⁸²

By 1996 West's notoriety fetched him a cover story in the February issue of the *American Bar Association Journal*.⁸³ Noting that "West's self-proclaimed forensic abilities . . . have long been questioned by many of his peers," and that "West has claimed to see things that he has not been able to document, fail[ing] to follow generally accepted scientific techniques," he nevertheless remained in demand by prosecutors.⁸⁴ Although Mississippi courts upheld his testimony, West was excoriated in several dissents, especially in the appeal from Levon Brooks's conviction, in which Justice McCrae commented, "This is not the first time that Dr. West has been able to boldly go where no expert has gone before."⁸⁵

⁷⁸ See Radley Balko, *Video Shows Controversial Forensic Specialist Michael West Fabricating Bite Marks*, HUFFINGTON POST (Sept. 1, 2011, 7:43 AM), https://www.huffpost.com/entry/michael-west-fabricating-bite-marks_n_944228 [<https://perma.cc/P752-D99P>].

⁷⁹ See BALKO & CARRINGTON, *supra* note 49, at 119.

⁸⁰ See *id.* at 120.

⁸¹ See *id.* In this case, West claimed that three forensic scientists used the method, but all filed affidavits denying this. See *id.* at 120–21. The suspect was ultimately released and sued West for civil damages. See *id.* at 121. The case was dismissed because while the affidavits of several forensic scientists discredited West's methods, a supporting affidavit by Stephen Hayne, West's partner in arms, led the court to ascribe the criticism of his methods as a difference of opinion among experts. See *id.* at 121–22.

⁸² See *Brooks v. State*, 748 So. 2d 736, 749 (Miss. 1999) (McRae, J., dissenting). "This Court's apparent willingness to allow West to testify to anything and everything so long as the defense is permitted to cross-examine him may be expedient for prosecutors but it is harmful to the criminal justice system." *Id.* at 750 (footnote omitted). West also used terms like "astronomical" and "without question" in "boastful reports larded with certainty." BALKO & CARRINGTON, *supra* note 49, at 114.

⁸³ See Hansen, *supra* note 64, at 50. He was also called out by a report by John Stossel on *ABC News*, by the *National Law Journal*, *New Orleans Times-Picayune*, *Newsweek* and *60 Minutes*. See BALKO & CARRINGTON, *supra* note 49, at 206, 241–42.

⁸⁴ Hansen, *supra* note 64, at 50–51.

⁸⁵ *Brooks*, 748 So. 2d at 748 (McRae, J., dissenting).

West's decisions were so egregious that he was eventually brought to book. His status and affiliations were challenged in the late 1990s.⁸⁶ The defense attorney in the case in which West identified a knife as a murder weapon by sight,

John Holdridge of the Mississippi and Louisiana Capital Trial Assistance Project, filed complaints about West with professional organizations. An ethics committee of the American Academy of Forensic Sciences [AAFS] concluded that West had “misrepresented data in order to support his testimony” and that the term “indeed and without doubt” was unwarranted. Similarly, an ethics committee of the American Board of Forensic Odontologists [ABFO] concluded that West had “materially misrepresented the evidence and data.” It also concluded that the “West Phenomenon” was not “founded on scientific principles” and that West had presented testimony “outside the field of forensic odontology.” Finally, the Crime Scene Certification Board of the International Association of Identification [IAI] concluded (but only by a majority) that there was a basis for the complaint and provided West with an opportunity to relinquish his “Senior Crime Scene Analyst” certification.⁸⁷

West continued to practice but as court rulings began to go against him he “stopped doing bite mark analyses in 2006 . . . [and] gave up his private dental practice in 2009.”⁸⁸ “In 2012, he said in a deposition, ‘I no longer believe in bite mark analysis,’ and then later said to a reporter, ‘The science is not as exact as I had hoped.’”⁸⁹ It is worth considering that West was not only an egregious confabulator among forensic dentists, but along with Steven Hayne and morgue owner Jimmy Roberts, poured enormous energy into efforts that “would come to dominate Mississippi’s medicolegal system. ‘The

⁸⁶ See *id.* at 749.

⁸⁷ Paul C. Giannelli, *The Abuse of Scientific Evidence in Criminal Cases: The Need for Independent Crime Laboratories*, 4 VA. J. SOC. POL. & L. 439, 454–55 (1997) (alterations in original) (internal cites omitted).

⁸⁸ BALKO & CARRINGTON, *supra* note 49, at 317. Simultaneously, Steven Hayne’s control on forensic pathology slipped. See *id.* at 287, 288.

⁸⁹ *Id.* at 315. Nevertheless, bite mark analysis, some of it inspired by West’s widely publicized methods, continue to be used by prosecutors and supported by courts. See Radley Balko, *Yet Another Bite-Mark Conviction is Unraveling*, WASH. POST (May 21, 2018, 2:09 PM), <https://www.washingtonpost.com/news/the-watch/wp/2018/05/21/yet-another-bite-mark-conviction-is-unraveling/> [https://perma.cc/5Q5E-DB33].

Mississippi system was run by a triumvirate for years,' says one long-serving former coroner. 'Imagine that. A pathologist, a small-town dentist, and a funeral director. . . . The state provided an audience of adoring idiots.'"⁹⁰ No other forensic odontologist came close to matching West's outrageous career and none other was expelled from the ABFO.⁹¹

Our study of Michigan exonerations led to the Cristini-Moldowan case and to Dr. Allan Warnick.⁹² Dr. Warnick, now retired, practiced dentistry in suburban Detroit with an unblemished record, until he expanded his work to include bite mark analysis.⁹³ Drawn to forensic odontology, he did what was best in that specialization by identifying deceased victims of airplane crashes and of the 9/11 World Trade Center attack.⁹⁴ He was chief forensic odontologist in the Wayne County Medical Examiner's Office and a consultant to Macomb

⁹⁰ BALKO & CARRINGTON, *supra* note 49, at 115 (alteration in original).

⁹¹ ABFO officers did file an ethics complaint against Dr. Michel Bowers, a prominent bite mark skeptic, with the American Academy of Forensic Sciences (AAFS) in retaliation for his outspoken criticism of bite mark evidence. See Balko, *Bite Mark Attack*, *supra* note 66. Dr. Bowers had previously resigned from the ABFO in 2011. See *id.* Dr. Bowers was also sued for defamation by two forensic odontologists (who testified for the prosecution in a wrongful conviction case). See *id.*

⁹² The review of Warnick's work in the Cristini-Moldowan case provides some data to support our argument in Part IV, *infra*, suggesting why odontologists may find it difficult to drop bite mark analysis from their professional repertoire.

⁹³ See *Otero v. Warnick*, 614 N.W.2d 177, 182 (Mich. Ct. App. 2000); ABDO DIPLOMATE INFORMATION, *supra* note 53; Allan Warnick, *People at Detroit Mercy*, U. DETROIT MERCY, <http://www.udmercy.edu/about/people/university/dental/presenters/allan-warnick> [<https://perma.cc/2N8Y-HHQQ>] [hereinafter *Warnick, Detroit Mercy*]; *Class of 2019 Spirit Awards: Allan J. Warnick, D.D.S. '64, Forensic Dentist*, FOREVER TITANS BLOG (Mar. 22, 2019), <http://sites.udmercy.edu/alumni/2019/03/22/class-of-2019-spirit-awards-allan-j-warnick-d-d-s-64-forensic-dentist/> [<https://perma.cc/VVS9-PJFC>] [hereinafter *Class of 2019 Spirit Awards*].

⁹⁴ Dr. Warnick did not respond to our inquiries to be interviewed for our larger project after he retired. He testified that he taught about odontology or "legal dentistry" at the University of Detroit School of Dentistry. Dr. Warnick's web site at the University of Detroit Mercy School of Dentistry reports that

Allan Warnick, DDS, DABFO, Course Director, Chief Forensic Odontologist, Wayne and Oakland County Medical Examiner's Office, earned his degree from the University of Detroit School of Dentistry. Dr. Warnick is a Diplomate of the American Board of Forensic Odontology and a Fellow of the Academy of Forensic Sciences. Dr. Warnick is the Team Leader of the Michigan Dental Association Forensic Dental Identification Team, which has responded to the Northwest Flight #255, Flight #1487, and Comair Flight #3272 airplane disasters. Most recently, he was deployed as part of the NDMS-DMORT team to assist at the World Trade Center.

Warnick, Detroit Mercy, *supra* note 93; see Trial Transcript at 49, *State v. Cristini*, No. 90-1514 (Mich. Cir. Ct. Macomb Cty. May 1, 1991) [hereinafter Trial Transcript, Cristini & Moldowan 1991].

County, Monroe County, and the Michigan State Police.⁹⁵ By all accounts Allan Warnick was a respected, sober, and competent professional and educator who displayed none of the flamboyance, carelessness, or excessiveness observed in Michael West's career,⁹⁶ and yet he was responsible for several mistaken identifications and one apparent ethical lapse coming out of his investment in bite mark analysis.⁹⁷

Epidermis and Enamel's central argument is that wrongful convictions are caused by a combination of errors, implying that shared causation releases forensic odontologists from or attenuates their responsibility.⁹⁸ Its loosely stated thesis creates a smokescreen that hides a critical problem seen in several cases, which offers a reason to eliminate bite mark evidence from prosecutions, namely that prosecutors rely on bite mark evidence to bolster weak cases.⁹⁹ An expert witness who appears credible to jurors can overcome a prosecutor's weak narrative. The Cristini-Moldowan case is a good example.

⁹⁵ See *Otero*, 614 N.W.2d at 178; Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 49. In addition, he taught at the University of Detroit Mercy School of Dentistry where he lectured at forensic investigation classes at Wayne State University.

⁹⁶ Compare *Class of 2019 Spirit Awards*, *supra* note 93, with Radley Balko, Leigh Stubbs, *Mississippi Woman, Serving 44-Year Sentence Despite Discredited Testimony*, HUFFINGTON POST, (Dec. 6, 2017), https://www.huffpost.com/entry/leigh-stubbs-michael-west-forensics-discredited-testimony_n_922219 [<https://perma.cc/X7GB-C7ZG>] (stating that even though Michael West was discredited, he continued to use his self-proclaimed "West Phenomenon" to testify in court), and Randy Balko, *Washington Post Reports on Controversial Medical Examiner Dr. Steven Hayne*, GEORGE C. COCHRAN MISS. INNOCENCE PROJECT (May 15, 2014, 1:07 PM), <https://innocenceproject.olemiss.edu/new-case-examiner/> [<https://perma.cc/377M-EYJJ>] (establishing that Michael West has been known to commit perjury on numerous occasions and was consistently criticized for his "sloppy practices and dubious testimony").

⁹⁷ See *Otero*, 614 N.W.2d at 182; Jim Fisher, *Forensics Under Fire: Bite Mark Evidence*, JIM FISHER OFFICIAL WEBSITE, <http://jimfisher.edinboro.edu/forensics/fire/mark.html> [<https://perma.cc/5SX6-E6WE>].

⁹⁸ See Barsley et al., *supra* note 2, at 92.

⁹⁹ See Meagan Flynn, *Texas Forensic Science Commission: Bite Mark Evidence is Junk Until Proven Otherwise*, HOUSTON PRESS, (Feb. 18, 2016, 9:00 AM), <https://www.houstonpress.com/news/texas-forensic-science-commission-bite-mark-evidence-is-junk-until-proven-otherwise-8166329> [<https://perma.cc/XAR7-FBE6>]; see also *Cases Based on Discredited Bite-Mark Evidence will be Tough to Find*, DALL. MORNING NEWS, (Oct. 26, 2015, 12:06 AM), <https://www.dallasnews.com/news/crime/2015/10/26/cases-based-on-discredited-bite-mark-evidence-will-be-tough-to-find/> [<https://perma.cc/JC56-8KYB>] (providing a real-life example of how bite-mark evidence was used to bolster a weak case leading to a wrongful conviction and the subsequent decision to prohibit prosecutors from going forward with cases "in which bite mark is the lone evidence"). In Part III, *infra*, we explain how *Epidermis and Enamel* misinterprets JON B. GOULD ET AL., PREDICTING ERRONEOUS CONVICTIONS: A SOCIAL SCIENCE APPROACH TO MISCARRIAGES OF JUSTICE (2013). The study is described in detail in Jon B. Gould et al., *Predicting Erroneous Convictions*, 99 IOWA L. REV. 471 (2014).

In the early morning hours of August 9, 1990, Emergency Medical Services responded to a call and found twenty-four-year old Maureen Fournier lying at the intersection of Glenwood Street and McCrary Avenue on Detroit's east side, nearly naked and "partially disemboweled."¹⁰⁰ She was immediately transported to a local hospital.¹⁰¹ Not fully alert, she moaned her parent's phone number.¹⁰² Her jaw, broken in three places, was wired shut.¹⁰³ Her main wounds were closed-head and rectal injuries.¹⁰⁴ At the time of her operation to repair internal injuries, she had a blood alcohol concentration (BAC) of .274 and was in a state of severe inebriation.¹⁰⁵ An emergency room examination with a speculum detected no injuries or small lacerations to the vaginal area.¹⁰⁶ As Maureen was being readied for her operation to repair her rectal injuries, "a vaginal swab for a wet mount" was negative, indicating that "there were no sperm on the slide."¹⁰⁷ The severity of her injuries precluded police from interviewing her for two days.¹⁰⁸ Bite marks were observed on her body.¹⁰⁹

Several days after the operation Maureen, supported by her sister, Colleen Corcoran, claimed that she was stopped on the night of

¹⁰⁰ See Jeffrey Moldowan, NAT'L REGISTRY OF EXONERATIONS (July 17, 2019), <https://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3481> [<https://perma.cc/P8S6-AJXL>].

¹⁰¹ See Plaintiff-Appellee's Answer to Application for Leave to Appeal at 14, *State v. Moldowan*, No. 232196 (Mich. Ct. App. 2001) [hereinafter Plaintiff-Appellee's Answer]. She remained in the hospital for 22 days. *Id.*

¹⁰² See Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 35. Seven days after the injuries, Maureen slipped between coherence and a semi-stupor while odontologists obtained bite mark impressions. *See id.* at 51–52.

¹⁰³ Transcript of Preliminary Examination Volume I at 7, *State v. Moldowan*, No. 224451, (37th Dist. Ct. Macomb Cty. Mich. 1990) [hereinafter Preliminary Examination]. In the hospital she communicated by pointing to letters on a board. *See Moldowan v. City of Warren*, 578 F.3d 351, 364 (6th Cir. 2009). She could speak at the preliminary examination in September. *See Preliminary Examination, supra*, at 7.

¹⁰⁴ *See* Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 26. "[H]er colon was protruding out of her abdominal cavity with severe injuries to her anus . . ." *Id.* (recounting the testimony of the emergency room senior surgical resident in charge).

¹⁰⁵ *Id.* at 12–13.

¹⁰⁶ *See id.* at 26.

¹⁰⁷ *Id.* at 38–39. Neither motile nor immotile sperm was detected. *See id.* at 44.

¹⁰⁸ *See Moldowan v. City of Warren*, 578 F.3d 351, 364 (6th Cir. 2009).

¹⁰⁹ Preliminary Examination, *supra* note 103, at 33. She testified to having been vaginally and anally raped. *See id.* at 24–25. She indicated that Last Rites were administered by a Catholic Priest and that her head was "split open." *Id.* at 31–32. She was operated on for four hours and spent 22 days in the hospital. *Id.* at 34. She also testified that her pain was worse than giving birth and that she had to wear a colostomy bag permanently. *See id.* at 32, 34. The senior surgical resident at the emergency room physician who saw Fournier at about 4:30 a.m. reported, "She was in shock, her blood pressure was low. . . . [Her] core [body] temperature was 93 degrees." Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 22.

August 8, while walking in the vicinity of Eleven Mile and Mound Roads in the Macomb County city of Warren.¹¹⁰ Her story was that her former boyfriend of thirteen months, Jeffrey Moldowan, and three other men, Michael Cristini, James Cristini, and Tracy Tapp, drove up to her in a light-colored van, shoved her in, and drove her to Detroit.¹¹¹ She was beaten, vaginally and anally raped, anally sodomized with a metal bar while in the van and left for dead on a Detroit street where she had never been before.¹¹² The sisters supported the story by claiming that Moldowan made telephone threats and cited his previous abuse of Maureen.¹¹³

Because Maureen claimed the abduction occurred in Warren, Detroit law enforcement turned the case over to the Warren police.¹¹⁴ Moldowan and the other three men were arrested and charged with kidnapping, assault with intent to commit murder, and sexual assault.¹¹⁵ Tracy Tapp had a solid alibi and charges against him were quickly dropped.¹¹⁶ At the preliminary hearing, Maureen, who claimed to have been abducted at dusk, could not identify James or Michael Cristini.¹¹⁷ Based on a good alibi and Maureen's confused testimony, charges against James Cristini were dropped.¹¹⁸ Both Moldowan and Michael Cristini had alibis.¹¹⁹ Jeffrey spent the entire evening with friends while Michael worked until 2:00 a.m. on August 9 delivering pizzas from a local restaurant, an alibi supported by witness testimony and receipts.¹²⁰ As for Jeffrey's physical condition, a week before the August 9 attack on Maureen, Moldowan's leg was

¹¹⁰ See *Moldowan*, 578 F.3d at 363–64; Preliminary Examination, *supra* note 103, at 13–15, 48.

¹¹¹ See *Moldowan*, 578 F.3d at 363–64; Preliminary Examination, *supra* note 103, at 8, 16, 19, 59.

¹¹² See *Moldowan*, 578 F.3d at 364; Preliminary Examination, *supra* note 103, at 24–27; Michigan Department of Corrections Presentence Investigation Report at 5, *Moldowan v. City of Warren*, No. 90-1517 FC (Macomb Cty. Ct. Mich. Jun. 3, 1991) [hereinafter Presentence Investigation Report].

¹¹³ See *Moldowan*, 578 F.3d at 364; Preliminary Examination, *supra* note 103, at 8–10, 78.

¹¹⁴ See *Moldowan*, 578 F.3d at 363–64. The case was assigned to Det. Donald Ingles, described as clueless by interview subjects. See Summary of Interview with Jeff Moldowan in Casco, Mich. (May 24, 2016) [hereinafter *Moldowan Interview*] (on file with authors).

¹¹⁵ See Presentence Investigation Report, *supra* note 112, at 3.

¹¹⁶ See *Moldowan*, 578 F.3d at 364.

¹¹⁷ See Preliminary Examination, *supra* note 103, at 16, 18–19, 29–30, 48, 61.

¹¹⁸ See *Moldowan*, 578 F.3d at 364.

¹¹⁹ See *id.* at 365.

¹²⁰ See *id.* at 364, 365; *Moldowan Interview*, *supra* note 114, at 8; Memorandum of Law in Support of Motion to Compel Key Prosecution Witness to Undergo Polygraph Examination at 4, *State v. Moldowan*, No. 90-1517 (Cir. Ct. Macomb Cty. Mich. Sept. 6, 2001) [hereinafter *Polygraph Examination*].

broken and in a cast after James Cristini ran over him with his car during an argument.¹²¹

Looked at objectively, the evidence against Cristini and Moldowan was weak. Maureen, an alcoholic, had been drinking heavily and was ejected from a bar at 8:30 p.m.¹²² Her sister allegedly refused to pick her up and she walked around the streets in a confusing pattern.¹²³ If Maureen's BAC was .274 at 4:30 a.m., she was more highly intoxicated earlier in the night, casting doubt on her memory. She claimed to have been abducted at dusk in the preliminary examination, but testified at trial that she wandered the streets of Warren for hours before her kidnapping.¹²⁴ Her story that four men she knew including her ex-boyfriend attacked her was undermined by the quick release of two;¹²⁵ police should have searched for the other two or reevaluated her story. Detectives never questioned why white guys from Macomb County would drop a body in a poor, African American Detroit neighborhood, rather than in more familiar haunts. No one questioned Moldowan's ability to jump out of a van, abduct a struggling woman, participate in a gang rape, and inflict hideous injuries while his broken leg was in a cast. A huge red flag to her rape allegation should have been the absence of sperm—a fact that was not developed in the trial. Their alibis, especially Michael Cristini's, were overlooked.

In retrospect, biases clouded police and prosecutorial thinking.¹²⁶ Sympathy for the victim of a horrible attack stifled any serious probing of her credibility, and neither the police nor defense lawyers dug more closely into her lifestyle. Jeffrey Moldowan and Michael Cristini were suspect figures in police eyes.¹²⁷ Jeffrey was a school dropout, lived to party and do drugs, and had several encounters with the law, including a 90-day jail sentence for assaulting Maureen's dad.¹²⁸ The police were certain they had the right men; crime narrative weakness was brushed aside.

¹²¹ See Moldowan Interview, *supra* note 114, at 2.

¹²² See Polygraph Examination, *supra* note 120, at 3; Preliminary Examination, *supra* note 103, at 15, 41.

¹²³ See Preliminary Examination, *supra* note 103, at 47, 58.

¹²⁴ See Polygraph Examination, *supra* note 120, at 3; Preliminary Examination, *supra* note 103, at 16.

¹²⁵ See *Moldowan*, 578 F.3d at 364.

¹²⁶ See Moldowan Interview, *supra* note 114, at 8; Interview with Cindy Barach, in Roseville, Mich. (May 27, 2016) [hereinafter Barach Interview] (on file with authors).

¹²⁷ See Moldowan Interview, *supra* note 114, at 7.

¹²⁸ See Barach Interview, *supra* note 126, at 2, 6–7; Moldowan Interview, *supra* note 114, at 2–3, 8–9.

Any doubts were removed by the introduction of scientific evidence. Maureen's doctors observed several bite marks on her body and Dr. Allan Warnick was tasked with their examination, but not for a week, giving time for the bite mark bruises to begin healing.¹²⁹ He asked Dr. Pamela Hammel to assist.¹³⁰ Two days after photographing the bite marks, he took impressions of Moldowan and Cristini's dentitions.¹³¹ He worked up the case, making overlays and refining his analysis with the use of a scanning electron microscope.¹³² His expert opinion to the jury was that bite marks on Maureen's neck and left breast area were made by Jeffrey Moldowan's teeth¹³³ and that a bite mark on Maureen's right forearm was made by the dentition of Michael Cristini.¹³⁴ He also testified that he excluded the dentition of two other individuals.¹³⁵

The defense team was quite competent. Moldowan's attorney, Jeffrey Schwartz, had done his homework and brought out much of the weakness in bite mark analysis: that it is a subjective method in contrast to dental identification, especially when the bite mark patterns on acetate are drawn by hand;¹³⁶ that skin is a poor medium for bite mark registration;¹³⁷ that bite marks in food tend to be more definite than on skin;¹³⁸ that unlike fingerprints which do not change, bite marks on skin do change over time;¹³⁹ and that unlike fingerprint analysis, there was no numbering method to gauge bite marks.¹⁴⁰ He also brought out that bite mark analysis was the smaller part of Dr. Warnick's odontology practice.¹⁴¹ Both defense attorneys had Dr. Warnick emphasize the qualifications of Dr. Raymond Rawson, a bite

¹²⁹ See Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 51, 110. He was called by the Warren Police Department on August 16, 1990, a week after the attack on Maureen to obtain bite mark impressions. *Id.*

¹³⁰ See *Moldowan v. City of Warren*, 578 F.3d 351, 365 (6th Cir. 2009); Testimony of Pamela Hammel 16–17, *People v. Cristini*, No. 90-1514-FC (Mich. Cir. Ct. Macomb Cty. Mar. 31, 2004) [hereinafter Hammel Testimony].

¹³¹ See Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 58.

¹³² See *id.* at 62, 77.

¹³³ See *id.* at 92.

¹³⁴ See *id.* at 77, 84. After conviction, Moldowan's attorney got an opinion from Dr. Richard Souviron who wrote, "From analysis of the bite would [*sic*] pattern, it is my opinion that the bite on the right forearm and the bite on the neck were made by the same individual." Polygraph Examination, *supra* note 120, exhibit 15 at 1.

¹³⁵ Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 84.

¹³⁶ See *id.* at 103, 113. "So that we are not talking about an exact replica [of the bite mark] done by a machine." *Id.* at 103.

¹³⁷ See *id.* at 105.

¹³⁸ See *id.* at 106.

¹³⁹ See *id.* at 107.

¹⁴⁰ See *id.* at 137, 138–39.

¹⁴¹ See *id.* at 101, 102.

mark pioneer under whom Warnick trained, knowing that Dr. Rawson had been retained as a defense expert.¹⁴² A defense slip on cross-examination by Cristini's lawyer allowed Warnick to express a statistical conclusion about the likelihood of a random match in terms that had to impress the jury, although it was later criticized.¹⁴³ On direct examination, Warnick discussed a 1984 article by Dr. Rawson on bite mark uniqueness. Dr. Rawson indicated in his article that when four or five "areas of matching parts or distinctive areas" of bite marks and teeth are found, taking into account a world population of 4 billion, that "the chances are, and I use the term when we teach our classes, 2.1 billion to 1 that another individual can make those same marks."¹⁴⁴ The flawed statistical conclusion was re-emphasized when asked on cross-examination if someone else could show a similar dental pattern. This allowed Warnick to opine, "In utilizing the statistics that [Rawson] has shown, which I feel is an extremely good article, that chances of an individual having the same distinct points are probably well over three to four million to one."¹⁴⁵

Forensic odontologists Dr. James Woodward and Dr. Raymond Rawson testified for the defense. Both were university-based, members of the American Board of Forensic Odontology and other organizations and were experienced bite mark analysts. Dr. Rawson, who never before testified for the defense in a bite mark case,¹⁴⁶ was the more experienced of the two and testified because of his expertise with the scanning electron microscope.¹⁴⁷ The defense odontologists testified that they found no match between the overlays made from models of the defendants' dentition and the bite mark photos.¹⁴⁸

The prosecution's weak case based on the story of a highly inebriated complainant, on her sister's report that Moldowan made threatening calls, and on no physical evidence except for the bite mark testimony, carried the day. The vigorous defense challenge to bite mark evidence was insufficient to convince the jury that the

¹⁴² See *id.* at 115, 127.

¹⁴³ See *id.* at 126–27.

¹⁴⁴ See *id.* at 93–94. This analysis was based on Raymond D. Rawson et al., *Statistical Evidence for the Individuality of the Human Dentition*, 29 J. FORENSIC SCI. 245 (1984). Warnick's erroneous understanding of the application of the statistical argument is discussed *infra* notes 260–272.

¹⁴⁵ Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 127.

¹⁴⁶ Defendant-Appellant's Affidavit Explaining Delayed Application for Leave to Appeal 25, *People v. Moldowan*, 643 N.W.2d 570 (Mich. 2002) (No. 119812) [hereinafter Royal Brief].

¹⁴⁷ See Trial Transcript, Cristini & Moldowan 1991, *supra* note 94, at 127.

¹⁴⁸ See Royal Brief, *supra* note 146, at 25–26, 34.

wrong men were being blamed for a hideous attack.¹⁴⁹ After conviction, Jeffrey lamely protested his conviction for the presentence report: “Moldowan states he is innocent. ‘At 8:30 or 9:00, I was at Alter Road and Shoemaker. Later, I was out in Clawson.’”¹⁵⁰ The final word was not spoken. A glimpse of the Cristini-Moldowan exoneration to come appeared at the tail end of the Presentence Investigation Report: “Mrs. [Sally] Moldowan feels her son is innocent, supports him, has spent a good deal of money hiring private detectives and expert witnesses. She said her son lived with the victim for about six months, and added, ‘She’s telling this story to cover whatever happened that night.’”¹⁵¹

Sally Moldowan was right. In the summer after the convictions, Cindy Barach, Jeffrey’s sister, a real estate salesperson, enlisted the help of private investigator, Leland Spencer, and the support of her boss, realtor Ralph Roberts, and began investigating his case.¹⁵² She and Spencer patiently and doggedly hung out in the neighborhood where Maureen’s body was found and posted reward notices with Maureen’s picture.¹⁵³ The ugly reality that emerged was that Maureen had become a crack-addict, street-walking prostitute who frequented the Detroit east side area where her body was found.¹⁵⁴ She was punished by crack-house enforcers for not paying her drug debts.¹⁵⁵ Cindy Barach was told by a Detroit police officer that other prostitutes had been similarly punished.¹⁵⁶ Desperate to shield their middle-class parents, social workers no less, from learning of their lifestyles, and from fear of retaliation, Maureen and Colleen, concocted their story to deflect suspicion from the really dangerous men in their lives.

It took Cindy Barach several years to locate and mobilize the witnesses, gain the excellent legal representation of attorney John Royal, and find in Carl Marlinga a sympathetic Macomb County prosecutor who, after interviewing witnesses, supported Moldowan and Cristini in their bid for a new trial.¹⁵⁷ Witnesses came forward

¹⁴⁹ See Presentence Investigation Report, *supra* note 112.

¹⁵⁰ *Id.* at 5. The report included three pages of incriminating details largely lifted from the police investigation.

¹⁵¹ *Id.* at 8.

¹⁵² See Barach Interview, *supra* note 126, at 2, 6.

¹⁵³ See *id.* at 2, 3, 4.

¹⁵⁴ See *id.* at 3, 9.

¹⁵⁵ *Id.* at 9.

¹⁵⁶ *Id.*

¹⁵⁷ See Hans Sherrer, *Prosecutor Indicted for Bribery After Two Men Exonerated of Kidnapping and Rape*, JUSTICE, no. 27, 2005, at 10; Royal Brief, *supra* note 146. But see Carl

who testified to the fact of Maureen's prostitution in Detroit's northeast area, her addiction, her involvement with crack cocaine dealers, and the reign of fear created by drug sellers and their enforcers.¹⁵⁸ A friend testified that Maureen admitted to having lied about Jeffrey's guilt.¹⁵⁹

The critical difference, however, was made by reversals related to the bite mark testimony. Prosecutor Marlinga announced publicly that a conviction based on false evidence violates due process and ethical rules require a prosecutor to rectify the matter when discovered.¹⁶⁰ He therefore supported a new trial while maintaining that other evidence would support a conviction on retrial.¹⁶¹ The Michigan Supreme Court in 2002 ordered a new trial for Moldowan in a brief opinion reversing the conviction.¹⁶² "In this case the prosecutor's two expert witnesses with respect to 'bite-mark' evidence have either recanted testimony which concluded that bite marks on the victim were made by the defendant or presented opinion evidence which has now been discredited."¹⁶³

A decade earlier, no one questioned Dr. Warnick's bite mark conclusions. The unraveling of his reputation was part of the larger story of DNA exonerations. Warnick linked two Wayne County suspects to murder victims through bite mark analysis, only to have both cases dismissed when DNA and other tests exonerated them.¹⁶⁴

Marlinga, Letter to the Editor, *Change of Course Justified in Rape Case*, DETROIT FREE PRESS, Aug. 22, 2002, at 17 (expressing that even though he is fully convinced that Moldowan committed the crime, Moldowan is nevertheless entitled to due process of law). The Michigan Supreme Court granted a new trial. See *People v. Moldowan*, 643 N.W.2d 570 (Mich. 2002) (reversing Moldowan's conviction and remanding the case for a new trial).

¹⁵⁸ See Royal Brief, *supra* note 146, at 38, 40, 42.

¹⁵⁹ See *id.* at 38.

¹⁶⁰ See Marlinga, *supra* note 157.

¹⁶¹ See *id.* Marlinga published his reasoning in the news media after an allegation linking his support for Moldowan's new trial was claimed to result from a campaign contribution to him (he was running for Congress at the time) by Cindy Barach's employer, Ralph Roberts. See *Marlinga Says Ethics Guided His Decisions*, MACOMB DAILY (Sept. 21, 2006), <https://www.macombdaily.com/sports/marlinga-says-ethics-guided-his-decisions/> [<https://perma.cc/87J4-E8SJ>]. He was later federally prosecuted for this and was acquitted. See *World's Greatest Realtor and Keeper of Uniroyal Nail Files for Bankruptcy*, DEADLINE DETROIT (June 04, 2012, 2:45 PM), http://www.deadlinedetroit.com/articles/642/world_s_greatest_realtor_and_keeper_of_uniroyal_nail_files_for_bankruptcy [<https://perma.cc/4TBB-TU62>]. He now serves as a trial judge. See Norb Franz, *FBI, Oakland Sheriff Raid Utica Offices of Realtor Ralph Roberts*, OAKLAND PRESS (Jun. 29, 2017), <https://www.theoaklandpress.com/news/fbi-oakland-sheriff-raid-utica-offices-of-realtor-ralph-roberts/> [<https://perma.cc/RA4K-A35G>].

¹⁶² See *People v. Moldowan*, 643 N.W.2d 570, 570–71 (Mich. 2002).

¹⁶³ *Id.* at 570.

¹⁶⁴ See INNOCENCE PROJECT, DESCRIPTION OF BITE MARK EXONERATIONS 11, 12 (July 2016), https://www.innocenceproject.org/wp-content/uploads/2016/07/Description-of-Bite-Mark-Exonerations-as-of-July-2016_final.pdf [<https://perma.cc/973B-QFXQ>]. The wrongfully

These exonerations led the Wayne County Prosecutor's office to quietly distance itself from his work in 1995.¹⁶⁵ Warnick's record became well known to the public in 1997 when Rod Hansen, an award winning reporter for a highly popular Detroit AM radio station, *WJR*, conducted a six-month investigation and ran a thirteen-part story over two and a half weeks that exposed the cases of Otero and Amolsch and explored the weaknesses of the bite mark evidence in Moldowan's case and that of Carol Ege.¹⁶⁶ Four of the thirteen stories focused on Jeffrey Moldowan's case and when interviewed, Dr. Warnick backtracked from his earlier practice of citing astronomical odds of the likelihood of another person making a similar bite mark.¹⁶⁷

Equally significant, the reinvestigation led Dr. Pamela Hammel to recant her testimony at the 1991 trial, where she testified as a rebuttal witness.¹⁶⁸ In seeking a new trial Moldowan argued that the prosecutor misused process by reserving Hammel as a rebuttal witness when she should have been called in the case-in-chief. After reevaluating the bite marks, she concluded that the marks on Maureen's neck, right arm, and right side were not consistent with the dentition of either Jeffrey Moldowan or Michael Cristini.¹⁶⁹

charged men were Anthony Otero and Ricky Amolsch. *Id.*; see *Otero v. Warnick*, 614 N.W.2d 177, 178 (Mich. Ct. App. 2000); *Amolsch v. Warnick*, 1999 Mich. App. LEXIS 1725 at *5-6 (Mich. Ct. App. 1999) (stating that the claim against Warnick was dismissed on basis of public duty doctrine); *id.* at *12 ("We agree that Amolsch's allegations in his case are horrific and, if true, call into question Warnick's judgment, Warnick's competence and perhaps even Warnick's motivation. These questions, however, are not before us"); Joe Swickard, *Freed Suspect Asks Justice*, DETROIT FREE PRESS, Aug. 25, 1999, at 1.

¹⁶⁵ The Wayne County Prosecutor's Office concluded that it "will not approve warrants where the main evidence as to the identity of a potential defendant is the opinion of Dr. Warnick that he/she is the source of the bite marks." *Ege v. Yukins*, 485 F.3d 364, 372 (6th Cir. 2007).

¹⁶⁶ See Mitch Albom, *Reporter's Digging Gives a Man His Life*, DETROIT FREE PRESS (Nov. 21, 2008), <https://www.mitchalbom.com/reporters-digging-gives-a-man-his-life/> [<https://perma.cc/WV38-P8UZ>] (describing Hansen's investigation in the Amolsch case); Zlati Meyer, *Longtime WJR Journalist Rod Hansen Dead at 75*, DETROIT FREE PRESS (July 4, 2016, 7:45 PM), <https://www.freep.com/story/news/local/michigan/detroit/2016/07/04/longtime-wjr-journalist-rod-hansen-dead-75/86682790/> [<https://perma.cc/M8H7-C98L>].

¹⁶⁷ See Trial Transcript, *Cristini & Moldowan* 1991, *supra* note 94, at 93-94. The series ran from November 10, 1997, to November 26, 1997. Transcripts of the series and copy of an affidavit from Rod Hansen made in Moldowan's civil rights case available at <https://perma.cc/S7D5-ERUD>.

¹⁶⁸ See Affidavit of Pamela Wallace Hammel at ¶ 5 (Sept. 17, 1999) (on file with the authors); Hammel Testimony, *supra* note 130, at 35.

¹⁶⁹ See Hammel Testimony, *supra* note 130, at 68, 69; Letter from Pamela Hammel, Forensic Dental Consultant, to John F. Royal, Co-Counsel for Defendant Moldowan (Aug 19, 1999) (on file with authors); see also Royal Brief, *supra* note 146, at 19.

The men were acquitted in their 2003 and 2004 retrials.¹⁷⁰ Colleen and Maureen stuck to their stories, but their lies were exposed by the new witnesses who testified to their demimondaine lifestyle.¹⁷¹ More explosive was Dr. Hammel's testimony that doubts she harbored about her bite mark identifications before the 1991 trial were overridden by a lie told by Dr. Warnick.¹⁷² In preparing for the 1991 trial she told Dr. Warnick that she "was having a difficult time lining up the acetates with the photographs of the bites and the models"¹⁷³ and felt "very uncomfortable with the case."¹⁷⁴ Dr. Warnick suggested reversing the orientation of the acetate to align upper and lower teeth.¹⁷⁵ In addition, he assured Dr. Hammel that he had sent the materials to a renowned forensic odontologist, Dr. Normal Sperber.¹⁷⁶ That caused Dr. Hammel "to think the problem was with me," and she went on to testify as a rebuttal witness in 1991 that both Moldowan and Cristini's dentitions fit the bite marks.¹⁷⁷ Several years later, she was brought in on the Amolsh and Ege cases and "realized that they were also bad cases,"¹⁷⁸ and then learned that Dr. Warnick had never sent the Cristini and Moldowan material for a second opinion to Dr. Sperber; at that point she came to believe that he had lied to her.¹⁷⁹ As a result, Dr. Hammel testified in Moldowan's and Cristini's second trials without compensation.¹⁸⁰ When asked why she was testifying she said,

Yes, I would like to tell the ladies and gentlemen of the jury that I am here to right a wrong. I made a mistake and I want to correct that. I am responsible for my actions in the past, but I also feel like I was misled and misinformed to come to my incorrect conclusion.¹⁸¹

¹⁷⁰ See *Michael Cristini*, NAT'L REGISTRY EXONERATIONS (June 2012), <https://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3133> [<https://perma.cc/MW8X-G7VE>].

¹⁷¹ See Royal Brief, *supra* note 146, at 38–44.

¹⁷² See Hammel Testimony, *supra* note 130, at 28, 32.

¹⁷³ *Id.* at 28.

¹⁷⁴ *Id.* at 34.

¹⁷⁵ See *id.* at 32.

¹⁷⁶ *Id.* at 34.

¹⁷⁷ *Id.* at 35.

¹⁷⁸ *Id.* at 37 (spelling the names phonetically as "Amosh" and "Egee").

¹⁷⁹ *Id.* at 38, 56.

¹⁸⁰ *Id.* at 71, 81.

¹⁸¹ *Id.* at 72.

II. A BRIEF, CRITICAL REVIEW OF BITE MARK EVIDENCE

Forensic odontology is a recognized specialization within forensic science,¹⁸² itself a complex field “not easy to generalize about.”¹⁸³ Defined broadly, forensic science is the application of science to legal matters.¹⁸⁴ In the realm of criminal law, “forensic sciences encompass a broad range of disciplines, each with its own” distinct practices.¹⁸⁵ The forensic sciences include such diverse areas as crime scene investigation, medicolegal death investigation, laboratory methods based on accepted physical science (e.g., toxicology, DNA profiling), and laboratory practices based on pattern-matching or feature-comparison methods, such as fingerprint (or friction ridge) analysis.¹⁸⁶ Bite mark analysis and comparison falls into the latter category.¹⁸⁷

The sociology of forensic science provides a useful frame for our discussion. The tendency to compare a popular image of forensic science, perhaps shaped by the entertainment media, to an idealized image of research science,¹⁸⁸ should be tempered by appreciating the diversity of scientific practices and the distinctiveness of forensic science practices. Simon Cole contrasts “research science” aimed at producing new knowledge about the natural world” with “more mundane activities such as industrial science or ‘regulatory

¹⁸² See *Types of Forensic Scientists: Disciplines of AAFS: Odontology*, AM. ACAD. FORENSIC SCI., <https://www.aafs.org/home-page/students/choosing-a-career/types-of-forensic-scientists-disciplines-of-aafs/> [<https://perma.cc/33SU-TQY9>] [hereinafter *Types of Forensic Scientists*].

¹⁸³ NRC REPORT, *supra* note 21, at 6. Odontology is a section within the American Academy of Forensic Science. See *Types of Forensic Scientists*, *supra* note 182.

¹⁸⁴ “‘Forensic science’ has been defined as the application of scientific or technical practices to the recognition, collection, analysis, and interpretation of evidence for criminal and civil law or regulatory issues.” PCAST, *supra* note 23, at 1.

¹⁸⁵ *Id.* at 21. The forensic sciences also apply to homeland security. See Erin Murphy, *The New Forensics: Criminal Justice, False Certainty, and the Second Generation of Scientific Evidence*, 95 CALIF. L. REV. 721, 723 (2007) (stating that newer forensic science techniques include, inter alia, data mining, location tracking, and biometric scanning); IMMIGRATION & CUSTOMS ENF’T, INVESTIGATING ILLEGAL MOVEMENT OF PEOPLE & GOODS: HSI FORENSIC LABORATORY (2018), <https://www.ice.gov/hsi-fl> [<https://perma.cc/J3D4-RVTP>].

¹⁸⁶ See PCAST, *supra* note 23, at 21, 25, 67; Murphy, *supra* note 185, at 723.

¹⁸⁷ See PCAST, *supra* note 23, at 67.

¹⁸⁸ See CHRISTOPHER LAWLESS, FORENSIC SCIENCE: A SOCIOLOGICAL INTRODUCTION 20, 24, 33 (2016). A sociological review of forensic science is incomplete without giving attention to the representation of forensic science in popular culture. See *id.* Idealized science has had a negative impact on the courts. See David S. Caudill & Lewis H. LaRue, *Why Judges Applying the Daubert Trilogy Need to Know about the Social, Institutional, and Rhetorical—and Not Just the Methodological—Aspects of Science*, 45 B.C. L. REV. 1, 30–1 (2003).

science,”¹⁸⁹ and is critical of the National Academy of Sciences Report for not sufficiently marking this difference.¹⁹⁰ Cole differentiates the social attributes of research and forensic science along a dozen criteria including: audience (peer scientists vs. legal actors); accountability mechanisms (scholarly peer review vs. legal adversarialism); data (intentionally collected and unlimited vs. adventitiously produced and inherently limited); knowledge claims (general vs. specific); time frame (open-ended vs. limited); product (scientific papers vs. reports); productivity goals (volume and impact vs. volume and speed); data sharing (unlimited, in principle vs. treated warily, sometimes prohibited by legal actors); research agenda (driven by paradigms vs. driven by demands of courts, the state); valid feedback (sometimes vs. rarely); reward structure (prestige vs. bureaucratic); and reporting of results (conservative, statistical, ambiguous vs. ambitious, colloquial, unambiguous).¹⁹¹ Contemplating these differences warns us to be cautious about easily imposing the characteristics of research science on forensic science, and instructs us about the distance that must be travelled by forensic scientist to accept valid critiques and move forensic science toward a reform position.

The innocence movement has become a vital reform program across most criminal justice system practices, including forensic science.¹⁹² While a forensic science reform movement existed before innocence consciousness arose in the 1990s and 2000s,¹⁹³ according to Simon Cole the innocence crisis “has become a crucially important input into the forensic science reform process.”¹⁹⁴ The crisis presaged a

¹⁸⁹ Simon A. Cole, *Forensic Culture as Epistemic Culture: The Sociology of Forensic Science*, STUD. HIST. & PHIL. BIOLOGICAL & BIOMEDICAL SCI., Sept. 27, 2012, at 36 (2013) [hereinafter Cole, *Culture*].

¹⁹⁰ See *id.* at 44 & tbl.1; Simon A. Cole, *Acculturating Forensic Science: What is ‘Scientific Culture’, and How Can Forensic Science Adopt it?*, 38 FORDHAM URB. L.J. 435, 437 (2010) [hereinafter Cole, *Acculturating*].

¹⁹¹ See Cole, *Culture*, *supra* note 189, at 44 tbl.1.

¹⁹² See Simon A. Cole, *The Innocence Crisis and Forensic Science Reform*, in WRONGFUL CONVICTION AND CRIMINAL JUSTICE REFORM 167, 169 (Marvin Zalman & Julia Carrano eds., 2014) [hereinafter Cole, *Innocence Crisis*]; Marvin Zalman & Julia Carrano, *Sustainability of Innocence Reform*, 77 ALB. L. REV. 955, 974–75 (2014) [hereinafter Zalman & Carrano, *Sustainability*]. Innocence reforms mainly affect the investigation-prosecution-adjudication side of the criminal process and have limited effect on the sentencing-correctional area in which mass incarceration has become a huge societal problem. See *id.* at 960–61.

¹⁹³ See Cole, *Innocence Crisis*, *supra* note 192, at 167; Zalman & Carrano, *Sustainability*, *supra* note 192, at 974–75; Zalman, *supra* note 63, at 1468.

¹⁹⁴ Cole, *Innocence Crisis*, *supra* note 192, at 167. *Innocence consciousness* is defined as

paradigm shift brought on by DNA and other exonerations, which challenged a complacent view toward forensic science.¹⁹⁵ It should be noted, in general, that reactions to the National Academy of Science's critical report by various forensic science organizations varied from strong support, to measured support, to resistance.¹⁹⁶ The two landmark surveys—the National Research Council's congressionally authorized review of forensic science generally, and the narrower review of “Feature-Comparison Methods” by the President's Council of Advisors on Science and Technology (PCAST)—were, after assessing existing research, especially critical of bite mark analysis.¹⁹⁷ A major research project headed by Dr. Mary Bush at the State University of New York at Buffalo School of Dental Medicine, conducted between 2009 and 2013 and based on cadaver models of bite marks, has seriously eroded the scientific foundation and assertions of reliability of bite mark evidence.¹⁹⁸ Proficiency tests of bite mark samples by odontologists that displayed weak agreement has further undermined the belief in bite mark analysis reliability.¹⁹⁹ Significantly, the Texas Forensic Science Commission called for a moratorium on the use of bite mark comparison in 2016.²⁰⁰ In this Part we provide a brief summary of these findings, relying on three recent and overlapping articles which critique bite mark analysis.²⁰¹

the idea that innocent people are convicted in sufficiently large numbers as a result of systemic justice system problems to require efforts to exonerate them, and to advance structural reforms to reduce such errors in the first place. Innocence consciousness replaces a belief that the justice system almost never convicts an innocent person.

Zalman, *supra* note 63, at 1468.

¹⁹⁵ See Saks & Koehler, *supra* note 50, at 892; Keith A. Findley, *Flawed Science and the New Wave of Innocents*, in *WRONGFUL CONVICTIONS AND THE DNA REVOLUTION*, *supra* note 41, at 184.

¹⁹⁶ See Cole, *Innocence Crisis*, *supra* note 192, at 175, 176.

¹⁹⁷ See NRC REPORT, *supra* note 21, at 176; PCAST, *supra* note 23, at 87.

¹⁹⁸ See M. Chris Fabricant & Tucker Carrington, *The Shifted Paradigm: Forensic Science's Overdue Evolution from Magic to Law*, 4 VA. J. CRIM. L. 1, 60 & n.236, 62 (2016) (citing to the published research resulting from Dr. Bush's project).

¹⁹⁹ See *infra* notes 289–305 and accompanying text.

²⁰⁰ See Bowers, *Pseudoscience*, *supra* note 53, at 37; Saks et al., *supra* note 19, at 542; Erik Eckholm, *Texas Panel Calls for an End to Criminal IDs via Bite Mark*, N.Y. TIMES, Feb. 12, 2016, at A10.

²⁰¹ An earlier, devastating critique of bite mark evidence was authored by the late Erica Beecher-Monas, a laboratory scientist and legal scholar:

Simply put, bite-mark testimony cannot meet [the relevance] standard. It has no empirical support. None of the trappings of science, the scientific sounding titles, group “certification” and publication in journals put out and reviewed by other members of the group, can serve to make bite-mark evidence helpful in deciding the perpetrator's identity

The first article by Michael J. Saks, joined by thirty-seven leading scholars, had its origin in an amicus curiae brief challenging bite mark evidence.²⁰² It briskly reviews the challenges to forensic science in recent years²⁰³ and succinctly describes how the admission of an unusual (and “exceedingly rare”) bite mark into evidence in a California case led other courts to incautiously accept bite mark evidence without it ever passing muster under tests of relevance.²⁰⁴ Saks et al. specify with clarity, thoroughness, and in lay language the issues regarding the challenge to bite mark evidence,²⁰⁵ a review of how to think scientifically about forensic evidence,²⁰⁶ the meaning of a forensic “inclusion,”²⁰⁷ the inherent limitations of bite mark evidence,²⁰⁸ the inability of forensic dentists to come to reliable (similar) conclusions in simulated bite mark tests,²⁰⁹ and reviews the research of Dr. Mary Bush et al. on bite marks in a cadaver model that suggests that the likelihood of bite marks on skin ever being

unless the theory and assumptions on which the identification is based, the data supporting the theory, and the methodology used are sound. Bite-mark testimony fails on each of these fronts: the theory is based on unsupportable assumptions, the data is absent and what we do have demonstrates the invalidity of the theory, and the methodology lacks professional guidelines or standards, and is entirely subjective. Absent empirical support, the testimony can have no tendency to make a disputed issue of identity more or less probable.

Erica Beecher-Monas, *Reality Bites: The Illusion of Science in Bite-Mark Evidence*, 30 CARDOZO L. REV. 1369, 1376 (2009) (footnote omitted). Other accessible critiques are the two parts of a chapter on bite mark evidence in Koen and Bowers. See Ray Krone & Wendy J. Koen, *Case Study: Ray Krone in His Own Words*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, *supra* note 57, at 138, 138–145; C. Michael Bowers, *Bite Mark Evidence*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, *supra* note 57, at 145, 145–165.

²⁰² See Saks et al., *supra* note 19.

This article was modified from “Amici Brief” of Michael Saks, Thomas Albright, Thomas L. Bohan, Barbara E. Bierer, C. Michael Bowers and 33 Other Scientists, Statisticians and Law-and-Science Scholars and Practitioners in Support of the Petition for Writ of Habeas Corpus by William Joseph Richards.

Bowers, *Pseudoscience*, *supra* note 53, at 37 n.46.

²⁰³ The article references the NRC Report. See NRC REPORT, *supra* note 21. It also indicates that several previously used forensic techniques such as voiceprints, comparative bullet lead analysis, and older standards for determining the existence of arson from the residue of fires have been abandoned in the face of scientific re-analysis. See Saks et al., *supra* note 19, at 540–41, 542.

²⁰⁴ See *People v. Marx*, 126 Cal. Rpt. 350, 357 (Ct. App. 1975); Saks et al., *supra* note 19, at 545, 547.

²⁰⁵ See Saks et al., *supra* note 19, at 547–48.

²⁰⁶ See *id.* at 549, 550–51, 552.

²⁰⁷ See *id.* at 552.

²⁰⁸ See *id.* at 548.

²⁰⁹ See *id.* at 563.

reliable evidence is low.²¹⁰ Saks et al. conclude by castigating the courts for having allowed unreliable evidence into criminal trials,²¹¹ holds out no hope that bite marks can ever be seen as reliable evidence,²¹² and by referring to the “rise and coming fall of bitemark evidence,”²¹³ recommends that courts should declare such evidence as inadmissible.²¹⁴

Fabricant and Carrington,²¹⁵ the second article, reviews the phenomenon of “shifted science”—that courts often lag behind scientific advances—and is critical of the weak pattern-comparison forensic techniques of hair and bite mark evidence.²¹⁶ Its strong suit lies in deconstructing how courts have bootstrapped bite mark evidence as a purportedly scientific technique when the field of forensic odontology had not done so.²¹⁷ The article quotes a Wisconsin Court of Appeals case²¹⁸ at length to show how reciting the exacting *techniques* of bite mark analysis with professional jargon is so impressive to lawyers and jurors as to cloud the underlying weaknesses of the practice.²¹⁹ This article usefully cites the dozen articles produced between 2009 and 2013 by Dr. Mary Bush and the scientific research team she led.²²⁰

²¹⁰ See *id.* at 565, 566.

²¹¹ See *id.* at 566–67.

²¹² See *id.* at 563.

²¹³ *Id.* at 566.

²¹⁴ Cf. *id.* at 566–67 (cautioning courts to carefully examine bitemark identification before allowing it as evidence).

²¹⁵ See Fabricant & Carrington, *supra* note 198.

²¹⁶ See *id.* at 38–40, 63–64. Regarding the concept of “shifted science,” see Caitlin Plummer & Imran Syed, “*Shifted Science*” and *Post-Conviction Relief*, 8 STAN. J. CIV. RTS. & CIV. LIBERTIES 259, 261–62 (2012) [hereinafter Plummer & Syed, *Shifted Science*], and Caitlin Plummer & Imran Syed, *Criminal Procedure v. Scientific Progress: The Challenging Path to Post-Conviction Relief in Cases that Arise During Periods of Shifts in Science*, 41 VT. L. REV. 279, 281–82 (2016) [hereinafter Plummer & Syed, *Criminal Procedure*].

²¹⁷ See, e.g., Fabricant & Carrington, *supra* note 198, at 38–39 (“*People v. Marx*, the first reported case to consider the admissibility of bite mark comparison evidence in human flesh [without any proper evidentiary hearing was cited by other states], turned an obscure, unvalidated subdiscipline of ‘forensic odontology’ into mainstream, ‘generally accepted,’ ‘scientific’ evidence without any basic or applied research to validate the technique’s . . . underlying hypotheses . . .”).

²¹⁸ See *State v. Stinson*, 397 N.W.2d 136, 137–39, 142 (Wis. Ct. App. 1986); Fabricant & Carrington, *supra* note 198, at 47–52.

²¹⁹ See Fabricant & Carrington, *supra* note 198, at 47–52.

²²⁰ See *id.* at 60 n.236. The scientists in these articles include Dr. Mary A. Bush, Peter J. Bush, Kyle Thorsrud, and Dr. Raymond G. Miller of the Laboratory for Forensic Odontology Research, School of Dental Medicine, SUNY at Buffalo; Dr. Robert B. J. Dorion, Laboratoire de sciences judiciaires et de médecine légale, Ministère de la Sécurité publique Québec; Dr. Howard I. Cooper; Dr. H. David Sheets, Department of Physics, Canisius College. See Mary A. Bush et al., *The Response of Skin to Applied Stress: Investigation of Bitemark Distortion in a Cadaver Model*, 55 J. FORENSIC SCI. 71, 71 nn.1–2 (2010); Mary A. Bush et al., *Inquiry into the*

In the most recent and succinct article challenging bite mark evidence, published in a scientific journal,²²¹ Dr. C. Michael Bowers makes several points not stated or emphasized in Saks et al. or in Fabricant and Carrington. It is worth noting, for example, that an injury caused by a bite mark can be a source of DNA evidence if properly gathered by first responders.²²² Also, helpful in our attempt to understand the thinking of bite mark odontologists,²²³ we recognize that while the environment of forensic science “is predominantly separate from university, medical and commercial empirical scientific rigors[, t]his path was not intentional.”²²⁴ In this vein, Bowers emphasizes the uniformity of scientific critics of bite mark analysis and the relative scientific isolation of ABFO members.²²⁵

Although bite mark analysis was fixed in the popular imagination by its prominent use to convict serial killer Ted Bundy in 1979 for the murders of two Florida State University coeds,²²⁶ the Bundy case was the first high-profile criminal trial introducing expert bite mark

Scientific Basis for Bitemark Profiling and Arbitrary Distortion Compensation, 55 J. FORENSIC SCI. 976, 976 nn.1–2 (2010) [hereinafter Bush et al., *Inquiry*]; Mary A. Bush et al., *Similarity and Match Rates of the Human Dentition in Three Dimensions: Relevance to Bitemark Analysis*, 125 J. INT’L LEGAL MED. 779, 779 (2011).

²²¹ See Bowers, *Pseudoscience*, *supra* note 53, at 38. The article explained that *Weak Foundations* by Saks et al. originated as an amicus curiae brief. See *id.* at 37 n.46.

²²² See *id.* at 35.

²²³ See *infra* Part IV.

²²⁴ Bowers, *Pseudoscience*, *supra* note 53, at 34.

²²⁵ Bowers states in his article,

Contemporary independent scientific reviews of forensic expertise use surprisingly similar language in rejecting its use. In the clearest terms possible, they describe a framework of scientific rigor and supporting research that should exist but are absent from proffering bitemark analysts. The material reads like a primer for the Scientific Method and these groups, rich with scientific qualifications, are outside the insular community of bitemark matching dentists—in contrast to the membership of the American Board of Forensic Odontology. The qualifications of these external reviewers exist at the highest levels of the relevant physical and biological sciences.

Id. at 36 (footnote omitted).

²²⁶ See STEVE JACKSON, NO STONE UNTURNED: THE TRUE STORY OF THE WORLD’S PREMIER FORENSIC INVESTIGATORS 96–97 (2002); ANN RULE, THE STRANGER BESIDE ME 392 (2018). The memory of Ted Bundy, the serial killer with the boy-next-door persona who was executed in 1989, has so influenced popular attention that Netflix promoted *two* films about him. See *Conversations with a Killer: The Ted Bundy Tapes*, NETFLIX (2019), <https://www.netflix.com/title/80226612> [<https://perma.cc/D84G-SY2F>] (four-part documentary); *Extremely Wicked, Shockingly Evil and Vile*, NETFLIX (2019), <https://www.netflix.com/watch/81028570> [<https://perma.cc/2PBJ-DJ26>] (fictionalized version).

evidence;²²⁷ yet this case did not seem important to the legal acceptance of bite mark evidence.²²⁸ Cases as early as 1870²²⁹ and a 1954 bite-marks-in-cheese case²³⁰ were ruled admissible, but the important precedent is *People v. Marx*.²³¹ Three dentists in this murder trial identified the defendant's teeth as the source of the bite marks on the victim's body.²³² When challenged, the California Court of Appeals concluded that the experts applied scientifically and professionally established techniques to show the defendant made the bite marks on the female victim.²³³ According to Saks et al., "*Marx* became the paradoxical seed from which most, if not all, subsequent decisions about admissibility of bitemark expert testimony grew."²³⁴ As Saks et al. note, *Marx* magically converted an exception to the rule into the rule: forensic dentists were free to testify in trials as courts cited *Marx* as precedent for admissibility although that decision did not apply the Frye general acceptance test.²³⁵

Oddly, while the courts were consistently allowing bite mark comparison testimony in criminal cases between 1954 and 1981,²³⁶

²²⁷ See N.E. GENGÉ, *THE FORENSIC CASEBOOK: THE SCIENCE OF CRIME SCENE INVESTIGATION* 160–61 (2002).

²²⁸ See *infra* notes 229–235 and accompanying text. The reputations of forensic odontologists Richard Souviron and Lowell Levine who matched bite marks to castings of Bundy's teeth were elevated; their success may have influenced others. See BALKO & CARRINGTON, *supra* note 49, at 112. Michael West was drawn to investigate the case of Florida serial killer Danny Rolling (who was "inspired" by Ted Bundy), playing "the Gainesville murders for maximum exposure" and being quoted in the newspapers. *Id.* at 111–12. The growing skepticism of bite mark comparison evidence suggests that the evidence introduced against Bundy would be more sharply questioned today. See Gina Tron, *If Ted Bundy's Trial was Today, He May Have Walked Free—Thanks to Bite Mark Evidence*, OXYGEN (Feb. 14, 2019, 12:56 PM), <https://www.oxygen.com/blogs/how-ted-bundy-got-convicted-is-bite-mark-evidence-credible> [<https://perma.cc/7759-LBQP>].

²²⁹ See Roger D. Metcalf, *Doyle v. State of Texas: The Bitemark Case that Started it All*, BITEMARK, http://www.bitemark.org/doyle_v_state_of_texas [<https://perma.cc/4GUA-5855>].

²³⁰ See *Doyle v. State*, 263 S.W.2d 779, 779 (Tex. Crim. App. 1954); BOWERS, *HANDBOOK*, *supra* note 54, at 183–84 (discussing other cases along with the *Doyle* case); Metcalf, *supra* note 229. The Texas Court of Criminal Appeals affirmed *Doyle*'s conviction, viewing a bite mark in cheese as the equivalent of footprints and fingerprints "so long recognized by this court." *Doyle*, 263 S.W.2d at 780. Other Texas cases have admitted evidence of a bite mark made on skin. See *Patterson v. State*, 509 S.W.2d 857, 861 (Tex. Crim. App. 1974); Metcalf, *supra* note 229.

²³¹ See *People v. Marx*, 126 Cal. Rptr. 350 (Ct. App. 1975); Saks et al., *supra* note 19, at 545.

²³² See *Marx*, 126 Cal. Rptr. at 352–53.

²³³ See *id.* at 356.

²³⁴ Saks et al., *supra* note 19, at 545.

²³⁵ See *id.* Additionally, *Patterson* held bite mark analysis evidence admissible, going to weight and not admissibility. See *Patterson*, 509 S.W.2d at 863 (citing *Polk v. State*, 500 S.W.2d 825 (Tex. Crim. App. 1973)).

²³⁶ See, e.g., *State v. Garrison*, 585 P.2d 563, 566, 567 (Ariz. 1978) (allowing Dr. Campbell to provide expert testimony explaining the methods used to match the dental imprints from the

both dentists and odontologists themselves were struck by the flaws in procedures to identify matches between defendants and the bite marks on victim's bodies.²³⁷ As odontologists Mertz and Stinson point out in their 1997 text, *Forensic Dentistry*, they believed that considerable work was needed before bite mark comparison techniques could be considered scientific.²³⁸ Furthermore, following the formation of the American Board of Forensic Odontology (ABFO) in 1976, many odontologists expressed concerns that the procedures used by odontologists—which had been accepted by the courts—were somewhat less than scientific.²³⁹ Saks et al. support this point by citing a respected criminalist.²⁴⁰

Odontologists' skepticism likely led the ABFO to form a bite mark study committee.²⁴¹ Its members conducted their own research and noted there was great variability in bruising, discoloration, and bite marks left on the skin, and that variability related to an individual's skin and even the victim's gender.²⁴² This research resulted in ABFO's 1984 adoption and subsequent 1986 publication of guidelines for "Bite Mark Analysis."²⁴³ After that, the ABFO attempted to bring out a set of scoring guidelines for bite mark analysis, but it became evident that bite marks were so different from one another that the ABFO had no choice but to retract its intention.²⁴⁴ Not only could the organization agree that there was little scientific basis for a handbook on either scoring or analysis,²⁴⁵ but the ABFO freed a prisoner based on a previously improper evaluation of bite mark evidence in the case of *Wilhoit v. State* in 1991.²⁴⁶

victim's skin to that of the accused); *Marx*, 126 Cal. Rptr. at 356–57 (Ct. App. 1975) (affirming the trial court's decision to allow expert testimony regarding bite-mark evidence); *State v. Temple*, 273 S.E.2d 273, 280 (N.C. 1981) (holding that the trial court had "properly admitted the testimony of Drs. Webster and Hudson," which concluded that the bite-marks on the victim's skin matched the defendant's teeth).

²³⁷ See Paul G. Stimson & Curtis A. Mertz, *Bite Mark Techniques and Terminology*, in *FORENSIC DENTISTRY* 137, 137, 138 (Paul G. Stimson & Curtis A. Mertz eds., 1997).

²³⁸ See *id.* at 137.

²³⁹ See *id.*

²⁴⁰ See Saks et al., *supra* note 19, at 547 n.29 (citing ANDRE A. MOENSSSENS ET AL., *SCIENTIFIC EVIDENCE IN CIVIL AND CRIMINAL CASES* 985 (4th ed. 1995)).

²⁴¹ See Stimson & Mertz, *supra* note 237, at 137–38.

²⁴² See *id.* at 138.

²⁴³ See *id.* at 138; Am. Bd. of Forensic Odontology, *Guidelines for Bite Mark Analysis*, 112 J. AM. DENTAL ASS'N 383 (1986).

²⁴⁴ See Stimson & Mertz, *supra* note 237, at 139.

²⁴⁵ See *id.*

²⁴⁶ See *id.* at 139 & 158 n.7; *Wilhoit v. State*, 816 P.2d 545 (Okla. Crim. App. 1991).

By 1994, the ABFO developed guidelines for bite mark terminology;²⁴⁷ at the very least, they agreed on definitions and the use of terms. The guidelines, for example, agreed to define a bite mark as “a physical alteration in or on a medium caused by the contact of teeth.”²⁴⁸ This set of guidelines also listed the standards of proof in written and oral testimony.²⁴⁹ These included such degrees of certainty as a “possible biter,” a “probable biter,” and a “reasonable medical/dental certainty.”²⁵⁰ However, since the ABFO was concerned about odontologist outliers, Stimson and Mertz wrote that when forensic dentists made false claims about their findings and the reliability of those findings they were often using statements and results that were “unprovable and reckless.”²⁵¹ Alex Forrest and Alistair Soon, in their 2016 text, acknowledged the scientific limitations of conclusions drawn from bite mark analysis. They concluded that, at best, only three possible outcomes of bite mark comparison could be asserted: “1. Can exclude the suspect. 2. Cannot exclude the suspect. 3. Cannot reach a conclusion because of insufficient detail to perform a valid comparison.”²⁵² Forrest and Soon go on to say that the British Association for Forensic Odontology includes the category “Beyond reasonable doubt,” which, these authors contend, “is statistically unjustified and inappropriate in a legal setting.”²⁵³

As noted, in 2016 PCAST found that “[b]itemark analysis is a subjective method,”²⁵⁴ that bite mark standards do not provide “well-defined standards” that would lead to reliable conclusions when trying to match dentition to bite marks left on a victim,²⁵⁵ and that “skin has been shown to be an unreliable medium for recording the precise patterns of teeth.”²⁵⁶ The report concludes that “bitemark analysis does not meet the scientific standards for foundational validity” and that “the prospects of developing bitemark analysis into a scientifically valid method [are] low.”²⁵⁷ These conclusions are

²⁴⁷ Stimson & Mertz, *supra* note 237, at 139.

²⁴⁸ *Id.* at 141.

²⁴⁹ *See id.* at 142.

²⁵⁰ *Id.* at 145.

²⁵¹ *See id.* at 137, 145.

²⁵² Alex Forrest & Alistair Soon, *Bite Marks*, in *FORENSIC ODONTOLOGY: PRINCIPLES AND PRACTICES* 228, 278 (Jane A. Taylor & Jules A. Kieser eds., 2016).

²⁵³ *Id.*

²⁵⁴ PCAST, *supra* note 23, at 83.

²⁵⁵ *Id.*

²⁵⁶ *Id.* at 84.

²⁵⁷ *Id.* at 87.

based on three important assumptions: (1) that dentition and dental characteristics differ substantially from one person to another and that each person's dentition is unique; (2) that the skin can reliably capture the distinctive features of the characteristics of any person's dentition; and (3) that trained and experienced forensic dentists can match bite marks left on the skin of a victim with the dental characteristics of an individual.²⁵⁸ Herein we discuss the research related to each assumption in greater depth.

Assumption 1: each person's dentition is unique. According to PCAST, a number of studies cast serious doubt on this fundamental premise of the field of forensic odontology.²⁵⁹ However, there were also studies that purported to establish a scientific basis for this aspect of forensic dentistry. For instance, a 1984 paper claimed that human dentition was unique "beyond any reasonable doubt[.]"²⁶⁰ This study examined 397 bite marks that were made in a wax wafer.²⁶¹ Twelve parameters from each were then measured and it was concluded that the chance of two bite marks having the same parameters is less than one in six trillion.²⁶² More a theoretical rather than an empirical paper, it reports that the bite marks were not actually compared to one another in this study.²⁶³

In 2010, however, a paper published by the Mary Bush group critiqued Rawson et al.'s claims.²⁶⁴ Bush et al. studied 344 human dental casts, measuring them by three-dimensional laser scanning.²⁶⁵ This study found "that matches occurred vastly more often than expected under the theoretical model."²⁶⁶ "For example, the theoretical model predicted that the probability of finding even a single five-tooth match among the collection of bitemarks is less than one in one million"²⁶⁷ Yet in a study examining uniqueness in human dentition, Bush, Bush, and Sheets revealed 32 such matches.²⁶⁸ Studying human mandibular models in both two

²⁵⁸ See *id.* at 8.

²⁵⁹ See *id.* at 84, 85–86.

²⁶⁰ Rawson et al., *supra* note 144. This study was the grounds for Dr. Warnick's exaggerated statistical claims. See *supra* notes 142–145 and accompanying text.

²⁶¹ See PCAST, *supra* note 23, at 84.

²⁶² See *id.*

²⁶³ See *id.*

²⁶⁴ See *id.*; Bush et al., *Inquiry*, *supra* note 220, at 983.

²⁶⁵ See PCAST, *supra* note 23, at 84; Bush et al., *Inquiry*, *supra* note 220, at 977.

²⁶⁶ PCAST, *supra* note 23, at 84; see Bush et al., *Inquiry*, *supra* note 220, at 978.

²⁶⁷ PCAST, *supra* note 23, at 84.

²⁶⁸ See Mary A. Bush et al., *Statistical Evidence for the Similarity of the Human Dentition*, 56 J. FORENSIC SCI. 118, 120 tbl.4 (2011).

dimensions (2D) and three dimensions (3D) and then performing statistical analysis, random matches could not be eliminated.²⁶⁹ In fact, there were a substantial number of random matches.²⁷⁰ The authors contend that it is not possible to avoid random matches.²⁷¹

Almost all of the above-cited studies, as PCAST pointed out, were conducted under ideal conditions.²⁷² That is, the bite marks were produced in mediums other than skin.²⁷³ How well does the skin allow bite marks to be analyzed?

Assumption 2: the skin captures the precise pattern of teeth. Studies in which bite marks were made on the skin of animals or humans were shown to be very unreliable in terms of recording the precise pattern of teeth. For instance, “[s]tudies that . . . involved inflicting bitemarks either on living pigs”²⁷⁴ or on human cadavers²⁷⁵ have demonstrated that there are significant distortions.²⁷⁶ A 2010 study by Bush, Cooper, and Dorion, in which bite marks were produced by known biters, concluded that the skin distorts bite marks so substantially and so variably that current procedures for comparing bite marks are unable to reliably exclude or include a suspect as a potential biter.²⁷⁷ The authors stated that “the same dentition could not create a measurable impression that was consistent in all of the parameters in any of the test circumstances.”²⁷⁸ Experimental conditions, it must be noted, are unlike criminal events because “biting often occurs during struggles, in which the skin may be stretched and contorted at the time a bitemark is created.”²⁷⁹

At the most basic level of bite mark analysis, “research suggests that forensic odontologists do not consistently agree even on whether an injury is a human bitemark at all. A study by the American Board

²⁶⁹ See *id.* at 119–20.

²⁷⁰ See *id.* at 120.

²⁷¹ See *id.* at 122. See also Mary A. Bush & Peter J. Bush, *Current Context of Bitemark Analysis and Research*, in BITEMARK EVIDENCE: A COLOR ATLAS AND TEXT 303, 308–309 (Robert B. J. Dorion ed., 2d ed. 2011), reviewing the Rawson et al. study and concluding, “The statement that human dentition is unique is not justified.”

²⁷² See PCAST, *supra* note 23, at 84.

²⁷³ See *id.*

²⁷⁴ *Id.*; see Iain A. Pretty, *Reliability of Bitemark Analysis*, in BITEMARK EVIDENCE: A COLOR ATLAS AND TEXT, *supra* note 271, at 587, 593, 594.

²⁷⁵ See PCAST, *supra* note 23, at 84; H. David Sheets et al., *Bitemarks: Distortion and Covariation of the Maxillary and Mandibular Dentition as Impressed in Human Skin*, 223 FORENSIC SCI. INT’L 202, 203 (2012).

²⁷⁶ See PCAST, *supra* note 23, at 84; Sheets et al., *supra* note 275, at 206.

²⁷⁷ See Bush et al., *Inquiry*, *supra* note 220, at 982.

²⁷⁸ *Id.* at 983.

²⁷⁹ PCAST, *supra* note 23, at 84.

of Forensic Odontology (AFBO) [*sic*] involved showing photos of 100 patterned injuries to ABFO board-certified bitemark analysts.”²⁸⁰ These analysts were asked three elementary questions: “(1) whether there was sufficient evidence to render an opinion as to whether the injury is a human bitemark; (2) whether the mark is a human bitemark . . . or not a human bitemark; and (3) whether distinct features ([such as] arches and toothmarks) were identifiable.”²⁸¹ After a total of 38 examiners analyzed the photos, ABFO “reported that there was unanimous agreement on the first question in only 4 of the 100 cases and agreement of at least 90 percent in only 20 of the 100 cases. Across all three questions, there was agreement of at least 90 percent in only 8 of the 100 cases.”²⁸²

In a similar Australian study, fifteen odontologists were shown a series of six bite marks from contemporary cases.²⁸³ Five of the six bite marks were confirmed by living victims to have been caused by teeth.²⁸⁴ The odontologists were asked to comment on whether the injuries were actually bite marks.²⁸⁵ The results of this study found great variability among the odontologists in their conclusions about the origin, circumstance, and characteristics of the injuries. The researchers were surprised that those forensic dentists “with the most experience (21 or more years) tended to have the widest range of opinions as to whether [a] mark was of human dental origin.”²⁸⁶ The odontologists’ opinions varied considerably as to whether they thought a given mark was suitable for analysis, and individual odontologists showed little consistency in their approach to analyzing bite marks.²⁸⁷ The researchers concluded, “This inconsistency indicates a fundamental flaw in the methodology of bitemark analysis and should lead to concerns regarding the reliability of any conclusions reached about matching such a bitemark to a dentition.”²⁸⁸

²⁸⁰ *Id.*

²⁸¹ *Id.* at 84–85. The study was conducted by Adam Freeman and Iain Pretty and the raw data were reviewed by PCAST Senior Advisor Professor Karen Kafadar. *See id.* at 84 n.231, 85 n.232.

²⁸² *Id.* at 85.

²⁸³ *See* Mark Page et al., *Expert Interpretation of Bitemark Injuries—A Contemporary Qualitative Study*, 58 J. FORENSIC SCI. 664, 665 (2013).

²⁸⁴ *See id.*

²⁸⁵ *See id.*

²⁸⁶ *Id.* at 666.

²⁸⁷ *Id.* at 667, 670.

²⁸⁸ *Id.* at 670.

Assumption 3: trained and experienced forensic odontologists can match bite marks with the teeth making those bite marks. The 2009 National Academy of Science Report found that the scientific validity of bite mark analysis had not been established.²⁸⁹ “In its own review of the literature PCAST found few empirical studies that attempted to study the validity and reliability of the methods to identify the source of a bitemark.”²⁹⁰ Other studies attempting to establish the validity of matching go back decades. For example, in a 1975 paper, two examiners were asked to match photographs of bite marks made by twenty-four volunteers in skin from freshly slaughtered pigs with dental models from these same volunteers.²⁹¹ Some of the photographs were taken right after the bite marks were made, some an hour later, and others twenty-four hours after the bite mark was produced.²⁹² The experimenter found that the two examiners’ performance was not only poor, but their ability to match bite marks with biters deteriorated with time.²⁹³ That is, the longer the delay between the bite mark and the photograph, the greater the inability to match. At the twenty-four-hour mark, the incorrect identification was almost 84 percent.²⁹⁴

A 1998 study examined whether forensic dentists, along with general dentists, dental students, and lay participants could determine whether color prints of bite marks from fifty actual criminal cases were produced by an adult or a child.²⁹⁵ Comparing the results to the verdicts in the cases, it was discovered that all groups, including forensic dentists, did poorly.²⁹⁶ Three years later, thirty-two AFBO-certified diplomates were asked to indicate how certain they were as to which dental models made each of four bite marks.²⁹⁷ The experts were given seven models, four of which did produce the bite marks, along with three unrelated models.²⁹⁸ The forensic odontologists made incorrect attributions eleven percent of

²⁸⁹ See NRC REPORT, *supra* note 21, at 173, 174.

²⁹⁰ PCAST, *supra* note 23, at 85.

²⁹¹ See D.K. Whittaker, *Some Laboratory Studies on the Accuracy of Bitemark Comparison*, 25 INT’L DENTAL J. 166, 167 (1975).

²⁹² See *id.*

²⁹³ See *id.* at 169.

²⁹⁴ See PCAST, *supra* note 23, at 86; Whittaker, *supra* note 291, at 169.

²⁹⁵ See D.K. Whittaker et al., *A Comparison of the Ability of Experts and Non-Experts to Differentiate Between Adult and Child Human Bite Marks Using Receiver Operating Characteristic (ROC) Analysis*, 92 FORENSIC SCI. INT’L 11, 13 (1998).

²⁹⁶ See *id.* at 13, 15, 17.

²⁹⁷ See Kristopher L. Arheart & Iain A. Pretty, *Results of the 4th AFBO Bitemark Workshop—1999*, 124 FORENSIC SCI. INT’L 104, 105 (2001).

²⁹⁸ See *id.* at 105.

the time.²⁹⁹ That same year, in another study involving ten AFBO-certified diplomates, bite mark evidence from a dental model clamped onto a freshly slaughtered pig was given to them along with two possible sources;³⁰⁰ the researchers made sure that sufficient detail was provided in the photographs of the bite marks.³⁰¹ The mean false-positive rate found in this study was 15.9%, meaning that about one in six identifications was incorrect.³⁰² In a similar study with twenty-nine forensic dentists, including nine who were AFBO-certified diplomates, the dentists were provided with photographs of eighteen human bitemarks and dentition from three human individuals.³⁰³ The examiners were asked to match the bite marks with one of the three individuals (or that the bite mark did not come from the three individuals).³⁰⁴ The error rate in this study was seventeen percent, or again, they misidentified the match one in every six identifications.³⁰⁵

Thus, the research does not support any of the three assumptions that are crucial for bite mark analysis to be considered reliable. Yet, courts continue to allow these bite mark experts to testify in criminal court trials—despite years of wrongful convictions based on the testimony of these expert witnesses.³⁰⁶ While there are repeated calls for the elimination of bite mark evidence in trials,³⁰⁷ still the travesty of unscientific evidence is allowed in court—all with no efforts by the ABFO or the forensic odontologists to study their field or to restrict its members from offering highly subjective opinions in trials.³⁰⁸

Having reprised some of the substantial scientific and legal criticism that erodes if not destroys the scientific basis and reliability

²⁹⁹ See PCAST, *supra* note 23, at 86.

³⁰⁰ See *id.*

³⁰¹ See *id.*

³⁰² See *id.*

³⁰³ See *id.*

³⁰⁴ See *id.*

³⁰⁵ See *id.*

³⁰⁶ See Beecher-Monas, *supra* note 201, at 1372–74.

³⁰⁷ See, e.g., *id.* at 1374–75 (stating that permitting bite-mark evidence testimony to be introduced at trial, despite its proven lack of scientific reliability, is detrimental to the criminal justice system and adds no probative value to the jury in their determination of any disputed issue of fact); Fabricant & Carrington, *supra* note 198, at 7 (questioning the justice system's ability to sufficiently determine the underlying scientific value associated with bite-mark analysis, further explaining that courts and litigants often reflexively rely on bite-mark evidence despite its growing notoriety as a scientifically invalid precedent); Saks et al., *supra* note 19, at 541–42 (expressing concern, stemming from the judicial system's perceived reluctance to question the reliability of bite-mark evidence, despite the lack of empirical evidence to support such testimony).

³⁰⁸ See Balko, *Flawed Science*, *supra* note 66.

of bite mark evidence as a forensic tool to identify culprits, we now turn to the defense of that method offered by a group of forensic odontologists.

III. A CRITIQUE OF *EPIDERMIS AND ENAMEL*

Epidermis and Enamel, outlined at the beginning of this article,³⁰⁹ is an editorial-article which argues, largely by indirection, against courts' ruling bite mark evidence inadmissible as an unreliable pattern-comparison forensic technique.³¹⁰ The article's thesis comes midway: "Bitemark evidence at trial can be powerful and compelling. The tissue damage created by human teeth is demonstrable. The judges and juries that hear the testimony and see the demonstrations can better understand bitemark evidence, including the violent nature and potential pain associated with biting."³¹¹ To state that a bruise which probably is a bite mark is "demonstrable" is not the same as providing evidence that bite mark comparisons made by forensic odontologists are grounded in science or have been proven a reliable method of pattern comparison.

Epidermis and Enamel begins by noting that critics seek "obsessively" to eliminate bite mark evidence "from United States courtrooms"³¹² and then provides "An Odontology Response."³¹³ In this section the authors state that forensic odontology is an applied science "derive[d] from well-founded maxims that evolve over time as more knowledge is gained."³¹⁴ As with other applied science conclusions that are accepted by courts, opinions of forensic odontologist are "subject to cognitive (observer effect) biases."³¹⁵ What the authors miss here is a major conclusion to be drawn from PCAST and other careful analyses of pattern-comparison practices which generate impression evidence: that some forensic pattern-comparison practices are more reliable than others. Some, like ear mark or lip mark impression evidence, seem intuitively weak and have been found wanting,³¹⁶ although prosecutors still promote them

³⁰⁹ See *supra* notes 2–24 and accompanying text.

³¹⁰ See Barsley et al., *supra* note 2, at 89.

³¹¹ *Id.* at 94.

³¹² *Id.* at 88. Critics' reviews are discussed *infra* in text accompanying notes 413–443.

³¹³ *Id.* at 88.

³¹⁴ *Id.*

³¹⁵ *Id.*

³¹⁶ See NRC REPORT, *supra* note 21, at 150.

as reliable forensic identification techniques.³¹⁷ Latent fingerprint analysis is the feature-comparison method with the best record of being acceptably reliable.³¹⁸ Fingerprint analysis, which is no longer deemed to be error free, has been subject to substantial research and has advanced farthest among the feature-comparison techniques from a deterministic to a probabilistic model.³¹⁹ PCAST reviewed several studies and indicates that

serious efforts are now being made to try to put the field on a solid scientific foundation—including by measuring accuracy, defining quality of latent prints, studying the reason for errors, and so on. Much credit belongs to the FBI Laboratory, as well as to academic researchers who had been pressing the need for research. Importantly, the FBI Laboratory is

³¹⁷ The NRC Report notes that very few laboratories, according to a European survey, perform lip print or ear print examinations making it challenging to determine their reliability. *See id.* at 149–50. One American exoneration involved the submission of lip print evidence at trial, Lavelle Davis:

In 2006, Kane County Circuit Court Judge Timothy Q. Sheldon granted the petition following a hearing at which independent experts testified that lip print identification was not accepted science.

Davis's attorneys also presented a letter from the chief of the FBI's latent fingerprint unit stating: "The FBI Laboratory has not conducted any validation studies of lip print identification and has determined that it will not perform lip print analysis."

Lavelle Davis, NAT'L REGISTRY EXONERATIONS (June 2012), <https://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3160> [<https://perma.cc/5FU5-FYD7>]. In Lavelle Davis's case, an independent expert witness was

Andre A. Moenssens, professor emeritus at the University of Missouri, Kansas City Law School, and "Distinguished Fellow" of the American Academy of Forensic Sciences. Moenssens was emphatic when he stated that "lip impressions are a form of impression evidence very similar to earprints, elbow prints, and other comparative endeavors which have neither developed as forensic disciplines nor been the topic of extensive scientific research and experimentation". Furthermore, he adds "... the use of lip print comparisons in criminal prosecutions has been very rare and the comparison methodology or case details have mainly been transmitted anecdotally."

Gabriel M. Fonseca et al., *Lip Print Identification: Current Perspectives*, 65 J. FORENSIC & LEGAL MED. 32, 35 (2019) (alterations in original) (emphasis omitted). Nevertheless, there is substantial research on lip print identification and the practice seems to be used with some regularity in Poland; Fonseca et al. are cautiously negative about the reliability of lip print identification evidence but hope for better research. *See id.* at 37.

³¹⁸ *See* PCAST, *supra* note 23, at 101.

³¹⁹ *See* Christophe Champod, *Fingerprint Identification: Advances Since the 2009 National Research Council Report*, PHIL. TRANSACTIONS ROYAL SOC'Y B, May 4, 2015, no. 20140259, at 1–4. Although the field of friction ridge analysis has moved in this direction, many "fingerprint examiners today have adopted a new language without the necessary educational and scientific change that comes with it." *Id.* at 3.

responsible for the only black-box study to date that has been *published* in a peer-reviewed journal.³²⁰

One well cited post-National Academy Report study found a very high level of reliability in a test of fingerprint examiners.³²¹ Comparable efforts by the ABFO, however well intentioned, do not compare to the quality and quantity of research conducted regarding the reliability of fingerprint analysis, and the distance between the advances related to fingerprint analysis and bite mark evidence are great.³²² From our lay perspective, a critical difference between latent fingerprint and bite mark (or lip impression, or ear impression, or elbow impression) analysis is the amount of information imparted by the impressions of incisors left on skin compared to even one fingerprint; the greater information content in fingerprints allows for the potential for more accurate, although always probabilistic, identifications.³²³ In any event, *Epidermis and Enamel* barely mentions the scientific criticism of bite mark evidence and concocts a variety of supportive arguments that are logically flawed. It does not provide a research-based or a logical reply to the scientific critique.³²⁴ It could have done so as there continues to be a stream of bite mark research that is published,³²⁵ although we suspect that however

³²⁰ PCAST, *supra* note 23, at 95.

³²¹ See Bradford T. Ulery et al., *Accuracy and Reliability of Forensic Latent Fingerprint Decisions*, 108 PNAS 7733, 7738 (2011).

³²² The ABFO has responded to the forensic science challenge by expressing a commitment to proficiency testing, suggesting a second opinion in bite mark cases, seeking accreditation, establishing ethical standards and eliminating the acceptability of “certainty” statements by odontologists. See Barsley et al., *supra* note 2, at 87–89. The claim that “odontologists do not continue analysis in most cases they initially evaluate,” *id.* at 89, speaks well to the care taken by odontologists but does not allay the concern that the unreliability shown in various tests may result in wrongful convictions.

³²³ See *id.* at 88; Bradford T. Ulery et al., *Understanding the Sufficiency of Information for Latent Fingerprint Value Determinations*, 230 FORENSIC SCI. INT’L 99, 99–100 (2013).

³²⁴ It makes some head-scratching statements, for example, “Regarding criticisms of the uniqueness of the dentition, logic holds that the dentition is unique on a molecular level” Barsley et al., *supra* note 2, at 88; see *supra* Part II.

³²⁵ See, e.g., Valeria Santoro et al., *Experimental Study of Bite Mark Injuries by Digital Analysis*, 56 J. FORENSIC SCI. 224, 224 (2011) (researching bite marks on pig skin analyzed mathematically; authors note that distortion of bite mark on skin not taken into account); Mihran Tuceryan et al., *A Framework for Estimating Probability of a Match in Forensic Bite Mark Identification*, 56 J. FORENSIC SCI. S83, S83–84 (2011) (discussing a statistical model from dental casts and bite mark images from the casts pressed into foam cushion doll). Such work continues after the publication of *Epidermis and Enamel*. See, e.g., Uttara Deshpande & Scheila Mânica, *Exploring Bite Marks on Different Types of Skin Tones*, 6 REVISTA BRASILEIRA DE ODONTOLOGIA LEG. 40, 40, 41 (2019) (analyzing the validity of bitemark identification procedures using skin tone as a control variable). In his blog post, Dr. Bowers was dismissive toward the kind of research in the last publication: “As usual, dentists show little interest and

alluring on the surface such studies do not shake the critical analysis of bite mark reliability that is described in this Part.

If there is a main argument it seems to be that wrongful convictions are rarely if ever the product of a single error (e.g., eyewitness misidentification alone) but are almost always the product of multiple errors. This is old news, but is important to take into account when developing comprehensive strategies to reduce the likelihood of wrongful convictions.³²⁶ Consequently, the authors conclude that bite mark evidence critics who advocate removing it from admissible forensic evidence are wrong.³²⁷ *Epidermis and Enamel* does not quite make the point directly, but suggests this conclusion by listing nineteen wrongful conviction cases in which bite mark evidence was introduced against twenty one defendants, and by showing that in every case one or more of fourteen other factors played a role in bringing about the wrongful conviction.³²⁸ “The authors submit that the cases that have been characterized as wrongful convictions involving bitemark evidence also included factors unrelated to bitemark evidence.”³²⁹ To which one answers, “So what?” If the scientific critique is that bite mark comparison evidence is inherently unreliable, then pointing out that *other* errors

generally ignore the fact that skin is easily distorted. This paper studies skin color. Meh.” Michael Bowers, *Forensics: Dentists Continue to Assume Bitemark Patterns are Accurate*, CSIDDS (Apr. 25, 2019), <https://csidds.com/2019/04/25/forensics-dentists-continue-to-assume-bitemark-patterns-are-accurate/> [https://perma.cc/7PXN-LXWP].

³²⁶ See George Castelle & Elizabeth F. Loftus, *Misinformation and Wrongful Conviction*, in *WRONGLY CONVICTED: PERSPECTIVES ON FAILED JUSTICE* 18, 18 (Saundra D. Westervelt & John A. Humphrey eds., 2001); James M. Doyle, *Learning from Error in the American Criminal Justice*, 100 J. CRIM. L. & CRIMINOLOGY 109, 109, 126 (2010); Zalman & Carrano, *Sustainability*, *supra* note 192, at 986. In addition, appreciating the cascading effects of multiple error in causing wrongful convictions has led to fruitful research and research proposals, including studies using matched comparison samples and a proposal that social science researchers analyze wrongful convictions with path-analysis or decision tree methods. See Richard A. Leo & Jon B. Gould, *Studying Wrongful Convictions: Learning from Social Science*, 7 OHIO ST. J. CRIM. L. 7, 21–28 (2009). The *Epidermis and Enamel* polemic seems insensitive to the need to conduct meaningful research to better assess the causes of wrongful convictions, as is seen in its failure to understand the research of Gould et al., *supra* note 99. See Barsley et al., *supra* note 2, at 92; *infra* notes 338–341 and accompanying text.

³²⁷ See Barsley et al., *supra* note 2, at 87, 88. The odd thing is that *Epidermis and Enamel* does not say this directly, although it is the main point of the article. The point is made indirectly by a combination of obsequiousness and an attack on lawyers who represent the wrongfully convicted, which may be the covert aim of the article. *Epidermis and Enamel* concludes, “Odontologists today are more reflective and conservative in their approach to bitemark casework. Judges should continue to improve their skills as gatekeepers. This gatekeeping role must not devolve to third parties that are potentially unqualified or may have partisan political or financial agendas.” *Id.* at 95.

³²⁸ See *id.* at 89, 90–91 tbl.1.

³²⁹ *Id.* at 89.

occur in exoneration cases is a classic non sequitur.³³⁰ The non sequitur, though hidden by a cloud of other arguments and by the editorial's remorseful tone, should be apparent to any careful reader.³³¹ If this is the best argument that bite mark analysis defenders can come up with, it tends to support our thesis that their thinking reflects a psychological and social process similar to the denial of DNA exonerations by the prosecutors observed by Orenstein.³³² A less charitable explanation sees the article as propaganda, addressed not to legal and scientific bite-mark-evidence-critics, but to a base of supporters among police, prosecutors, judges and other forensic examiners, who seek to preserve a redoubt of certainty in a world made more probabilistic by the challenges to forensic science.³³³

Epidermis and Enamel supports its claim in a section (mis)describing an important empirical study of wrongful conviction causation by Gould et al.³³⁴ This social scientific study compared 260 wrongful convictions and 200 near misses and found ten statistically significant factors associated with why some wrongful prosecutions led to wrongful conviction while others were dismissed or resulted in acquittals.³³⁵ Of the ten statistically significant factors associated with wrongful conviction, some are included among common wrongful conviction "causes" (e.g., *Brady* violations; errors in forensic analysis).³³⁶ However, several factors usually counted as "causes" of wrongful conviction (e.g., false confessions; mistaken, as opposed to intentional, eyewitness identification) were not statistically significant.³³⁷ Additionally, several variables that are not typically included among standard wrongful conviction "causes" were significantly associated with wrongful conviction (e.g., state death

³³⁰ See *id.* at 89, 92. A commercial website lists non sequitur among 300 logical fallacies. See LOGICALLY FALLACIOUS, *Non-Sequitur*, <https://www.logicallyfallacious.com/tools/lp/Bo/LogicalFallacies/136/Non-Sequitur> [<https://perma.cc/A79F-CFSV>].

³³¹ The cloud of material in the article, or irrelevant filler includes a listing of what a bite mark can signify, as well as attacks on innocence organizations. See Barsley et al., *supra* note 2, at 88, 92, 94.

³³² See Orenstein, *supra* note 28, at 402–03, 428–30. We expound on this matter in Part IV.

³³³ We address this issue in Part V. Simon Cole "suggests that some of the current sense of crisis in forensic identification may be attributed to a historical failure to articulate defensible epistemological foundation for the testimonial claims that forensic identification experts make." Simon A. Cole, *Forensics Without Uniqueness, Conclusions Without Individualization: The New Epistemology of Forensic Identification*, 8 LAW, PROBABILITY & RISK 233, 234 (2009).

³³⁴ See Barsley et al., *supra* note 2, at 92; Gould et al., *supra* note 99, at 447.

³³⁵ See Gould et al., *supra* note 99, at 477, 494.

³³⁶ See *id.* at 488–89.

³³⁷ See *id.* at 489.

penalty culture positively associated; age of defendant negatively associated with wrongful convictions).³³⁸ The editorial misses the import of the fact that Gould et al. identified the factors as correlates rather than causes. While *Epidermis and Enamel* relies on that conclusion to support its view that multiple factors absolves erroneous bite mark analysis, the larger goal of Gould et al. was to infuse the study of wrongful conviction with scientific rigor by not calling significant factors “causes” if they could not meet the most stringent standards of scientific causation as is the case in controlled experiments.

We believe that a better understanding of Gould et al. supports our argument that a real danger of bite mark analysis is to bolster weak prosecution cases.³³⁹ One of their most baffling statistical findings was that a *weak* prosecution case is statistically associated with wrongful convictions.³⁴⁰ This finding was so counterintuitive that the study’s principal investigators turned to a panel of experienced criminal justice professionals who suggested that prosecutors who believed they were right but had weak evidence were more willing to engage in unethical behavior, like withholding exculpatory evidence.³⁴¹ Thus, “[w]eak facts may also encourage prosecutors to engage in certain behaviors designed to bolster the case, which our statistics show help predict an erroneous conviction.”³⁴² Rather than supporting *Epidermis and Enamel*’s vacuous main argument, the Gould et al. study undercuts it. Their argument is also part of the fog machine, filling the editorial with irrelevant or erroneous, but smart-sounding, arguments.

Misreading Gould et al. connects to another way in which *Epidermis and Enamel* intentionally or blindly smudges reality. It is now accepted that cognitive biases are a normal part of human psychology,³⁴³ and includes the thinking of forensic scientists and

³³⁸ See *id.* at 485–86.

³³⁹ See *id.* at 494, 501. “Bite marks often are associated with highly sensationalized and prejudicial cases, and there can be a great deal of pressure on the examining expert to match a bite mark to a suspect.” NRC REPORT, *supra* note 21, at 175.

³⁴⁰ Gould et al., *supra* note 99, at 501 (“Of all the statistically significant factors that harm an innocent defendant, a weak prosecution case is hardest to explain.”).

³⁴¹ See *id.* at 495, 501. “To fully understand our statistical results, a qualitative assessment of the cases, aided by the expert panel, was vital.” *Id.* at 495.

³⁴² *Id.* at 501.

³⁴³ See DANIEL KAHNEMAN, THINKING, FAST AND SLOW 1, 4 (2011); Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 1130 (1974). This widely researched conclusion is based on a half-century of research beginning in the 1960s. See MERCIER & SPERBER, *supra* note 51, at 21–23; Raymond S. Nickerson, *Confirmation Bias: A Ubiquitous Phenomena in Many Guises*, 2 REV. GEN. PSYCHOL. 175, 175 (1998).

analysts.³⁴⁴ *Epidermis and Enamel* acknowledges this fact but blurs its impact by conflating cognitive biases with the physical perceptual biases discovered in early nineteenth century psychological research³⁴⁵ and illogically goes on to say that if cognitive bias affects all forensic scientists then there is no issue with such bias among forensic odontologists.³⁴⁶ Confirmation bias, a key cognitive bias implicated in wrongful convictions and often related to the notion of “tunnel vision,”³⁴⁷ is defined as “the tendency to interpret new information in ways that confirm one’s pre-existing beliefs.”³⁴⁸ Mercier and Sperber suggest that confirmation bias is better thought of as “myside bias.”³⁴⁹

³⁴⁴ See Itiel E. Dror & David Charlton, *Why Experts Make Errors*, 56 J. FORENSIC IDENTIFICATION 600, 602 (2006); Itiel E. Dror & Simon A. Cole, *The Vision in “Blind” Justice: Expert Perception, Judgment, and Visual Cognition in Forensic Pattern Recognition*, 17 PSYCHONOMIC BULL. & REV. 161, 162 (2010); Itiel E. Dror & Greg Hampikian, *Subjectivity and Bias in Forensic DNA Mixture Interpretation*, 51 SCI. & JUST. 204, 204 (2011); NRC REPORT, *supra* note 21, at 122–24; PCAST, *supra* note 23, at 31–32 (identifying cognitive and conformation biases as a potential cause of forensic science error).

³⁴⁵ See Barsley et al., *supra* note 2, at 88; Kurt Danziger, *The Origins of the Psychological Experiment as a Social Institution*, 40 AM. PSYCHOL. 133, 138 (1985).

³⁴⁶ They state,

In applied science, opinions are formed by humans and are subject to potential human error. Decision making is a cognitive process subject to cognitive (observer effect) bias. This is unintentional and outside of awareness. Most disciplines in forensic sciences and medicine are vulnerable to this bias, yet the courts accept and rely on opinion testimony from witnesses deemed to possess adequate knowledge, skill, training, and experience.

Barsley et al., *supra* note 2, at 88.

³⁴⁷ See Keith A. Findley & Michael S. Scott, *The Multiple Dimensions of Tunnel Vision in Criminal Cases*, 2006 WIS. L. REV. 291, 396. Conflating tunnel vision with cognitive biases appears to be scientifically untenable and it may be useful for discussions of wrongful conviction to move away from a reflexive use of the term *tunnel vision*. See Brent Snook & Richard M. Cullen, *Bounded Rationality and Criminal Investigations: Has Tunnel Vision Been Wrongfully Convicted?*, in CRIMINAL INVESTIGATIVE FAILURES 72, 72–73 (D. Kim Rossmo ed., 2009); Marvin Zalman, *The Detective and Wrongful Conviction*, in WRONGFUL CONVICTION AND CRIMINAL JUSTICE REFORM, *supra* note 192, at 147, 153.

³⁴⁸ See Jeff Kukucka et al., *Cognitive Bias and Blindness: A Global Survey of Forensic Science Examiners*, 6 J. APPLIED RES. MEMORY & COGNITION 452, 452 (2017).

³⁴⁹ They state,

[P]eople have no general preference for confirmation. What they find difficult is not looking for counterevidence or counterarguments in general, but only when what is being challenged is their own opinion. Reasoning does not blindly confirm any belief it bears on. Instead, reasoning systematically works to find reasons for our ideas and against ideas we oppose. It always takes our side. As a result, it is preferable to speak of a *myside bias* rather than of a confirmation bias.

MERCIER & SPERBER, *supra* note 51, at 218.

Confirmation bias, which has led to numerous wrongful identifications, often comes about because the forensic expert receives direct communication from a police officer or because of cross-communication among different forensic examiners during an investigation,³⁵⁰ or because police and prosecutors request re-examination by a forensic expert if the first report results in an unfavorable conclusion providing a more favorable result.³⁵¹ It also involves forensic and other experts overestimating the strength of their evidence.³⁵² Confirmation bias, therefore, is exacerbated by experts being influenced by extraneous information and contextual pressure.³⁵³

The complacency exhibited by *Epidermis and Enamel* toward cognitive biases misses the many proposals and measures being advanced for combating the negative effects of cognitive biases in critical decision-making areas like forensic science including “thinking slow,” blinding, including comparison samples in forensic tests, expanding awareness of cognitive biases, cultural changes and the like.³⁵⁴ The problem with bite mark evidence is that, as already noted, almost all odontologists are practicing dentists who work part time at the entirety of forensic cases and that not only are bite mark cases the smaller part of their forensic work, but they tend to be sought by police and prosecutors in “sensationalized” cases.³⁵⁵ Thus,

³⁵⁰ See Saul M. Kassir et al., *The Forensic Confirmation Bias: Problems, Perspectives, and Proposed Solutions*, 2 J. APPLIED RES. MEMORY & COGNITION 42, 43 (2013).

³⁵¹ See *id.*; Michael J. Saks et al., *Context Effects in Forensic Science: A Review and Application of the Science of Science to Crime Laboratory Practice in the United States*, 43 SCI. & JUST. 77, 86 (2003); Glen Whitman & Roger Koppl, *Rational Bias in Forensic Science*, 9 LAW PROB. & RISK 69, 69 (2010) (“[C]urrent organization of forensic science induces biases in the conduct of forensic science even if forensic scientists are perfectly rational.”).

³⁵² See Andrea O. Baumann et al., *Overconfidence Among Physicians and Nurses: The ‘Micro-Certainty, Macro-Uncertainty’ Phenomenon*, 32 SOC. SCI. & MED. 167, 173 (1991); Kassir et al., *supra* note 350, at 43.

³⁵³ See Kassir et al., *supra* note 350, at 43. Extraneous information includes knowing that a suspect has confessed, being aware that there is an eyewitness identification, or knowing that there is testimony from a snitch or informant. See Dror & Charlton, *supra* note 344, at 612; Kassir et al., *supra* note 350, at 46.

³⁵⁴ Brandon L. Garrett, *Blinding Eyewitness Identification*, in *BLINDING AS A SOLUTION TO BIAS: STRENGTHENING BIOMEDICAL SCIENCE, FORENSIC SCIENCE, AND LAW* 297, 297 (Christopher T. Robertson & Aaron S. Kesselheim eds., 2016); see KAHNEMAN, *supra* note 343, at 13; Itiel E. Dror et al., *New Application of Psychology To Law: Improving Forensic Evidence and Expert Witness Contributions*, 2 J. APPLIED RES. MEMORY & COGNITION 78, 78–80 (2013); Ralph N. Haber & Lyn Haber, *The Culture of Science: Bias and Forensic Evidence*, 2 J. APPLIED RES. MEMORY & COGNITION 65, 67 (2013); Kukucka et al., *supra* note 348, at 453.

³⁵⁵ See NRC REPORT, *supra* note 21, at 175; Trudy Brunot, *Necessary Skills to Be an Odontologist*, CHRON, <https://work.chron.com/necessary-skills-odontologist-30838.html> [<https://perma.cc/TSJ3-XSD6>].

the tendency of forensic odontologists to bolster weak cases is exacerbated by the inevitable impact of cognitive biases in their case work. Unlike a full-time forensic laboratory analyst who can be insulated from the contextual elements of the case, forensic odontologists are briefed on all the biasing aspects of cases.³⁵⁶ Perhaps blinding and other methods of reducing cognitive biases in bite mark analysis may be possible, but *Epidermis and Enamel* expresses no awareness or interest in such protective measures.

Epidermis and Enamel also argued, “The legal community has an obligation to safeguard against invalid and unreliable testimony.”³⁵⁷ This is true; indeed, commentators have noted that judges act as effective gatekeepers to screen out weakly supported scientific evidence in civil cases but not in criminal prosecutions.³⁵⁸ Thus, if judges were really doing their jobs in criminal cases, they would be more critical of bite mark evidence.³⁵⁹ But the point is made by *Epidermis and Enamel* in another non sequitur that passes the buck, a *tu quoque* fallacy: “turn[ing] criticism back upon the critic instead of dealing with the criticism itself.”³⁶⁰

A mitigating factor implied by *Epidermis and Enamel* is that “only a small fraction of” the 351 DNA exonerations reported by the Innocence Project, “27 or 28 cases, approximately 8% of their total, included bitemark evidence and resulted in later exonerations.”³⁶¹ Given that many factors, including a dozen or more forensic science methods,³⁶² contribute to wrongful convictions, it is no argument in defense of bite mark analysis to imply that “only” 27 or 28 wrongful

³⁵⁶ See Souviron & Haller, *supra* note 24, at 620–21. But see Gary Edmond et al., *Contextual Bias and Cross-Contamination in the Forensic Sciences: The Corrosive Implications for Investigations, Plea Bargains, Trials and Appeals*, 14 LAW, PROBABILITY & RISK 1, 1 (2015) (discussing how most forensic science evidence is not insulated from contextual information about the case that can result in bias).

³⁵⁷ Barsley et al., *supra* note 2, at 91.

³⁵⁸ See Peter J. Neufeld, *The (Near) Irrelevance of Daubert to Criminal Justice and Some Suggestions for Reform*, 95 AM. J. PUB. HEALTH S107, S109 (2005); D. Michael Risinger, *Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 100 (2000).

³⁵⁹ See Fabricant & Carrington, *supra* note 198, at 38 (“Perhaps no discredited forensic assay has benefited more from criminal courts’ abdication of gatekeeper responsibilities than bite mark analysis.”).

³⁶⁰ See *33 Logical Fallacies Everyone Should Know*, PASTORBRIANCHILTON <https://pastorbrianchilton.wordpress.com/2014/07/28/33-logical-fallacies-everyone-should-know/> [https://perma.cc/FQ35-UZVG].

³⁶¹ Barsley et al., *supra* note 2, at 88.

³⁶² See NRC REPORT, *supra* note 21, at xvi, 182. See generally FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, *supra* note 57, at 1, 25, 57, 95, 137, 167, 203, 239, 271, 299, 331 (discussing different forensic science methods throughout).

convictions based in part on bite mark analysis have been identified among the Innocence Project's list of DNA exonerations.³⁶³ Procedural challenges to obtaining exonerations and the many ways that prosecutors deflect wrongful convictions make it likely that other similar cases have not come to light, suppressing the number of exonerations.³⁶⁴ The authors then add an entirely unsubstantiated and false claim, writing, "However, not all of these cases were actual exonerations and not all of the exonerations were based on DNA,"³⁶⁵ raising doubts about the quality of the journal's peer review process.³⁶⁶

An additional argument is that forensic odontologists have helped to exonerate some of the wrongfully convicted.³⁶⁷ The logic is that by relying on forensic odontologists to win a client's freedom, the defense lawyer acknowledges the basic validity of bite mark comparison analysis; the original prosecution expert was in error and is set right by a more proficient forensic dentist for the prisoner. To a degree this is the Cristini and Moldowan case, except that they were not represented by innocence organization lawyers in the post-conviction

³⁶³ "[A]ny system involving human judgment, particularly at as many stages as a criminal case proceeds through, will yield some errors. However, to the extent that forensic science plays an important role in criminal proceedings, errors produced by flawed and unvalidated evidence and testimony are *unnecessary* . . ." Adam B. Shniderman, *Prosecutors Respond to Calls for Forensic Science Reform: More Sharks in Dirty Water*, 126 YALE L.J.F. 348, 350 n.9 (2017) (emphasis added).

³⁶⁴ In a number of clear wrongful conviction cases, prosecutors obtain guilty pleas for time served and release factually innocent defendants who, after years of imprisonment, are desperate to be released. See, e.g., Michael Hall, *The Trouble with Innocence*, TEXAS MONTHLY (Mar. 2017), <https://features.texasmonthly.com/editorial/the-trouble-with-innocence/> [<https://perma.cc/93HV-CBDL>] (discussing the Kerry Max Cook case, where the defendant (Cook) was convicted despite being factually innocent and was desperate to be released for decades). In other cases, government-official defendants in civil rights cases settle wrongful conviction cases, but "although the government defendants settled, they insisted that the settlement contain no admission of wrongdoing and that the facts of the wrongful conviction and prosecution would be concealed behind a confidentiality agreement. This isn't uncommon. In fact, it is normal." James Doyle, *Keeping the Wrong Secrets: The 'Cone of Silence' Around Exonerations*, CRIME REPORT (May 28, 2019), <https://thecrimereport.org/2019/05/28/keeping-the-wrong-secrets-the-cone-of-silence-around-exonerations/> [<https://perma.cc/6YA8-FFZE>].

³⁶⁵ Barsley et al., *supra* note 2, at 88.

³⁶⁶ The *American Journal of Forensic Medicine and Pathology* is published by a respected academic publisher, Wolters Kluwer; as the article is an editorial, perhaps peer review was waived or relaxed; the journal's web page does not impart information about peer review. "To be sure, no one is naïve enough to believe that peer review exposes all, or even most, faulty scientific knowledge claims. Rather, most sober observers understand peer review as a modest quality assurance procedure that functions as a mild deterrent against poor, or even fraudulent, scientific work." Cole, *Culture*, *supra* note 189, at 40.

³⁶⁷ See Barsley et al., *supra* note 2, at 88 ("Some [exonerees] were exonerated at least partially based on the postconviction work of specialist odontologists with extensive bitemark experience unrelated to the IP [Innocence Project] . . .").

phase or at their second trials but by private practitioners. If such clients are represented by innocence organizations,³⁶⁸ the innocence advocate (who as a matter of policy argues that bite mark evidence should be held inadmissible) could be accused of hypocrisy.

To sort out this argument requires understanding the institutional roles of defense lawyers generally and “innocence lawyers” affiliated with innocence organizations. Risinger and Risinger explain that the new innocence lawyer role in American criminal litigation differs from a traditional defense attorney’s role at trial, appeal, or in post-conviction proceedings.³⁶⁹ Traditional legal practice norms, established in England and the United States from the late-eighteenth to the mid-nineteenth centuries, require defense lawyers to accept any person charged with a crime as a client and are unconcerned with the client’s factual guilt or innocence.³⁷⁰ The lawyer’s role is to provide effective defense within the rules of evidence and to “put the government to its proof.”³⁷¹ Innocence projects differ on these norms and also in that they are pro bono organizations.³⁷² In contrast to traditional defense lawyers, the

³⁶⁸ Several of the defendants listed in *Epidermis and Enamel* were represented by innocence organizations, including Kennedy Brewer, Levon Brooks, Roy Brown, Keith Harward, Ray Krone, Gerard Richardson, Bennie Starks (New York Innocence Project), Robert Lee Stinson (Wisconsin Innocence Project), and William Richards (California Innocence Project). See *id.* at 90–91 tbl.1; *Kennedy Brewer*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/kennedy-brewer/> [<https://perma.cc/E3EQ-G6X7>]; *Levon Brooks*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/levon-brooks/> [<https://perma.cc/V63S-LXN7>]; *Roy Brown*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/roy-brown/> [<https://perma.cc/94ZC-BJ3R>]; *Keith Harward*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/keith-allen-harward/> [<https://perma.cc/HC3G-58ZV>]; *Ray Krone*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/ray-krone/> [<https://perma.cc/K94D-2BQC>]; *Gerard Richardson*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/gerard-richardson/> [<https://perma.cc/4TKB-GQUV>]; *Bennie Starks*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/bennie-starks/> [<https://perma.cc/7UXX-9NCA>]; *Robert Lee Stinson*, INNOCENCE PROJECT, <https://www.innocenceproject.org/cases/robert-lee-stinson/> [<https://perma.cc/5SK3-4SQV>]; *William Richards*, CAL. INNOCENCE PROJECT, <https://californiainnocenceproject.org/read-their-stories/william-richards/> [<https://perma.cc/5RZY-V373>].

³⁶⁹ See D. Michael Risinger & Lesley C. Risinger, *The Emerging Role of Innocence Lawyer and the Need for Role-Differentiated Standards of Professional Conduct*, in *CONTROVERSIES IN INNOCENCE CASES IN AMERICA*, *supra* note 27, at 123.

³⁷⁰ See *id.* The “cab rank” rule is not strictly applied in America as there are allowable practical and personal reasons for an attorney to not defend specific clients, but such deference is allowable if an unpopular defendant can be reasonably represented. See *id.* at 124 n.1.

³⁷¹ *Id.* at 124. More abstractly, the defense lawyer’s role encompasses the principles of partisanship (zealous advocacy for the client), neutrality (as to the moral merits of the client’s case), and non-accountability (the lawyer is not held accountable for the client’s views or actions). *Id.* at 130.

³⁷² See Ellen Yankiver Suni, *Ethical Issues for Innocence Projects: An Initial Primer*, 70 UMKC L. REV. 921, 923–26 (2002). Innocence organizations are funded by combinations of

innocence lawyer selects only clients who have been carefully screened to determine, to the degree possible, that they are factually innocent³⁷³ What is surely galling to many prosecutors and investigators who think of themselves as on the prosecution team, is that the traditional “criminal defense lawyer is there to aggressively test and contest the evidence proffered by the government, and to insure that all constitutional limitations on the prosecution are respected *regardless of their impact on the accuracy of the verdict of guilt, and regardless of underlying guilt or innocence.*”³⁷⁴ When innocence lawyers engage in postconviction litigation to free clients they believe are innocent, given the exigency of litigation and the obligation of an attorney to mobilize all relevant evidence in the client’s interest, they *must* use the same legal tools used by traditional attorneys and thus can be characterized as professionally unconcerned with the ground truth of the case.³⁷⁵ It would be malpractice and a basis for an ineffective-assistance-of-counsel claim for an attorney to not use a forensic odontologist’s services to counter a prosecutor’s expert.³⁷⁶ In light of the professional and ethical demands on defense attorneys, their use of forensic odontologists as experts, even by innocence organization attorneys whose policy stance opposes bite mark evidence, might be deemed hypocrisy, but it is logically not an argument for the scientific validity or reliability of bite mark evidence.³⁷⁷

Nevertheless, the argument has some weight. There may be a residual area in which bite mark evidence might be used to *eliminate*

grants and charitable contributions, and support by sponsoring universities or public defenders’ organizations. See INNOCENCE PROJECT, CELEBRATING 25 YEARS OF FREEDOM AND JUSTICE: THE INNOCENCE PROJECT 2016 ANNUAL REPORT 19–27 https://www.innocenceproject.org/wp-content/uploads/2018/01/IP-AR2016_16sm.pdf [<https://perma.cc/HP5Y-EX6D>]. Very little has been published about the organizational aspects of innocence organizations. See Steven A. Krieger, *Why Our Justice System Convicts Innocent People, and the Challenges Faced by Innocence Projects Trying to Exonerate Them*, 14 NEW CRIM. L. REV. 333, 333, 364–65 (2011).

³⁷³ See Keith A. Findley, *The Pedagogy of Innocence: Reflections on the Role of Innocence Projects in Clinical Legal Education*, 13 CLINICAL L. REV. 1101, 1113, 1119–20 (2006); Daniel S. Medwed, *Actual Innocents: Considerations in Selecting Cases for a New Innocence Project*, 81 NEB. L. REV. 1097, 1116–18 (2003); Jan Stiglitz et al., *The Hurricane Meets the Paper Chase: Innocence Projects New Emerging Role in Clinical Legal Education*, 38 CAL. W. L. REV. 413, 430–31 (2002); Suni, *supra* note 372, at 924.

³⁷⁴ Risinger & Risinger, *supra* note 369, at 124 (emphasis added).

³⁷⁵ See *id.* at 127–28, 129. But see *id.* at 123, 125, 130 (theorizing that innocence lawyers have different functions).

³⁷⁶ See Barsley et al., *supra* note 2, at 91; Krieger, *supra* note 372, at 354 (listing practices that could lead to ineffective defense representation).

³⁷⁷ This argument is related to *Epidermis and Enamel*’s criticism of the Texas Forensic Science Commission’s moratorium on bite mark analysis, discussed below. See *infra* notes 397–403 and accompanying text.

a suspect in a case where a bite mark pattern is so far out of sync with a suspect's dentition that the suspect should be released, whatever other factors have raised police suspicion.³⁷⁸ This point also weakly supports the argument that the work of some forensic dentists who testify regarding bite mark comparisons was so shoddy that other, more experienced or competent odontologists have the skills to correctly perform bite mark analysis.³⁷⁹

To a degree *Epidermis and Enamel* draws support from testimonials of like-minded authors, including a forensic pathologist who argues that “visual cognition is as, or more, important than the abstract weighing of evidence”;³⁸⁰ die-hard forensic examiners who have stridently attacked the innocence challenges to forensic science;³⁸¹ a Texas trial judge who argued that the admissibility of bite mark evidence is in the purview of courts and not a Commission;³⁸² and a “populist style” bad-mouthing of the financial success of the Innocence Project by a disaffected former director of an innocence organization.³⁸³ Whatever the merits of these authors,

³⁷⁸ This is the position of Souviron and Haller. See Souviron & Haller, *supra* note 24; *infra* Part V.

³⁷⁹ We address this issue in Part V.

³⁸⁰ WILLIAM R. OLIVER, THE INTERPRETATION OF PATTERNED INJURIES IN MEDICOLEGAL DEATH INVESTIGATION 20 (2017), <https://www.ncjrs.gov/pdffiles1/nij/grants/250570.pdf> <https://perma.cc/AW7P-ZLJH>, quoted in Barsley et al., *supra* note 2, at 94.

³⁸¹ John M. Collins & Jay Jarvis, *Contextual Contamination of Forensic Evidence by Post-Conviction Litigators*, J. INST. FOR ADVANCEMENT CRIM. JUST., 2009, at 7, 13 [hereinafter Collins & Jarvis, *Contextual*], quoted in Barsley et al., *supra* note 2, at 93–94. *Epidermis and Enamel* provides this incomplete or misleading citation: “J Crim Justice.” The *Journal of the Institute for the Advancement of Criminal Justice* is the journal of a nonprofit institute whose officers are, with a few exceptions, current or retired California prosecutors. Its offices are located in Sacramento, California’s capital. See Jan Scully, *IACJ President’s Message*, J. INST. FOR ADVANCEMENT CRIM. JUST., Summer 2007, at 2, https://www.conservativecriminology.com/uploads/5/6/1/7/56173731/iacjjournalissue1_3_strikes_ca.pdf [<https://perma.cc/YZD4-MSRW>].

³⁸² See Robert R. Barton, *Moratorium on Bite-Mark Evidence Not a Solution*, SAN ANTONIO EXPRESS NEWS (May 8, 2016, 12:00 AM), <http://www.mysanantonio.com/opinion/commentary/article/Moratorium-on-bite-mark-evidence-not-a-solution-7401435.php> [<https://perma.cc/4QYD-EM4P>].

³⁸³ *Epidermis and Enamel* cites a personal communication from attorney Jeff Blackburn who attacked the innocence project. See Barsley et al., *supra* note 2, at 93. For Blackburn’s quote and its context, see Mark Bennett, *Founder of Texas Innocence Project, Jeff Blackburn, Quits in Protest*, SIMPLE JUST. (May 19, 2015), <https://blog.simplejustice.us/2015/05/19/founder-of-texas-innocence-project-jeff-blackburn-quits-in-protest/> [<https://perma.cc/JPE7-XBQP>]. The organization he founded, the Innocence Project of Texas, continues to operate, having moved its offices from Lubbock to Ft. Worth and is directed by Mike Ware, who was the director of the first conviction integrity unit in Dallas established by former District Attorney Craig Watkins. See *Mission & History*, INNOCENCE PROJECT TEX., <https://innocencetexas.org/history-mission> [<https://perma.cc/H2UA-MUBV>]; Jessica Pishko, *No Country for Innocent Men*, D MAG. (May 15, 2018, 11:30 AM) <https://www.dmagazine.com/frontburner/2018/05/dallas-county-exonerations-innocent-conviction-integrity-unit/> [<https://perma.cc/44LL-G6FB>]. In a personal communication, a prominent innocence movement person who has worked with Jeff Blackburn

testimonials are essentially argument from authority, a form of defeasible argument that is “rationally compelling though not deductively valid.”³⁸⁴ Anyone barely familiar with the scientific revolution of the sixteenth and seventeenth centuries should know without citation that a major achievement of the new science was that ancient knowledge could be replaced with knowledge derived from direct observation (often using novel instrumentation like the microscope) and experimentation.³⁸⁵

What should have been a potent source of support for bite mark analysis in *Epidermis and Enamel* is a page devoted to “A Path Forward” in which the authors cite recommendations under six categories: Standards and Guidelines, Knowledge Transfer and Education, Research, Certification, Proficiency, and Casework.³⁸⁶ Under Standards and Guidelines, the authors note that the ABFO responded to problems generated by forensic odontologists’ testimony of certainty by creating a decision tree:

Once it has been determined that a patterned injury has been caused by human teeth, today an opinion in a bitemark report is limited to “inconclusive,” “dentition can be excluded as having made the bitemark,” or “dentition cannot be excluded as having made the bitemark.” Current ABFO Standards and Guidelines do not condone terminology that indicates the dentition of an individual is the only possible cause of the bitemark.³⁸⁷

This improvement indicates that the ABFO has been responsive to criticism, but only up to a point.³⁸⁸ This reform is welcome and may reduce erroneous bite mark attribution, but acknowledgement of

and praises his work finds his attack on the Innocence Project confusing and unwarranted. See Email from Keith Findley, Assoc. Professor of Law, Univ. of Wis.–Madison Law Sch., to Marvin Zalman, Professor, Wayne State Univ. Criminal Justice Dep’t (Feb. 15, 2019, 4:00 PM) (on file with author).

³⁸⁴ Robert Koons, *Defeasible Reasoning*, STAN. ENCYCLOPEDIA PHIL. (May 1, 2017), <https://plato.stanford.edu/archives/win2017/entries/reasoning-defeasible/> [https://perma.cc/7J38-3YRQ]; see Brett G. Scharffs, *The Character of Legal Reasoning*, 61 WASH. & LEE L. REV. 733, 779 n.145 (2004); Austin Cline, *Fallacies of Relevance: Appeal to Authority*, THOUGHTCO (Mar. 8, 2017), <https://www.thoughtco.com/logical-fallacies-appeal-to-authority-250336> [https://perma.cc/5RSU-PCQT].

³⁸⁵ See A.R. HALL, *THE SCIENTIFIC REVOLUTION 1500–1800: THE FORMATION OF THE MODERN SCIENTIFIC ATTITUDE* 51, 286 (1954).

³⁸⁶ Barsley et al., *supra* note 2, at 94–95.

³⁸⁷ *Id.* at 94.

³⁸⁸ See Bowers, *Pseudoscience*, *supra* note 53, at 36.

error does not address the range of scientific challenges to bite mark comparison analysis.³⁸⁹ As for the other points, they add virtually nothing. Relationships to universities and to medical examiner offices do not substitute for critical research.³⁹⁰ *Epidermis and Enamel* simply says that research “is needed” but does not refer to any.³⁹¹ The ABFO certifies forensic odontologists and states that a forensic dentist should not be allowed to testify without certification,³⁹² but without knowing the details of ABFO certification, it is wise to withhold judgment.³⁹³ Wariness regarding certification is justified by the article’s bland three-line statement that “all odontologists certified by the ABFO should periodically take and pass ABFO proficiency tests,”³⁹⁴ without mentioning the devastatingly poor results of such tests.³⁹⁵ The final paragraph, “Casework,” recommends second opinions.³⁹⁶ This section’s fine rhetoric is part of the article’s smokescreen and simply does not provide a competent defense of the scientific basis or reliability of bite mark comparison analysis.

Although *Epidermis and Enamel* is obsequious at points, agreeing with some boilerplate desiderata taken from “a critic of bitemark evidence”³⁹⁷ at the article’s conclusion, it is not hard to miss its venomous attacks on the Texas Forensic Science Commission and especially on the Innocence Project.³⁹⁸ The vehement and defamatory nature of its comments deserve attention because it supports the psychological processes that we believe has blinded the authors to a rational approach,³⁹⁹ and links the odontologist-authors with other

³⁸⁹ See *supra* Part II (offering a critical review of bite mark evidence).

³⁹⁰ See Barsley et al., *supra* note 2, at 95.

³⁹¹ See *id.*; *supra* Part II (reviewing different odontological research projects).

³⁹² See Barsley et al., *supra* note 2, at 88, 89, 95.

³⁹³ See *id.* at 89; NRC REPORT, *supra* note 21, at 208–10. The authors note that “[a]t present, the ABFO has FSAB [Forensic Specialties Accreditation Board] reaccreditation status for 2013 to 2018 and has successfully completed the rigorous FSAB reaccreditation process for reaccreditation status from 2018 to 2023.” Barsley et al., *supra* note 2, at 89.

³⁹⁴ Barsley et al., *supra* note 2, at 95.

³⁹⁵ See Bowers, *Pseudoscience*, *supra* note 53, at 36; C. Michael Bowers & Iain A. Pretty, *Expert Disagreement in Bitemark Casework*, 54 J. FORENSIC SCI. 915, 916 figs.2 & 3, 917 (2009) (finding expert disagreement increases as quality of bite mark decreases); Saks et al., *supra* note 19, at 562–64; PCAST, *supra* note 23, at 85–87; *supra* Part II.

³⁹⁶ See Barsley et al., *supra* note 2, at 95.

³⁹⁷ Barsley et al., *supra* note 2, at 95, agrees with the seven statements derived from Saks et al., *supra* note 19, at 567, e.g., “Resist the culture of exaggeration,” without meeting the major, evidence-based criticism of bite mark analysis posed there.

³⁹⁸ See Barsley et al., *supra* note 2, at 93.

³⁹⁹ See discussion *infra* Part IV.

forensic examiners and scientists who have reacted with irrational negativism to the innocent challenges to the forensic sciences.⁴⁰⁰

In what it describes as a “case study,” *Epidermis and Enamel* devotes a page to describing and criticizing the Texas Forensic Science Commission (TFSC).⁴⁰¹ In brief, the article criticizes the TFSC for proposing a moratorium on the admission of bite mark testimony based on a case where a forensic odontologist violated ABFO standards, and on this basis urges establishing a review process to screen bite mark cases.⁴⁰² As with the point regarding defense lawyers hiring forensic odontologists, *Epidermis and Enamel* finds it “ironic” that the TFSC both recommends that bite mark evidence not be admitted and yet “counterintuitively” has “certified forensic odontologists and attorneys working together to assess” bite mark cases.⁴⁰³

If these dental and legal practitioners were deemed to have sufficient knowledge, skill, training, and experience to be capable of making potentially life-altering determinations on behalf of the commission, and used public funds to do so, this suggests that the TFSC considers bitemark evidence expertise to have merit.⁴⁰⁴

This tendentious conclusion does not necessarily follow. As we suggested above, despite the overall weaknesses of bite mark evidence, there may be cases in which the admission of bite mark evidence may have been so patently wrong that a second look is called for, especially when a prisoner’s liberty is at stake.⁴⁰⁵ Also, it would have been unfair and impolitic for the TFSC to review bite mark cases without involving forensic dentists. Nevertheless, this point carries some weight and in Part V we suggest that further consideration of a limited role of bite mark analysis may be permissible.⁴⁰⁶ In addition, the odontologist-authors, like the nephew mail room worker in *How*

⁴⁰⁰ See discussion *infra* Part V.

⁴⁰¹ See Barsley et al., *supra* note 2, at 92–93.

⁴⁰² See *id.* at 92.

⁴⁰³ See *id.*

⁴⁰⁴ See *id.*

⁴⁰⁵ See, e.g., *People v. Marx*, 54 Cal. App. 3d 100, 112 (Cal. Ct. App. 1975) (finding the defendant guilty of voluntary manslaughter based in part on bite mark evidence); Souviron & Haller, *supra* note 24 (explaining that the *Marx* decision opened the floodgates for the misuse of bite mark comparison in subsequent convictions).

⁴⁰⁶ See *infra* notes 558–559 and accompanying text.

to *Succeed in Business without Really Trying*,⁴⁰⁷ cry foul when they discovered that autopsies conducted by forensic pathologists are legally exempted from TFSC review and analysis by forensic odontologists are not,⁴⁰⁸ especially when the authors claim that odontology is *not* forensic analysis, but is instead “the specialized practice of . . . dentistry,” just as pathology is a medical specialization.⁴⁰⁹ “Not fair!” There may be merit to this special pleading, or perhaps not if the foundation of forensic pathology and the proficiency of pathologists has been better established than that of forensic odontologists. In any event, while this argument may appeal to the self-regard of forensic odontologists, it does not answer the issue of that method’s scientific basis or reliability and adds to the smog of arguments generated by the editorial.

Epidermis and Enamel does not isolate the TFSC but sees the hand of the Innocence Project, Svengali-like, manipulating the Commission.⁴¹⁰ Indeed, the authors’ obsession with the New York Innocence Project may be the article’s real motive.⁴¹¹ The article begins on a petulant note by citing journalistic and legal criticism of bite mark evidence and analysis rather than by asserting the method’s strengths.⁴¹² The authors claim its “critics have been persuasive through forcefulness and repetition,”⁴¹³ implying that reason lies with the forensic odontologists and suggesting that the

⁴⁰⁷ See FISH, *supra* note 43, at 3; *supra* notes 43–45 and accompanying text.

⁴⁰⁸ See Barsley et al., *supra* note 2, at 92–93.

⁴⁰⁹ See *id.* at 93.

⁴¹⁰ They state,

A review of the earliest posted minutes from TFSC meetings reveals that representatives of the IP attended at least the first 7 organizational meetings in 2007 and 2008. According to those minutes, IP representatives participated in the meetings; assisted with the organization, process development, and integration of national efforts; and contributed to discussions on decisions and standards for what the TFSC will elect to investigate. Discussions about the IP assisting the TFSC to apply for a federal grant also occurred.

Id. at 92.

⁴¹¹ “They can keep their \$100,000 ‘VIP’ tables at galas, their friends from Goldman Sachs, and their need for control. It is not for me.” *Id.* at 93 (quoting Jeff Blackburn’s ill-tempered attack on the Innocence Project).

⁴¹² “Reports of errors made by odontologists in bitemark cases in the 1980s and 1990s have been the recent focus of aggressive and disparaging criticisms.” *Id.* at 87. The “aggressive” criticism claim may simply be seen as well-written and well-supported criticism. Again, a conspiratorial tone is engendered by asserting that “[s]ome journalists have been *enlisted* to further bolster critics’ arguments.” *Id.* (emphasis added). This is a subtly libelous attack on Radley Balko, a successful journalist and author with a libertarian bent who has criticized many aspects of the criminal justice system.

⁴¹³ *Id.*

public had been duped with fake news.⁴¹⁴ At the outset, *Epidermis and Enamel* claims that critics have ignored “the progress made by changes in standards, terminology, and the steps to inhibit bias”⁴¹⁵ since the 2009 National Academy of Sciences Report; but as our review has shown, forensic odontologists ignore the analysis that shows these steps to be ineffective in making bite mark analysis reliable.

The authors of *Epidermis and Enamel* simply cannot fathom challenges from its critics—who include “some members of the media, some but not all criminal defense attorneys, and some from within forensic science and forensic odontology.”⁴¹⁶ The critics’ comments are deemed so disparaging of forensic odontology “that a reasonable person might be convinced to distrust or totally disregard all opinions and conclusions of [its] members.”⁴¹⁷ But the critics singled out for the sharpest attack “include some individuals from the Innocence Project, Inc [sic] and its affiliates in the innocence network (hereafter referred to as the Innocence Project [IP]).”⁴¹⁸ The authors do not clearly understand the name of the Innocence Project (“Inc” is not part of its name) or the nature or structure of the institutional innocence movement. “[T]he Innocence Project does not actually have any affiliates; all innocence organizations in the Innocence Network are independent and none is controlled in any way by the Innocence Project”⁴¹⁹ The original Innocence Project (which

⁴¹⁴ See *id.* (“Those influenced include the public, some governmental agencies, and members of the legal profession.”).

⁴¹⁵ *Id.*

⁴¹⁶ *Id.* at 88.

⁴¹⁷ *Id.* This statement seems to be lifted and paraphrased from Collins and Jarvis without citation: “Much of this rhetoric disparaged the forensic sciences to the extent that reasonable people might be persuaded to distrust the work being performed in America’s crime laboratories.” Collins & Jarvis, *Contextual*, *supra* note 381, at 8.

⁴¹⁸ Barsley et al., *supra* note 2, at 88. The Innocence Project has trademarked the name, requiring other innocence projects to be nonprofit organizations and to adhere to *The Innocence Network Guide to Ethics and Best Practices for Innocence Project Practitioners*. See INNOCENCE NETWORK, STARTING AN INNOCENCE ORGANIZATION 18 (2015), <http://innocencenetwork.org/wp-content/uploads/Starting-an-Innocence-Organization-Guide.pdf> [https://perma.cc/96XD-ZGHL] [hereinafter INNOCENCE NETWORK, STARTING AN INNOCENCE ORGANIZATION]; INNOCENCE NETWORK, GUIDE TO ETHICS & BEST PRACTICES FOR INNOCENCE PROJECT PRACTITIONERS 2 (2015) [hereinafter INNOCENCE NETWORK, GUIDE TO ETHICS], <http://innocencenetwork.org/wp-content/uploads/Ethics-Best-Practices-Guide-August-2015.pdf> [https://perma.cc/JPL9-FM63]; Jacqueline McMurtrie, *The Innocence Network: From Beginning to Branding*, in *CONTROVERSIES IN INNOCENCE CASES IN AMERICA*, *supra* note 27, at 25.

⁴¹⁹ Email from Keith Findley, *supra* note 383; see Keith A. Findley & Larry Golden, *The Innocence Movement, the Innocence Network, and Policy Reform*, in *WRONGFUL CONVICTION AND CRIMINAL JUSTICE Reform*, *supra* note 192, at 93, 95; McMurtrie, *supra* note 418, at 25.

today goes simply by that name) was officially founded in 1992 “as a clinical program at Cardozo Law School, creating an organized, systematic way to investigate old cases and use DNA to exonerate prisoners when possible.”⁴²⁰ The Innocence Project at first had only four staff persons and was overwhelmed by a flood of inquiries by prisoners.⁴²¹ Although it has grown into a substantial and well-funded non-profit organization with more than fifty employees, in reality many of the fifty-five U.S. innocence organizations that are Innocence Network members “are underfunded, understaffed, and overworked.”⁴²²

The attack on the Innocence Project by *Epidermis and Enamel* then shifts from ignorant petulance to something close to defamation:

Interestingly, some trial attorneys from the IP may stand to gain financially from reviewing various cases being conducted ostensibly to determine if forensic methods are questionable, unreliable, or have resulted in wrongful convictions. This concern raises questions of potential conflicts of interest at best and the likelihood of an agenda-driven disingenuous attack at worst.⁴²³

There is a double irony in this statement. First, in order to use the trademarked name *Innocence Project* or to be an Innocence Network member, an organization must be a nonprofit organization, so no direct payments are involved in innocence work.⁴²⁴ Secondly, with

⁴²⁰ ROBERT J. NORRIS, EXONERATED: A HISTORY OF THE INNOCENCE MOVEMENT 55 (2017). Today, the Innocence Project formally describes itself and its mission in these terms: “Innocence Project is a national litigation and public policy organization dedicated to exonerating wrongfully convicted individuals through DNA testing and reforming the criminal justice system to prevent future injustice.” *Legal*, INNOCENCE PROJECT, <https://www.innocenceproject.org/legal/> [<https://perma.cc/X3LB-YBK3>].

⁴²¹ See NORRIS, *supra* note 420, at 55.

⁴²² INNOCENCE NETWORK, GUIDE TO ETHICS, *supra* note 418, at 5. As of June 2, 2019, the Innocence Network includes fifty-five organizations in the United States and Puerto Rico and twelve in other nations. See *About the Innocence Network*, INNOCENCE NETWORK, <https://innocencenetwork.org/about/> [<https://perma.cc/3DZK-62JD>]; see also Findley & Golden, *supra* note 419, at 95 (discussing the formation of the Innocence Network and some information about funding).

⁴²³ Barsley et al., *supra* note 2, at 88.

⁴²⁴ Innocence organizations take a number of forms, but all involve non-profit organizations or units: standalone nonprofit corporations; law school clinics; non-profits affiliated with one or more law schools; units in public defenders’ offices; pro bono units in large law firms. See INNOCENCE NETWORK, STARTING AN INNOCENCE ORGANIZATION, *supra* note 418. It is the case that some innocence lawyers represent exonerated clients in civil rights actions that can generate fees upon winning awards, but this is not automatic. See Barsley et al., *supra* note 2, at 88.

rare exceptions,⁴²⁵ we assume that bite mark dentists receive fees for their analysis and testimony, but we do not claim that testimonial fees cynically and corruptly “buy” their opinions. We do assume that cognitive biases, which affect everyone, have some influence on the thinking of expert witnesses and on attorneys, but that is far different from the smear found in *Epidermis and Enamel*.⁴²⁶ This insult against innocence organization lawyers is based on one cited source, a blog post by John Collins in *Science 2.0*, which refers to an anonymous complaint made apparently by “a concerned employee of a crime laboratory.”⁴²⁷ The complaint was made to the New York Joint Commission on Public Ethics (JCOPE) against the Innocence Project co-founders Barry Scheck and Peter Neufeld.⁴²⁸ Collins characterized Scheck and Neufeld, who at the time held seats on the New York Commission on Forensic Science, as publicly disparaging forensic experts who use “perfectly acceptable methods utilized in America’s forensic science laboratories” and “have undertaken a campaign to specifically discredit the *science* of forensic hair comparison.”⁴²⁹ This seems to be a reference to a major program in which the FBI crime laboratory acknowledged the weak foundation and risks of microscopic hair analysis, another discredited forensic

⁴²⁵ An example was provided by Dr. Pamela Hammel who testified pro bono in the second Moldowan and Cristini trials as a way of rectifying her earlier error. See Hammel Testimony, *supra* note 130, at 42, 71, 72, 91, 92.

⁴²⁶ See Barsley et al., *supra* note 2, at 88. The field of psychology has been deeply affected by a wealth of research in the last half-century that “discovered” and has elaborated on cognitive biases and psychological predilections. See KAHNEMAN, *supra* note 343, at 4. We elaborate on this theme in Part IV. One author previously addressed similar issues related to ideological predilections. See Marvin Zalman, *A Brief Reply to Professor Cassell*, 48 SETON HALL L. REV. 1493, 1495, 1512–13 (2018) (explaining the policy behind a more accurate criminal justice system).

⁴²⁷ See John Collins, *Ethics Complaint Brought Against NY Forensic Science Commissioners*, SCIENCE 2.0 (July 8, 2015, 7:20PM) https://www.science20.com/keeping_the_gate_a_science_and_justice_blog/blog/ethics_complaint_brought_against_ny_forensic_science_commissioners-156472 [<https://perma.cc/7S2D-2ST9>], cited in Barsley et al., *supra* note 2, at 88 n.8. Collins, a forensic scientist, former director of the Michigan State Police Crime Laboratories, and past managing editor of a newsletter, *The Crime Lab Report*, consistently took pot-shots at innocence movement critiques of forensic science. The newsletter appears to be defunct, but Academic Press has announced that past issues will be published as a book. See JOHN M. COLLINS, CRIME LAB REPORT: AN ANTHOLOGY ON FORENSIC SCIENCE IN THE ERA OF CRIMINAL JUSTICE REFORM xiii, xv (2020) [hereinafter COLLINS, CRIME LAB REPORT]; John Collins, *Drug Threat is ‘Unprecedented’ According to Forensic Experts*, SCIENCE 2.0 (Nov. 3, 2017, 11:54 AM), https://www.science20.com/john_collins/drug_threat_is_unprecedented_according_to_forensic_experts-228025 [<https://perma.cc/YTQ8-RW4H>]. Cole, *Innocence Crisis*, *supra* note 192, at 176, refers to Crime Lab Report (CLR) as “a group that functions as a self-appointed spokesperson for forensic science.”

⁴²⁸ See Collins, *Ethics*, *supra* note 427.

⁴²⁹ See *id.* (emphasis added).

technique, and entered into a joint investigation with the Innocence Project to review prior hair analysis cases.⁴³⁰

The anonymous complaint appears to have vanished; in any event the idea that Innocence Project lawyers pursued this project for personal monetary gain is preposterous. Yet the sly and indirect way in which *Epidermis and Enamel* advances such a baseless rumor is uncomfortably close to purveyors of disinformation campaigns or conspiracy-league dabblers who are so prevalent today on social media and even in some traditional news outlets. It is worrying when such “data” and “arguments” are advanced by credentialed professionals and academicians and appears in a scientific journal. That eminent professionals have advanced a hollow argument littered with unsupported invective, calls for a closer look.

IV. UNREASONED REASONS

What explains the illogical and hollow reasoning of *Epidermis and Enamel*? Despite research that has undermined if not demolished the basic assumptions of bite mark comparison analysis⁴³¹ the forensic odontologist-authors of *Epidermis and Enamel* continue to support the practice of comparing suspects’ dentition with bite marks⁴³² and claiming, in some cases, that “dentition cannot be excluded as having made the bitemark.”⁴³³ The accumulated criticism and undermining of bite mark evidence has led those dentists to admit previous errors without abandoning the technique.⁴³⁴ If anything, *Epidermis and Enamel* pushes back

⁴³⁰ See Fabricant & Carrington, *supra* note 198, at 92 & n.366; Dee J. Hall, *Innocent People Convicted from Flawed Hair Evidence*, POST CRESCENT (Apr. 30, 2017, 12:04 AM), <https://www.postcrescent.com/story/news/investigations/2017/04/30/innocent-people-convicted-flawed-evidence/100974186/> [<https://perma.cc/APR2-A3E8>]; Spencer S. Hsu, *FBI Admits Flaws in Hair Analysis over Decades*, WASH. POST (Apr. 18, 2015), https://www.washingtonpost.com/local/crime/fbi-overstated-forensic-hair-matches-in-nearly-all-criminal-trials-for-decades/2015/04/18/39c8d8c6-e515-11e4-b510-962fcfab310_story.html [<https://perma.cc/2AVA-S6T3>]; Norman L. Reimer, *Flawed Forensics: The Story Behind an Historic FBI Review*, CRIME REP. (Apr. 30, 2015), <https://thecrimereport.org/2015/04/30/2015-04-flawed-forensics-the-story-behind-an-historic-fbi-re/> [<https://perma.cc/7XT4-HVAH>].

⁴³¹ See *supra* Part II.

⁴³² See Barsley et al., *supra* note 2, at 89, 95.

⁴³³ *Id.* at 94. This is ABFO-approved terminology that replaces earlier terms (like *match*) that made positive assertions. See *id.* at 95. Standing alone the statement may be true but fails to consider that the high levels of error pose real dangers of misattribution and wrongful convictions.

⁴³⁴ See *id.* at 89.

against critics and hardens their self-styled position as legitimate experts in this aspect of forensic science.⁴³⁵

This article began by reviewing scholarship about prosecutors' irrational resistance to DNA testing. Along with institutional and cultural factors, the psychological constructs of loyalty and denial offered deeper insights, suggesting that prosecutors' overtly rational explanations to reject compelling DNA exonerations masked underlying and potent motive forces.⁴³⁶ This Part, in similar fashion, explores possible drivers of the odontologists' forensic denial of bite mark counterevidence. Before we begin, two linked caveats should be considered. First, our account does not have the explanatory power of a psychological experiment or full-fledged case study, and so must remain a suggestive rather than a scientific explanation.⁴³⁷ Second, we draw on a vast expanse of social psychological research that has for at least a half century explored the regularities of human

⁴³⁵ See *id.* at 88–89. They state,

The ABFO-certified forensic odontologists who follow the ABFO Standards and Guidelines are qualified to diagnose human bite injuries, compare those injuries with dentitions that may or may not have caused them, and express an opinion. There is no other group of individuals similarly qualified to complete bitemark analyses and comparisons.

Id. at 89.

⁴³⁶ See *supra* notes 27–48 and accompanying text.

⁴³⁷ See, e.g., LEON FESTINGER ET AL., WHEN PROPHECY FAILS: A SOCIAL AND PSYCHOLOGICAL STUDY OF A MODERN GROUP THAT PREDICTED THE DESTRUCTION OF THE WORLD 248–49 (1956) (discussing an in-depth case study of a group exhibiting cognitive dissonance); Lee Ross et al., *Perseverance in Self-Perception and Social Perception: Biased Attributional Processes in the Debriefing Paradigm*, 32 J. PERSONALITY & SOC. PSYCHOL. 880, 880, 882, 884 (1975).

error and has generated important disciplinary advances,⁴³⁸ making possible other explanatory hypotheses.⁴³⁹

It is worth noting that the scientific challenge to bite mark analysis is not an existential threat to the practice of forensic odontology. Forensic dentists could drop bite mark analysis and still engage in other accepted practices.⁴⁴⁰ This makes *Epidermis and Enamel's* strenuous resistance to critics, and its failure to confront the scientific challenges to bite mark evidence, all the more curious. We explore their resistance to change through three broad lenses. The first is the social psychological group dynamics that occur in organizations and more specifically the sociology of organizational deviance.⁴⁴¹ The second approach is the familiar psychological

⁴³⁸ We cite popular literature that draws on psychological research. Areas of research include *cognitive bias*, see GERD GIGERENZER, GUT FEELINGS: THE INTELLIGENCE OF THE UNCONSCIOUS 25 (2007); Tversky & Kahneman, *supra* note 343, at 50; *normal accidents*, see CHARLES PERROW, NORMAL ACCIDENTS: LIVING WITH HIGH-RISK TECHNOLOGIES 9 (1999); *safety*, see INST. OF MED., TO ERR IS HUMAN: BUILDING A SAFER HEALTH SYSTEM ix (Linda T. Kohn et al. eds., 2000); *behavioral economics*, see DAN ARIELY, PREDICTABLY IRRATIONAL: THE HIDDEN FORCES THAT SHAPE OUR DECISIONS xviii (2008); *memory studies*, see DANIEL L. SCHACTER, THE SEVEN SINS OF MEMORY: HOW THE MIND FORGETS AND REMEMBERS 1 (2001); *decision-making*, see PAUL C. NUTT, WHY DECISIONS FAIL: AVOIDING THE BLUNDERS AND TRAPS THAT LEAD TO DEBACLES xi (2002); and a number of works on what Kathryn Schulz dubbed *wrongology*, KATHRYN SCHULZ, BEING WRONG: ADVENTURES IN THE MARGIN OF ERROR (2010); e.g., ROBERT A. BURTON, ON BEING CERTAIN: BELIEVING YOU ARE RIGHT EVEN WHEN YOU'RE NOT (2008); THOMAS GILOVICH, HOW WE KNOW WHAT ISN'T SO: THE FALLIBILITY OF HUMAN REASON IN EVERYDAY LIFE (1991). In criminal justice and innocence studies, applied psychological research on eyewitness identification, false confessions, the testimony of child witnesses, and the psychology of the justice process have been fundamental to slowly moving justice system actors from a kind of "legalistic scholasticism" toward more scientific ways of thinking. See Richard A. Leo, *Rethinking the Study of Miscarriages of Justice: Developing a Criminology of Wrongful Conviction*, 21 J. CONTEMP. CRIM. J. 201, 201, 202, 208, 209, (2005); see also STEPHEN J. CECI & MAGGIE BRUCK, JEOPARDY IN THE COURTROOM: A SCIENTIFIC ANALYSIS OF CHILDREN'S TESTIMONY 7 (1995) (discussing case studies surrounding the validity of child testimony); ELIZABETH F. LOFTUS, EYEWITNESS TESTIMONY 153 (1979) (analyzing individual differences in eyewitness testimony); DAN SIMON, IN DOUBT: THE PSYCHOLOGY OF THE CRIMINAL JUSTICE PROCESS 2–3 (2012) (applying methods of experimental psychology in an attempt to better understand the criminal justice system); Saul M. Kassin & Gisli H. Gudjonsson, *The Psychology of Confessions: A Review of the Literature and Issues*, 5 PSYCHOL. SCI. PUB. INT. 33, 59 (2004) (discussing the psychology of false confessions and the need for a collaborative effort amongst the relevant legal and social science experts to attempt to mitigate future instances of wrongful convictions, often caused by faulty interrogation practices).

⁴³⁹ This admission may not seem important to lawyer-readers, but as social scientists we believe it is important to state.

⁴⁴⁰ See Shalini Gupta et al., *Contemporary Practice in Forensic Odontology*, 18 J. ORAL & MAXILLOFACIAL PATHOLOGY 244, 245–48 (2014). The dental identification of unidentified corpses is not subject to controversy, although other aspects of odontology such as tooth aging may be questionable. See *id.* at 245, 247. Any such inquiry is beyond the scope of this article.

⁴⁴¹ See Gregory S. Parks et al., *Belief, Truth, and Positive Organizational Deviance*, 56 HOW. L.J. 399, 407 (2013).

construct of cognitive dissonance.⁴⁴² The third analytic frame is the newer evolutionary interactionist theory of reasoning advanced by Mercier and Sperber.⁴⁴³

While individuals may experience change as annoying and bothersome, change in an organization or association means meeting resistance to proposed changes among the group's members. Given the ABFO's role in the bite mark saga, we begin by reviewing the functions and roles of professional organizations, which generally establish ethics and set practice standards for members.

According to Robert Merton, the foremost obligation of the professional organization is to set rigorous professional standards and help enforce those standards for professional practice.⁴⁴⁴ Within a dominant organization, a subculture may develop.⁴⁴⁵ By definition, a subculture is simply a culture within a culture and most often subcultures share values and norms with the dominant culture.⁴⁴⁶ However, a subculture may not observe all the norms and values set by the dominant organization.⁴⁴⁷ But a subculture may be or may become a counterculture if it acts in direct and active opposition to the larger culture.⁴⁴⁸ In some instances, the subculture gains the status of deviant when it violates the norms of the dominant culture.⁴⁴⁹ The members of the subculture or the counterculture can be said to be engaging in cognitive deviance, that is, they hold beliefs that are unconventional and non-normative and at odds with the umbrella organization.⁴⁵⁰ And while this may cause the subculture of "believers to be shunned, isolated, marginalized, rendered powerless, criticized, condemned, or punished," it is possible, too, that the subculture gains dominance in the main organization.⁴⁵¹ This may have been the case if a small group of forensic odontologists who

⁴⁴² LEON FESTINGER, A THEORY OF COGNITIVE DISSONANCE 3 (1957).

⁴⁴³ See MERCIER & SPERBER, *supra* note 51, at 7–9; *infra* notes 500–516 and accompanying text.

⁴⁴⁴ See Robert K. Merton, *The Functions of the Professional Organization*, 58 AM. J. NURSING 50, 52 (1958).

⁴⁴⁵ MARSHALL B. CLINARD & ROBERT F. MEIER, *SOCIOLOGY OF DEVIANT BEHAVIOR* 15 (11th ed. 2001).

⁴⁴⁶ *Id.*

⁴⁴⁷ *Id.*

⁴⁴⁸ *Id.*

⁴⁴⁹ See *id.* at 6; see, e.g., *id.* at 15–16 (discussing examples where subcultures gain the status of "deviant" when they oppose norms and values of the larger culture they are a part of, such as prison gangs within a larger prison system).

⁴⁵⁰ See *id.* at 15; ERICH GOODE, *DEVIANT BEHAVIOR* 338 (6th ed. 2001).

⁴⁵¹ See GOODE, *supra* note 450, at 338, 340.

strongly supported bite mark analysis gained the upper hand in the thinking of most members of the ABFO.

As indicated previously, the ABFO as early as the 1980s began to register some doubt about their members' abilities to make accurate bite mark matches.⁴⁵² However, the ABFO, following courts' lead in admitting bite mark evidence, got over this doubt and more recently has been supportive of bite mark analysis, perhaps indicating that a cognitively deviant idea supported by a fraction of forensic odontologists came to be accepted or even became a dominant idea.⁴⁵³ The ABFO not only came to accept bite mark analysis as normative but now defends its position by attacking critics of bite mark evidence.⁴⁵⁴ This kind of pushback tends to be fairly typical when people and organizations are under fire. Rather than accepting criticism, admitting that mistakes were made and adopting new, more empirically based positions, people very often marshal evidence to prove they were right all along.⁴⁵⁵

Clinard and Meier suggest that deviant subcultures can respond to criticism by (1) becoming more secretive; (2) manipulating the setting (or creating the appearance) of legitimacy; (3) changing to nondeviant beliefs or behaviors; (4) developing a new subculture; or, (5) rationalization.⁴⁵⁶ It is easy to see how the forensic odontologists responded to the criticism that threatened their ability to testify about bite marks in court. While the dominant culture (the ABFO) initially was wary of bite mark analysis, expressing "guarded professional conservatism,"⁴⁵⁷ when forensic odontology came to adopt bite mark analysis it responded, through *Epidermis and Enamel*, by using some of these stratagems.⁴⁵⁸ It claims that they weeded out rogue/deviant odontologists, they tightened guidelines and standards for forensic odontologists, they admitted past mistakes, and claimed that their "aggressive" critics do not understand the research and "experience" behind forensic odontology.⁴⁵⁹

⁴⁵² See *supra* notes 237–246 and accompanying text.

⁴⁵³ See Bowers, *Pseudoscience*, *supra* note 53, at 35, 36; Balko, *Bite Mark Attack*, *supra* note 66.

⁴⁵⁴ See Balko, *Bite Mark Attack*, *supra* note 66.

⁴⁵⁵ See *supra* notes 431–435 and accompanying text; see, e.g., Balko, *Bite Mark Attack*, *supra* note 66 (explaining that instead of accepting outside criticism, the ABFO launched an attack on anyone who denounced the validity of bite mark evidence).

⁴⁵⁶ See CLINARD & MEIER, *supra* note 445, at 90–94.

⁴⁵⁷ See Bowers, *Pseudoscience*, *supra* note 53, at 35.

⁴⁵⁸ See CLINARD & MEIER, *supra* note 445, at 90–94; Barsley et al., *supra* note 2, at 88–89.

⁴⁵⁹ See Barsley et al., *supra* note 2, at 87, 88–89, 94; *supra* Part III.

Viewing forensic odontologists through the sociology of deviance lens, they have employed similar measures for dealing with criticism.⁴⁶⁰ For instance, they have attempted to create an appearance of legitimacy;⁴⁶¹ they have used rationalization by suggesting only a few “rogue” forensic odontologists were responsible for most transgressions of standards (and ethics);⁴⁶² and they have created a new subculture by seeing themselves as outsiders and pariahs who are victims of their critics.⁴⁶³ By pushing back in various ways against any critics or authoritative organizations that seek to exercise control over their deviancy, forensic odontologists may work harder to assert their expertise in the area of bite mark comparison. Gary Marx refers to this as escalation and argues that when enforcement action (for example, through sanctions or suspensions) is taken by an authoritative body, this action actually promotes further deviance.⁴⁶⁴ However, because of the years in which the ABFO took no action against forensic odontologists, the forensic odontologists may have come to believe that they would suffer no sanctions and could operate with impunity.⁴⁶⁵

When members of an association or organization are confronted by the prospect of change, members may band together to resist the change.⁴⁶⁶ The reasons for this may include the combined difficulty of giving up old habits or behaviors, the problem of learning new thinking, attitudes, or behaviors, and close-mindedness.⁴⁶⁷ On a sociological level, for an organization or an association to change, it requires the members to debate and agree on a new set of norms or values—which demands a major shift in the association’s regulatory functions.⁴⁶⁸ The psychological reactions to change, then, is a relevant foundation for our analysis discussion. For the individual, change portends uncertainty, insecurity, loyalty to the past and a

⁴⁶⁰ See CLINARD & MEIER, *supra* note 445, at 90–94; Barsley et al., *supra* note 2, at 88–89, 94.

⁴⁶¹ See Barsley et al., *supra* note 2, at 89, 95.

⁴⁶² See *id.* at 89.

⁴⁶³ See *id.* at 88–89.

⁴⁶⁴ See Gary T. Marx, *Ironies of Social Control: Authorities as Contributors to Deviance Through Escalation, Nonenforcement, and Covert Facilitation*, in SOCIAL DEVIANCE: READINGS IN THEORY AND RESEARCH 7, 8–9 (Henry N. Pontell ed., 1999).

⁴⁶⁵ See *id.* at 12.

⁴⁶⁶ See Cem Karabal, *Resistance to Change and Conflict of Interest: A Case Study*, in ORGANIZATIONAL CONFLICT 115, 116, 118 (Ana Alice Vilas Boas ed., 2017).

⁴⁶⁷ *Id.* at 118.

⁴⁶⁸ See Royston Greenwood et al., *Theorizing Change: The Role of Professional Associations in the Transformation of Institutionalized Fields*, 45 ACAD. MGMT. J. 58, 59 (2002).

conflict of interest.⁴⁶⁹ In addition, change often means losses for individuals,⁴⁷⁰ and in the case of forensic odontologists who frequently testify in criminal trials, change may well represent a perceived loss of status and possibly of income, although most odontologists have dental practices and will continue to identify the dentition of bodies that are otherwise hard to name. But in order to more fully understand personal resistance to change, we review the odontologists' reactions through the concept of cognitive dissonance.

If forensic odontologists find it difficult or impossible to admit their fallibility and self-correct, it makes them human to be sure. Beyond that, to further our understanding of their tenacious grasp on a failed approach, it is also instructive to look at what drives the human need for self-justification in the face of counterevidence. According to psychologists Carol Tavris and Elliot Aronson, the engine that drives the need to justify our beliefs and actions, especially our wrong-headed positions and actions, is the uncomfortable feeling that social psychologist Leon Festinger called "cognitive dissonance."⁴⁷¹ Festinger saw cognitive dissonance as a state of tension that occurs when an individual holds two ideas or beliefs that are at odds with each other, and "the existence of dissonance will give rise to pressures to reduce it."⁴⁷²

Applying cognitive dissonance to the forensic odontologists who avidly support bite mark evidence, a forensic dentist may believe, "I am honest and have integrity." At the same time, that forensic dentist might also think, "My courtroom testimony has resulted in

⁴⁶⁹ See Karabal, *supra* note 466, at 117, 118.

⁴⁷⁰ See Melinda Seley, *Change is Loss and Loss Requires Grief*, AVENUES COUNSELING (Oct. 11, 2017), <http://avenuescounselingcenter.org/change-loss-loss-requires-grief/> [<https://perma.cc/P7VW-QVA7>].

⁴⁷¹ See CAROL TAVRIS & ELLIOT ARONSON, MISTAKES WERE MADE (BUT NOT BY ME): WHY WE JUSTIFY FOOLISH BELIEFS, BAD DECISIONS, AND HURTFUL ACTS 13 (2015). The theory was initially presented in FESTINGER, *supra* note 442. Festinger applied the theory of cognitive dissonance to explain the tenacity of millennial prophetic cults that persist after the prophecy fails. See FESTINGER ET AL., *supra* note 437, at 4–5, 216. While such extreme beliefs are not attributed to forensic dentists, the preconditions for the operation of cognitive biases for odontologists are similar to that of cultists: (1) there must be a conviction, (2) there must be commitment to the conviction, (3) the conviction must be "amenable to unequivocal disconfirmation," (4) such an unequivocal disconfirmation must occur, and (5) social support must be available subsequent to the disconfirmation. *Id.* at 216. The major differences are that conviction in bite mark analysis is grounded in measurable professional work and not in metaphysical beliefs, and that the scientific arguments and findings that show bite mark evidence to be unreliable are different from the unequivocal disconfirmation of a prophecy that the world will end at a certain date. Nevertheless, if the evidence disconfirming the reliability of bite mark evidence is strong, the five preconditions for cognitive dissonance exist.

⁴⁷² FESTINGER, *supra* note 442, at 2–3, 42.

sending an innocent man to prison.” Having those two conflicting thoughts or ideas would be inconsistent with each other and that would result in mental discomfort. Given this psychological unpleasantness, the odontologist, according to Festinger’s theory, would have to find a way to reduce the inconsistency.⁴⁷³ Tavris and Aronson suggest four ways that an individual might go about resolving this state of tension generated by cognitive dissonance.⁴⁷⁴

First, continuing with the forensic odontologist example, he (or she)⁴⁷⁵ might minimize the extent of the problem and the damage caused by his testimony.⁴⁷⁶ He could say that only one person he has testified against was later exonerated, or that he has put away many guilty people even if there were some not-so-guilty people he helped send to prison. In *Epidermis and Enamel*, these forensic dentists did minimize the damage. They point out early in the article, that only eight percent of exonerations based on DNA evidence involved bite mark evidence.⁴⁷⁷

Second, he could blame the victim or otherwise shift the blame.⁴⁷⁸ That is, he could argue that the person who he has said made the bite marks during the commission of a crime should have confessed rather than risk going to trial. In *Epidermis and Enamel*, the authors shift responsibility both to a “small subset of the overall discipline” and to the legal community: “[T]he legal community must acknowledge their roles in wrongful convictions.”⁴⁷⁹

Third, the conflicted odontologist could “kill the messenger.”⁴⁸⁰ This way of resolving the dissonance would involve pushing back against the scientists who conducted research that undermines his position as a respected and credible forensic scientist.⁴⁸¹ He could do this by filing ethics charges against the scientific researcher who criticized him. In *Epidermis and Enamel*, the authors suggest that trial lawyers from the Innocence Project may stand to gain financially by reviewing previous cases to determine if faulty forensic science resulted in wrongful convictions.⁴⁸²

⁴⁷³ See *id.* at 3.

⁴⁷⁴ See TAVRIS & ARONSON, *supra* note 471, at 160–61.

⁴⁷⁵ Ten of the eleven authors of *Epidermis and Enamel* are males, so we will use the masculine pronoun in our examples. See Barsley et al., *supra* note 2.

⁴⁷⁶ See TAVRIS & ARONSON, *supra* note 471, at 160.

⁴⁷⁷ See Barsley et al., *supra* note 2, at 88.

⁴⁷⁸ See TAVRIS & ARONSON, *supra* note 471, at 161.

⁴⁷⁹ See Barsley et al., *supra* note 2, at 89.

⁴⁸⁰ See TAVRIS & ARONSON, *supra* note 471, at 161.

⁴⁸¹ See *id.* at 161–62.

⁴⁸² See Barsley et al., *supra* note 2, at 88.

And fourth, he could dismiss all of the scientific research.⁴⁸³ He might argue that the studies that discredit bite mark matching were carried out by researchers who had an agenda that was anti-forensic odontology or that the research was done by jealous or vengeful scientists. The authors of *Epidermis and Enamel*, while not totally dismissing the research that shows the flaws in bite mark evidence assumptions, characterize the evidence by calling it “aggressive and disparaging criticisms,” and in another place contending that bite mark evidence critics “ignore the progress made by changes in standards, terminology, and the steps to inhibit bias.”⁴⁸⁴

Of course, people, such as forensic odontologists, experiencing the discomfort of cognitive dissonance could resolve the dissonance by a fifth possibility: admitting that past errors were based on a flawed method, and base future work and courtroom testimony on methods supported by credible research studies. To their credit, the eleven authors of *Epidermis and Enamel* acknowledge “mistakes have been made in the past.”⁴⁸⁵ However, instead of fully absorbing the power of the bite mark critique, they elide the challenge by stating that they have corrected the problems with bite mark analysis.⁴⁸⁶ But *Epidermis and Enamel* presents no evidence that the ABFO or individual odontologists have conducted any new scientific research to show that forensic odontology is something more than junk science. They write that calling it “‘junk science’ . . . is inappropriate,” while at the same time offering no scientific support.⁴⁸⁷ Nowhere do they state that they have learned from the legitimate research studies that have been critical of bite mark matching. Had they done so, it would be an appropriate way to resolve their cognitive dissonance.⁴⁸⁸

One forensic odontologist serves as a role model in this regard. A Fellow of the American Academy of Forensic Sciences and a Diplomate of the American Board of Forensic Odontology, C. Michael Bowers is also a Clinical Associate Professor at the University of Southern California’s School of Dentistry.⁴⁸⁹ In 2004, he published

⁴⁸³ See TAVRIS & ARONSON, *supra* note 471, at 162.

⁴⁸⁴ Barsley et al., *supra* note 2, at 87.

⁴⁸⁵ *Id.*

⁴⁸⁶ *Id.*

⁴⁸⁷ See *id.* at 89.

⁴⁸⁸ See *supra* note 325 and accompanying text (regarding ongoing bite mark research). We doubt that ongoing bite mark research of the kind cited will shake the criticisms leveled against bite mark analysis and comparison reviewed in Part II.

⁴⁸⁹ See BOWERS, HANDBOOK, *supra* note 54; C. Michael Bowers, USC, <https://pressroom.usc.edu/c-michael-bowers/> [<https://perma.cc/X8CK-JPBK>].

Forensic Dental Evidence: An Investigator's Handbook,⁴⁹⁰ which included a chapter on bite mark evidence. Although the chapter took a cautious approach, Bowers implies that he was convinced at that time that odontologists could match bite mark evidence with particular individuals.⁴⁹¹ However, in more recent years, he became a leading critic of bite mark evidence.⁴⁹² More recently, and citing the scientific research that undermines bite mark evidence, Bowers has recognized that he can no longer support the method, and views it as the “poster child” for failed forensic science.⁴⁹³ Two other forensic odontologists, Richard Souviron and Leslie Haller, have, in response to the argument presented by Saks et al.,⁴⁹⁴ retreated from the full support of bite mark analysis.⁴⁹⁵ They distinguish bite mark analysis from bite mark comparison, arguing that there is a place for forensic bite mark analysis, while apparently limiting bite mark comparison for the exclusion of suspects.⁴⁹⁶ Their language is far more respectful of bite mark analysis, and from a strategic perspective may be the kind of face saving rhetoric that will be helpful in getting forensic odontologists to tiptoe away from bite mark comparisons.

There is a divide between the willingness of Bowers, Souviron, and Haller, odontologists who formerly supported bite mark analysis, to engage intellectually with critical findings on the one hand, and the authors of *Epidermis and Enamel* on the other. The first group has carefully considered the content and implications of the scientific challenge and has dealt with the cognitive dissonance produced

⁴⁹⁰ See BOWERS, HANDBOOK, *supra* note 54. Dr. Bowers is quite outspoken in his blogpost about his battles with his contemporaries regarding bite mark evidence, for example, referring to a “a train wreck, where the ABFO continued to use their debunkable beliefs in microscopic chips and twists of crooked teeth leaving finger-print-like impressions on injured human skin.” Mike Bowers, *When Prosecutors Continue to Use Bitemarkers' Junk Testimony in New Jersey*, CSIDDS, <https://csidds.com/2018/05/01/when-prosecutors-continue-to-use-bitemarkers-junk-testimony-in-new-jersey/> [https://perma.cc/EK5F-4STX]. As a result, he “quit the ABFO” and raised doubts about role of the AAFS; he also views prosecutors’ reference to bite mark analysis as a science the product of groupthink. See *id.*

⁴⁹¹ See, e.g., BOWERS, HANDBOOK, *supra* note 54, at 91.

⁴⁹² See Bowers, *supra* note 201, at 145; Bowers, *Pseudoscience*, *supra* note 53, at 35. Dr. Bowers told a reporter that he “came out of the closet” on the issue of bite mark evidence “in an article for the American Society of Forensic Odontology” in 1996. Jordan Smith, *Bitten by Experts: How the Flawed Science of Bite-Mark Analysis Imprisoned a Man for Murder*, INTERCEPT (Aug. 20, 2015, 1:29PM), <https://theintercept.com/2015/08/20/flawed-science-of-bite-marks/> [https://perma.cc/BAG4-8NM3].

⁴⁹³ See Bowers, *supra* note 201, at 145.

⁴⁹⁴ See Saks et al., *supra* note 19.

⁴⁹⁵ See Souviron & Haller, *supra* note 24, at 617, 621–22.

⁴⁹⁶ See *id.* at 621–22.

either by accepting the critique or has offered a reasoned argument in response.⁴⁹⁷ The second group glossed over the criticism and has reflexively pushed back.⁴⁹⁸ This observation leads to our third explanation for the unreasoned reasons in *Epidermis and Enamel* and the evolutionary theory of “Reason” developed by cognitive psychologists Hugo Mercier and Dan Sperber.⁴⁹⁹

In Mercier and Sperber’s new interactionist theory of human understanding, the faculty or module of reason is an evolutionary adaptation designed to make human group living successful.⁵⁰⁰ Because solitary thinking is lazy and biased and can lead to erroneous conclusions,⁵⁰¹ Reason serves the functions of “producing reasons for justifying oneself, and . . . producing arguments to convince others”⁵⁰² in the interactionist setting in which humans evolved.⁵⁰³ These functions “provide tools for the kind of rich and versatile coordination that human cooperation requires.”⁵⁰⁴ They

make communication effective even when the communicators lack sufficient credibility in the eyes of their audience to be believed on trust. Reason produces reasons that communicators use as arguments to persuade a reticent audience. Reason, by the same token, helps a cautious audience evaluate these reasons, accept good arguments, and reject bad ones.⁵⁰⁵

This theory of the function of human reasoning differs from the classical view that the function of human reason is to “enhance

⁴⁹⁷ See, e.g., Bowers, *Pseudoscience*, *supra* note 53, at 35–36, 38; Souviron & Haller, *supra* note 24, at 620–21. As we suggested, the reasoned argument of Souviron and Haller may not be the best argument, but at least it is framed in a way that invites a counterargument, rather than the frustration of dealing with the unreasoned reasons of *Epidermis and Enamel*. See Souviron & Haller, *supra* note 24, at 621–22. See generally Barsley et al., *supra* note 2 (effectively dismissing the critics arguments as unfounded without providing sufficient objective evidence in support of their refutations).

⁴⁹⁸ See Barsley et al., *supra* note 2, at 88.

⁴⁹⁹ See MERCIER & SPERBER, *supra* note 51, at 180. They capitalize “Reason.” See *id.* at 8.

⁵⁰⁰ See *id.* at 181, 182–83 (reasoning shaped by natural selection).

⁵⁰¹ See *id.* at 9, 235. “When people reason on their own, they mostly produce reasons that support their decisions or their preconceived ideas, and they don’t bother to make sure that the reasons are strong.” *Id.* at 235. See generally *id.* at 210–20.

⁵⁰² *Id.* at 8; see also *id.* at 235 tbl.2 (summarizing results of production of reasons (biased and lazy) with the evaluation of others’ reasons (unbiased and demanding)).

⁵⁰³ See *id.* at 9, 287.

⁵⁰⁴ *Id.* at 8.

⁵⁰⁵ *Id.* at 9; see also *id.* at 107–201 (providing further support for these assertions).

individual cognition.”⁵⁰⁶ It also seeks to encompass the psychological findings related to the flaws of human reasoning that are cognitive biases.⁵⁰⁷ In the older view, the mental process of reasoning—“attending to reasons for adopting new conclusions”⁵⁰⁸—can be a solitary endeavor that can lead to brilliant or to warped insights.⁵⁰⁹ In the new theory, Reason’s functions are rooted in the link between cooperation and survival, the intrinsic unreliability of communication, and the need to detect lying.⁵¹⁰

The simple existence of communication within groups does not tend toward accuracy. The phenomena of groupthink,⁵¹¹ group polarization,⁵¹² and the biasing effects of motivated reasoning⁵¹³ have generated many examples of erroneous reasoning.⁵¹⁴ “When people have their ideas closely aligned to start with, it leads to polarization.”⁵¹⁵ From Mercier and Sperber’s evolutionary perspective, good reasons and decisions are more likely to result from the process in which the reason module developed in human societies: face to face argumentation.⁵¹⁶ They provide evidence to show that actual, robust argumentation provides better results to solving problems than solitary thought.⁵¹⁷ In this perspective, the epitome of reasoning is science, where an individual scientist’s hypothesis reflecting her myside bias “is tempered by a more demanding quality control that weeds out the weakest arguments.”⁵¹⁸ With rare exceptions, science advances through continuous dialogue,

⁵⁰⁶ See *id.* at 179, 182 (denoting the intellectualist view).

⁵⁰⁷ See *id.* at 4 (“The idea that reason does its job quite poorly has become commonplace.”). A similar analysis is seen in Daniel Schacter’s book, which views seven memory flaws, including bias, as side effects of memory functions that allow humans to operate successfully. See SCHACTER, *supra* note 438, at 4–5.

⁵⁰⁸ MERCIER & SPERBER, *supra* note 51, at 52.

⁵⁰⁹ See, e.g., *id.* at 17–20 (providing examples of the solitary rational man following his reasoned theories to ill or fruitful conclusions).

⁵¹⁰ See *id.* at 8, 9.

⁵¹¹ See IRVING L. JANIS, VICTIMS OF GROUPTHINK: A PSYCHOLOGICAL STUDY OF FOREIGN-POLICY DECISIONS AND FIASCOS 3 (1972).

⁵¹² See David G. Myers & George D. Bishop, *Discussion Effects on Racial Attitudes*, 169 SCI. 778, 779 (1970); Cass R. Sunstein, *The Law of Group Polarization* 1, 4 (John M. Olin Program in Law and Econ., Working Paper No. 91, 1999).

⁵¹³ See Ziva Kunda, *The Case for Motivated Reasoning*, 108 PSYCHOL. BULL. 480, 495–96 (1990).

⁵¹⁴ See JANIS, *supra* note 511, at 3; Kunda, *supra* note 513, at 496; Myers & Bishop, *supra* note 512, at 779.

⁵¹⁵ MERCIER & SPERBER, *supra* note 51, at 334.

⁵¹⁶ See *id.* at 182–83. Mercier and Sperber call this the interactionist approach to reason. See *id.* at 182–83, 306.

⁵¹⁷ See *id.* at 264.

⁵¹⁸ *Id.* at 322.

interactions, and the testing of findings and hypotheses through methods designed to disconfirm them.

Applying Mercier and Sperber's theory of reasoning, we conclude that *Epidermis and Enamel's* authors did not engaged in a real argument with the critics. The illogic at the root of *Epidermis and Enamel* was generated by groupthink or group polarization rather than a real exchange with bite mark evidence critics.⁵¹⁹ In contrast, Bowers is open to the data offered by scientific critics and finds that a meaningful response cannot be marshaled.⁵²⁰ Souviron and Haller occupy a different space. Their short article is defensive in that it makes much of the distinction between bite mark analysis and bite mark comparison and argues that odontologists can still do bite mark analysis.⁵²¹ This tack, however, can be seen as a tactical retreat that offers a way for odontologists to back away from the main reason they are called on by the prosecution: to make bite mark comparisons. So, while claiming that the National Academy of Sciences Report got it wrong,⁵²² bemoaning that dentists with "no training at all" were doing bite mark comparisons,⁵²³ and warning against an "over-reaction" that would eliminate bite mark analysis,⁵²⁴ their willingness to admit that "Saks et al. do an excellent job describing" the misuse of bite mark comparison leaves them with no alternative but to "agree that, with rare exception, bite mark comparison is not able to identify a suspect with a reasonable degree of certainty. However, under some circumstances bite mark comparisons can be useful for the exclusion of suspects."⁵²⁵ We cannot predict whether forensic odontologists as a group will finally engage in a meaning analysis of critical arguments and research and fully retreat from bite mark analysis as Bowers has done, or step back under the protective cover provided by Souviron and Haller, to renounce only bite mark comparisons. It is worrisome that *Epidermis and Enamel* drew on sources that have irrationally and broadly opposed forensic

⁵¹⁹ In the research science world, attempts to disconfirm findings are expected. *See id.* at 323. Because such challenge is expected, a research scientist will seek out counterarguments in advance of publication, improving the quality of individual work. "Scientists compete for the attention of their peers: only those who make the best arguments have a chance of being heard." *Id.* "From a sociology of science point of view, a proof is an argument that is considered, *in a scientific community*, as conclusive once and for all." *Id.* at 324 (emphasis added).

⁵²⁰ *See* Bowers, *Pseudoscience*, *supra* note 53, at 36, 37, 38.

⁵²¹ *See* Souviron & Haller, *supra* note 24, at 617, 618, 621–22.

⁵²² *See id.* at 621.

⁵²³ *Id.*

⁵²⁴ *See id.* at 622.

⁵²⁵ *Id.* at 621–22.

science reforms.⁵²⁶ Moreover, the use of lawsuits and ostracism as ways of dealing with critics, rather than scientific or rational counterarguments, suggests that the odontologists will be resistant to exchanging ideas.

We have examined the legal and scientific criticism of bite mark evidence, and the reaction to it, by opening a window on the organizational and psychological dynamics that have fueled opposition. We would be relieved to end our analysis at this point, but, unfortunately, the reasoning problems displayed by *Epidermis and Enamel* are expressed by other forensic scientists and may be finding an audience among some prosecutors.

V. CONCLUSION: THE COUNTERATTACK ON REASON AND EVIDENCE

Investigative writer Edward Humes, in his recently published popular book, *Burned*, analyzes the wrongful conviction of JoAnn Parks, based on a flawed arson investigation; her case has not (yet) resulted in an exoneration.⁵²⁷ Humes describes the origin of the evidence- and science-based standards for arson investigation, *NPFA 921*, in the 1990s, which led to the discovery of flashover and its importance in fire investigation.⁵²⁸ Yet, as late as 2018, a fire investigator could double down and deny that this scientific revolution ever occurred, supported by a prosecutor who would argue that position to maintain a conviction.⁵²⁹

It is dismaying that two decades after scientific standards were established to determine whether fires are set intentionally, a fire investigator would stand by the old, discredited, methods, “loyal to [his] convictions” to quote Bandes’s ironic usage, when a flawed investigation is challenged.⁵³⁰ It should come as no surprise that a sudden change of standards will not be immediately welcomed and easily adopted. This may especially be the case in an area like arson

⁵²⁶ Barsley et al., *supra* note 2, at 93–94.

⁵²⁷ See HUMES, *supra* note 52, at 273 (concerning the case of JoAnn Parks). JoAnn Parks’s case is also analyzed in Justin Brooks et al., *If Hindsight Is 20/20, Our Justice System Should Not Be Blind to New Evidence of Innocence: A Survey of Post-Conviction New Evidence Statutes and a Proposed Model*, 79 ALB. L. REV. 1045, 1045–47 (2015).

⁵²⁸ See NAT’L FIRE PROT. ASS’N, NPFA 921: GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS (2017), discussed in HUMES, *supra* note 52, at 56–58; Paul C. Giannelli, *Junk Science and the Execution of an Innocent Man*, 7 N.Y.U. J.L. & LIBERTY 221, 227–28 (2013).

⁵²⁹ See HUMES, *supra* note 52, at 230, 231–32; Plummer & Syed, *Shifted Science*, *supra* note 216, at 278–79; Plummer & Syed, *Criminal Procedure*, *supra* note 216, at 335–36.

⁵³⁰ See Bandes, *supra* note 27, at 486.

investigation where untrained investigators, perhaps without college degrees and with minimal training, cannot meet the rigorous requirements of a fire protection engineer.⁵³¹ Such a defensive reaction should not rile up forensic odontologists because the elimination of bite mark analysis or comparison would not put any of them out of work.

The reactions of the fire examiners and the prosecutors in JoAnn Parks' case raises questions about the extent of resistance to change in forensic science in criminal prosecutions. A good answer requires extensive inquiry into the reactions to challenges to the older forensic science paradigm among the scientists and analysts who conduct forensic examinations, the prosecutors who employ them, the defense attorneys tasked with challenging them, and the judges who are responsible for determining their ability to testify and the admissibility of their testimony. Such a full exploration is far beyond the scope of this article. In this conclusion we offer a few thoughts about the resistance to reason and evidence derived from our investigation into the work of the bite mark dentists.

The obverse of this question is the degree to which forensic science has improved in reaction to the National Academy of Sciences Report.⁵³² Although the question cannot be easily answered, there is some good news. For example, advances are being made in fingerprint analysis about studies assessing error rates, proficiency testing, and the potential to convert fingerprint analysis into an objective method.⁵³³ Improvements are seen to a lesser degree in other feature-comparison areas like firearms analysis.⁵³⁴ The National Academy of Sciences Report has also stimulated inquiry into the need for broader research agendas related to mature forensic

⁵³¹ See John J. Lentini, *Confronting Inaccuracy in Fire Cause Determinations*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, *supra* note 57, at 66, 72.

⁵³² "Today, forensic science conversations between criminal justice and scientific stakeholders around the world begin with the NAS report." Innocence Staff, *Ten Years Later: The Lasting Impact of the 2009 NAS Report*, INNOCENCE PROJECT (Feb. 19, 2019), <https://www.innocenceproject.org/lasting-impact-of-2009-nas-report/> [https://perma.cc/WSP6-A9DJ] [hereinafter Innocence Staff, *Ten Years*] (quoting Michigan Chief Justice Bridget McCormack).

⁵³³ See PCAST, *supra* note 23, at 87, 91, 101; Champod, *supra* note 319, at 2, 3, 5. "While the FBI should be commended for its progress [in implementing fingerprinting reforms], more progress is still needed." Simon A. Cole, Commentary, *Implementing Counter-Measures Against Confirmation Bias in Forensic Science*, 2 J. APPLIED RES. MEMORY & COGNITION 61 (2013) (noting that the FBI protocol has not been published, nor adopted by other U.S. laboratories, nor extended to other disciplines).

⁵³⁴ See PCAST, *supra* note 23, at 111.

areas based on established science.⁵³⁵ Even the Innocence Project reports that the 2009 National Academy of Sciences Report has “spurred various meaningful science-based criminal justice reforms,” and notes the significant federal funding which has supported forensic science research.⁵³⁶ Whether such improvements represent a substantial shift in the overall accuracy of forensic science experts in criminal justice will require analysis by specialists. Simon Cole, in 2013, referred to the “slow progress and staunch resistance” in how forensic examiners report their results, as the forensics disciplines are undergoing culture change.⁵³⁷ A wide scan of the wrongful conviction horizon, which involves the entire investigation-prosecution-adjudication complex, indicates that meaningful reform is a big and long project requiring informed change in every area of justice system practice.⁵³⁸

Whatever the balance sheet between advances in and resistance to forensic science reform, we must attend to carping or misguided criticism. Of course, reform proponents should welcome evidence-based objections to proposed changes that raise measured and answerable concerns.⁵³⁹ That is the very point of the human faculty of reason.⁵⁴⁰ Reason is institutionalized in such vital institutions as the adversary trial,⁵⁴¹ public comment to proposed rules under the

⁵³⁵ See Justice Tetley & Conor Crean, *New Psychoactive Substances: Catalysing a Shift in Forensic Science Practice?*, PHIL. TRANSACTIONS ROYAL SOC. B, Aug. 5, 2015, no. 20140265, at 1.

⁵³⁶ See Innocence Staff, *Ten Years*, *supra* note 532.

Over the past ten years, the National Institute of Justice has spent more than \$123 million on grants to address the research needs outlined in the NAS report, including improving accuracy and reliability of methods and quantifying measures of uncertainty. This investment has yielded evidence that advanced some forensic science disciplines from their status as ‘reviewed by the NAS report in 2009’ to ‘improved levels of validity.’

Id.

⁵³⁷ See Cole, *Culture*, *supra* note 189, at 43.

⁵³⁸ See Cole, *Innocence Crisis*, *supra* note 192, at 14; Zalman & Carrano, *Sustainability*, *supra* note 192, at 957–58, 960–61.

⁵³⁹ For example, soon after the NRC Report, the fingerprint scientific working group expressed concerns not addressed by the report and referred to forthcoming research. See Champod, *supra* note 319, at 2. While fingerprint analysts may have been engaged in rearguard action, their engagement with the criticism at least paved the way to later, iterative reform activity. See, e.g., Simon A. Cole, *Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States*, 13 LAW, PROBABILITY & RISK 117, 117–19 (2014).

⁵⁴⁰ MERCIER & SPERBER, *supra* note 51.

⁵⁴¹ See *id.* at 270–73 (commenting favorably on the adversary process from their psychological perspective).

Administrative Procedures Act,⁵⁴² and the process of real, as opposed to sham, political democracy and deliberation.⁵⁴³ Effective change must encompass the process of dialogue and informed input if it is to lead to workable solutions and legitimacy. However, some negative argumentation may be aimed not at improving proposed reforms, but only at preserving status quo advantages, or may be based on irrational fears,⁵⁴⁴ on other covert goals, or may simply be misguided.⁵⁴⁵

We cannot know whether the kind of negativity and unreason encountered in *Epidermis and Enamel* is widespread among forensic analysts and scientists. A more likely and hopeful scenario is that most forensic analysts want to improve their reliability and will join the forensic reform movement. As noted by Cole, a forensic science reform movement existed before the innocence movement, and many forensic science organizations formally supported the broad reforms called for by the National Academy of Sciences Report.⁵⁴⁶ It is also surely the case that many analysts in the feature-comparison methods will follow reform scripts without fully understanding the reasons for change or fostering the kind of culture change envisioned by many reformers.⁵⁴⁷

Nevertheless, justice-system decision makers, including gatekeeping and appellate judges, should be concerned that some forensic odontologists pursue an insular intellectual path, and by turning inward have generated self-serving and patently weak arguments to support bite mark analysis rather than trying to refute the critical arguments against bite mark evidence with better evidence.⁵⁴⁸ Indeed, the collective unreason displayed in *Epidermis and Enamel* may interfere with more rational considerations for the preservation of bite mark evidence, such as its use to exonerate

⁵⁴² OFFICE OF THE FED. REG., A GUIDE TO THE RULEMAKING PROCESS, https://www.federalregister.gov/uploads/2011/01/the_rulemaking_process.pdf [perma.cc/R729-LD8V].

⁵⁴³ See, e.g., Martin H. Redish & Andrew L. Mathews, *Why Punitive Damages are Unconstitutional*, 53 EMORY L.J. 1, 22 (2004) (referring to democracy as the “prime mechanism for the cultivation of human reason and moral development”).

⁵⁴⁴ For example, some forensic odontologists may fear losing positions.

⁵⁴⁵ E.g., Marvin Zalman, *The Anti-Blackstonians*, 48 SETON HALL L. REV. 1320, 1326 (2018).

⁵⁴⁶ See *supra* notes 120–123 and accompanying text.

⁵⁴⁷ See Black & Daeid, *supra* note 50, at 3. Issues related to forensic culture are far from simple, as noted in a 2013 symposium on the topic. See Ian Burney et al., Editorial, *Introducing ‘Forensic Cultures’*, 44 STUD. HIST. & PHIL. BIOLOGICAL & BIOMEDICAL SCI. 1, 1 (2013); Cole, *Acculturating*, *supra* note 190, at 437, 443, 466–67.

⁵⁴⁸ The likely implication is that at some level the bite mark dentists understood that they could not mobilize scientific evidence or strong arguments to refute the critics and instead resorted to a polemic.

espoused by Souviron and Haller,⁵⁴⁹ or the cautious statement by Mary Bush and Peter Bush that “bitemark evidence can be compelling and of significant evidentiary value under certain circumstances.”⁵⁵⁰ Our view is that the practice of forensic odontology, occurring in the hurly-burly of ongoing and urgent crime investigations, can almost never create the controlled atmosphere of the scientific experiment, and on balance will produce more wrongful convictions than accurate identifications. Thus, while we do not oppose rational debate on the issue, the weight of evidence both from legal experts and forensic scientists supports the termination of using bite-mark evidence, at least to prosecute.

The flawed logic of *Epidermis and Enamel* raises specific concerns of its defense of a small forensic science field that has generated a number of wrongful convictions.⁵⁵¹ A larger concern is that *Epidermis and Enamel*'s illogic and blind resistance may reflect the thinking of a larger number of forensic scientists and analysts, and may find an eager audience among prosecutors who strategically or ideologically reject forensic reforms. Collectively, prosecutors have the power to expand this kind of science denial and they can utilize writings, however weak, to advance their interest, just as the forensic odontologists drew on the defensive and flawed reasoning of John Collins and Jay Jarvis.⁵⁵² Two of their articles are little more than a long and whining complaint against Innocence Project leaders Barry Scheck and Peter Neufeld for having made uncomplimentary

⁵⁴⁹ Souviron & Haller, *supra* note 24, at 5.

⁵⁵⁰ Bush & Bush, *supra* note 271, at 314–15. We note that this weak, conciliatory statement was written soon after or as the Bush team was concluding that “[a]ny individual characteristics present in the dentition may or may not be present in the skin and, if so, may be significantly distorted.” *Id.* at 314. Bush and Bush also concluded, “Establishment of error rates in bitemark casework may therefore be beyond reach.” *Id.*

⁵⁵¹ We are just as concerned that even *one* false conviction has been supported by the application of lip mark analysis. In the serious world of crime detection, the pressures to solve crimes can push detectives toward all kinds of unverified methods, leading to mischief. See Zalman, *supra* note 347, at 152. For example, if a psychic assists an investigator in correctly solving one crime, others may clamor for attention, discounting the fortuitous nature of the success. See, e.g., Benjamin Radford, *Psychic Tip on Long Island Serial Killer?*, DISCOVERYNEWS (Apr. 14, 2011, 9:05AM), <http://news.discovery.com/human/psychic-tip-on-long-island-serial-killer.html> [<https://web.archive.org/web/20110417044331/http://news.discovery.com/human/psychic-tip-on-long-island-serial-killer.html>].

⁵⁵² They published a newsletter, *Crime Lab Report*, and are accreditation inspectors for ASCLD/LAB (American Society of Crime Laboratory Directors/Laboratory Accreditation Board). See Collins & Jarvis, *Contextual*, *supra* note 381, at 7, 14 n.54.

statements about forensic science.⁵⁵³ Weak or nonexistent logic was employed to conclude that forensic science needs little correcting.⁵⁵⁴

We would think that the poorly argued editorializing of overly sensitive forensic examiners and managers could be easily ignored,⁵⁵⁵ except that in addition to their influence on the forensic odontologists, their message seems to appeal to at least some prosecutors. As noted above,⁵⁵⁶ a Collins and Jarvis article was either originally published or reprinted in a journal that appeared to be a vehicle for the views of a distinctly partisan group of prosecutors. The inaugural issue of the *Journal of the Institute for the Advancement of Criminal Justice* (Summer 2007), the only one available online, was devoted to supporting California's Three-Strikes Law.⁵⁵⁷ Again, one would not make much of this except for the strident negative reaction of the National District Attorneys Association to the publication of the PCAST Report.⁵⁵⁸ "[R]epresenting 2,500 elected and appointed

⁵⁵³ See *id.* at 8, 13–14; John M. Collins & Jay Jarvis, *The Wrongful Conviction of Forensic Science*, 1 FORENSIC SCI. POL'Y & MGMT. 17, 17–18, 23 (2009) [hereinafter Collins & Jarvis, *Wrongful*].

⁵⁵⁴ For example, the simple inductive conclusion has been made that unverified forensic science is the *second leading cause* of wrongful conviction. This is based on enumerating *causal* factors appearing in DNA exonerations. In this way, the Innocence Project showed that flawed forensic science appeared in 36% of DNA exoneration cases. Collins and Jarvis softened this to 20% by keeping the numerator (71 cases) and expanding the denominator from the number of exonerations to the "total number of instances" of errors found in the exoneration cases, a way of using numbers as a scaffold for the logical flaw of discrediting one's critic (*tu quoque*). See Collins & Jarvis, *Wrongful*, *supra* note 553, at 21–22. They engage in similar numerology and parse cases to claim that the forensic scientists did not commit malpractice. They also set the stage for defaming the innocence movement that was continued by *Epidermis and Enamel*. See *id.* at 23–25; see, e.g., Barsley et al., *supra* note 2, at 93–94 (criticizing the Innocence Project's statistics).

⁵⁵⁵ As a former director of the Michigan State Police forensic science division, John Collins surprisingly supported a Michigan proposal to establish a forensic science commission in "fiery testimony" to the Michigan State legislature. See Beth LeBlanc, *Ex-Director Promotes Oversight Panel as He Criticizes State Police Labs*, DETROIT NEWS (Nov. 27, 2018), <https://www.detroitnews.com/story/news/local/michigan/2018/11/27/michigan-oversight-criticism-state-police-labs/2127998002/> [https://perma.cc/2GF8-RWXT]. Tellingly, he testified about improper pressure on his former agency from a prosecutor. See *id.*

⁵⁵⁶ See *supra* note 381.

⁵⁵⁷ See Scully, *supra* note 381, at 2. The partisan and ideological clash between prosecutors with traditional "get-tough-on crime" attitudes and practices and "reform-minded prosecutors" is playing out in the election campaign for Los Angeles County District Attorney. See Tim Arango, *Why Los Angeles Could be the Setting for the 'Most Important D.A. Race' in the U.S.*, N.Y. TIMES (June 21, 2019), <https://www.nytimes.com/2019/06/21/us/jackie-lacey-george-gascon-district-attorney.html> [https://perma.cc/KBZ7-M23Y].

⁵⁵⁸ See Press Release, Nat'l Dist. Attorneys Ass'n, National Dist. Attorneys Ass'n Slams President's Council of Advisors on Sci. & Tech. Report (Sept. 2, 2016), <http://ndaa.org/pdf/NDAA%20Press%20Release%20on%20PCAST%20Report.pdf> [https://perma.cc/M3RY-AWG6]; *Testimony of Kay Chopard, National District Attorneys Association, Before the President's Council of Advisors on Science and Technology*, CRIME SCENE INVESTIGATOR 2 (Sept.

District Attorneys across the United States, as well as 40,000 Assistant District Attorneys,”⁵⁵⁹ the NDAA is clearly a powerful organization and its opinions are consequential. The NDAA spokesperson reminded PCAST that it “is merely a temporary advisory body, whose existence expires at the end of this [Obama] administration,”⁵⁶⁰ and if the orientation of prosecutors were in any doubt, President Obama’s own Attorney General, Loretta Lynch, brushed the report aside.⁵⁶¹ In a thoughtful and informative review, Professor Adam Shniderman noted that “[t]he NDAA’s hyperbolic response to the PCAST Report borders on contempt for truth and justice.”⁵⁶²

This may be so, but as *Epidermis and Enamel* has shown, the proper use of reason, let alone doing science or drawing on scientific findings, cannot gain traction where social arrangements are such that only one voice is heard, promoting motivated reasoning, groupthink and group polarization. As the NDAA’s warning made clear, if PCAST’s influence depends on power rather than reason and science, it extends only as far as a President’s term or a President’s willingness to expend political capital to weigh in against entrenched and remorseless prosecutors for whom winning trumps truth every time. And it might seem that in a presidential administration where the findings and institutions of science are openly trashed, and where the slow advance toward forensic science reform has been blocked,⁵⁶³

30, 2016), <https://www.crime-scene-investigator.net/PDF/national-district-attorneys-association-response-to-the-report-forensic-science-in-criminal-courts-ensuring-scientific-validity-of-feature-comparison-methods.pdf> [<https://perma.cc/4QJ6-GADZ>]. The NDAA accused PCAST of being biased, lacking the membership of even “a single working forensic scientist”; was aghast that PCAST claimed that “forensic feature comparison methods belong to the scientific field of ‘metrology (including statistics)’ . . . [when] no metrologists were included on PCAST’s working group”; displayed its scientific chops by distinguishing between complex DNA mixture samples that could and could not be deconvoluted; and a bit more. *See id.*

⁵⁵⁹ Press Release, *supra* note 558.

⁵⁶⁰ *See Testimony of Kay Chopard, supra* note 558, at 2.

⁵⁶¹ *See* Rebecca McCray, *Justice Department Says No Thanks to Forensic Science Report*, TAKEPART (Sept. 24, 2016), <http://www.takepart.com/article/2016/09/24/doj-forensic-science> [<https://perma.cc/A683-WDNE>]; Kira Lerner, *Attorney General to Ignore New Report Finding That Commonly-Used Forensics Are Bogus*, THINKPROGRESS (Sept. 21, 2016), <https://thinkprogress.org/attorney-general-to-ignore-new-report-finding-that-commonly-used-forensics-are-bogus-633a3b313a6a/> [<https://perma.cc/VT7K-U9C9>].

⁵⁶² Shniderman, *supra* note 363, at 357.

⁵⁶³ For example, former Attorney General Jeff Sessions terminated the Justice Department’s involvement in the National Commission on Forensic Science (NCFS), and appointed a prosecutor who had been a thorn in NCFS proceedings as head of the Justice Department’s Forensic Science Working Group, described as an “opaque pseudo-successor to the very public work” of the NCFS. *See* Liliana Segura & Jordan Smith, *Bad Evidence: Ten Years After a Landmark Study Blew the Whistle on Junk Science, the Fight over Forensics Rages*

a new Dark Age is descending.⁵⁶⁴ Still, it is important to know that serious work on refining forensic science standards continues to advance in the Organization of Scientific Area Committees (OSAC) for Forensic Science under the National Institute of Standards and Technology (NIST).⁵⁶⁵ Most progressive and middle-of-the-road prosecutors are sufficiently grounded in concerns for truth and justice to appreciate forensic science reforms. A new bipartisan rapprochement regarding penal policies has tempered if not eliminated the prosecutorial drive to win cases at all costs.⁵⁶⁶ Even in today's world, then, courts, prosecutors, and police, when confronted with the substantial scientific work and reasoning that has undermined the admissibility of bite mark evidence,⁵⁶⁷ may decide that bite mark analysis should not be admissible, and in coming to such a conclusion, might also consider the kind of reasoning that has been used by defenders of such methods.

On, INTERCEPT (May 5, 2019), <https://theintercept.com/2019/05/05/forensic-evidence-aafs-junk-science/> [<https://perma.cc/K4VL-DD4K>].

⁵⁶⁴ See Gretchen T. Goldman et al., *Ensuring Scientific Integrity in the Age of Trump*, SCI. MAG., Feb. 16, 2017, at 696.

⁵⁶⁵ See NAT'L INST. OF STANDARDS & TECH., THE ORGANIZATION OF SCIENTIFIC AREA COMMITTEES FOR FORENSIC SCIENCE, <https://www.nist.gov/topics/organization-scientific-area-committees-forensic-science> [<https://perma.cc/FQG9-SDM8>].

⁵⁶⁶ Progressive prosecutors, however, can expect a "tough on crime" backlash. See Rory Fleming, *Beware of the Backlash Against Reform Prosecutors*, CRIME REPORT (Jan. 7, 2019), <https://thecrimereport.org/2019/01/07/beware-of-the-backlash-against-reform-prosecutors/> [<https://perma.cc/VSZ6-BYJH>].

⁵⁶⁷ See Souviron & Haller, *supra* note 24, at 622; *supra* Part II (except, perhaps, to exonerate suspects).