STRENGTHS AND LIMITATIONS OF FORENSIC SCIENCE: WHAT DNA EXONERATIONS HAVE TAUGHT US AND WHERE TO GO FROM HERE

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The criminal justice system has historically accepted forensic science testimony with great deference and trust.[1] After all, scientists are intellectually curious experts with specialized training who make dispassionate observations about the laws of nature. However, over the past 25 years, post-conviction deoxyribonucleic acid ("DNA") testing has revealed the limitations of scientific evidence by conclusively proving innocence in cases in which forensic analysts had previously presented evidence of guilt.[2] In this way, DNA exoneration cases have prompted a more critical evaluation of forensic science in general.[3] This evaluation has revealed a range of problems including the misapplication of otherwise solid science, overstated conclusions, and some disciplines that lack fundamental scientific foundations.[4] We have also learned that scientists are not impervious to the influences of an adversarial criminal justice system; they are not uniquely immune to the cognitive biases that all humans possess.[5] These DNA exoneration cases provide a common starting point, representing what we have learned about the limitations of forensic science thus far, as we continue to explore how science can contribute to wrongful convictions and how it can be strengthened to avoid additional miscarriages of justice.

The Innocence Project, a non-profit organization dedicated to exonerating the wrongfully convicted through DNA testing and to reforming the criminal justice system to prevent future injustice, maintains a database of case facts from every DNA exoneration across the United States.[6] These case facts

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1 *See* NAT'L RES. COUNCIL, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD 109–10 (2009) [hereinafter NAS REPORT].

2 *See generally* JOHN ROMAN ET AL., POST-CONVICTION DNA TESTING AND WRONGFUL CONVICTION (Urban Institute, 2012); Robert J. Norris, *Framing DNA: Social Movement Theory and the Foundations of the Innocence Movement*, J. CONTEMP. CRIM. JUSTICE (forthcoming 2016), http://ccj.sagepub.com/content/early/2016/10/20/1043986216673014.abstract.

3 NAS REPORT, *supra* note 1, at 4.

4 *Id.*

5 *Id.* at 123.

6 *See generally Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/cases (last visited Nov. 3, 2016).

come from several sources: directly from post-conviction attorneys, from others in the innocence movement (e.g., the team at the National Registry of Exonerations, law professor Brandon Garrett), from reputable media outlets, and from the Innocence Record. The Innocence Record, a collaboration between the law firm Winston & Strawn and the Innocence Project, is an online repository of DNA exoneration case summaries and underlying source documents including police and laboratory reports, trial transcripts, and trial and post-conviction motions and pleadings.[7] Using these documents, and guided by findings from the experts at the National Academy of Sciences ("NAS"),[8] the Innocence Project has been able to identify DNA exoneration cases that involved the misapplication of forensic science.

For the purposes of Innocence Project research, the misapplication of forensic science is defined as an instance in which forensic evidence (i.e., analysis and/or testimony) was used to associate, identify, or implicate someone who was later conclusively proven innocent with post-conviction DNA testing, thereby demonstrating that the original forensic evidence was incorrect.[9] To date, 158 DNA exonerees' cases—nearly half (46%) of all 343 DNA exonerees nationwide—meet this definition, making flawed forensics the second most common contributing factor among those we systematically track.[10] In 13 cases, misapplied forensic science was the only evidence that linked an innocent suspect to a crime, but more often (in 145 cases) it appeared in conjunction with other factors, lending an air of credibility to problematic evidence like eyewitness misidentification, false confession, and/or incentivized informant testimony.[11]

Breaking these numbers down further, serology (the study of blood and other bodily fluids) was the discipline that was misapplied most often, with 86 cases featuring flawed serological analysis and/or testimony.[12] Although,

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7 *About Us*, THE INNOCENCE REC., http://www.innocencerecord.org (last visited Nov. 3, 2016).

8 The NAS is a society of distinguished scientists, "charged with providing independent, objective advice to the nation on matters related to science and technology." *Mission*, NAT'L ACAD. OF SCIS., http://www.nasonline.org/about-nas/mission/ (last visited Nov. 3, 2016). In 2009, the NAS published a comprehensive report in which it evaluated the status of forensic science in the United States. NAS REPORT, *supra* note 1. This report has been a guide for the Innocence Project and others who seek to understand the strengths and limitations of forensic science. *Id.*

9 *Unvalidated or Improper Forensic Science*, INNOCENCE PROJECT http://www.innocenceproject.org/causes/unvalidated-or-improper-forensic-science/ (last visited Nov. 3, 2016).

10 *DNA Exonerations in the U.S.*, INNOCENCE PROJECT, http://www.innocenceproject.org/dna-exonerations-in-the-united-states/ (last visited Nov. 3, 2016).

11 Statistics available from the Innocence Project's internal database (on file with the author).

12 *See infra* Figure 1; *Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/all-cases/#exonerated-by-dna,flawed-serology (last visited Nov. 10, 2016) (cases filtered by type of forensic science problem—here, flawed serology).

according to the NAS, serology—and also DNA testing—are based on solid theory and research,[13] these disciplines can be misapplied through scientific error, misleading testimony, or misconduct. A common example of misapplied serology involves testimony about a phenomenon known as masking.[14] Humans have different blood types, which are inherited from our parents and determined by the presence or absence of different antigens.[15] Type A, Type B, Type AB, and Type O are the four major groups in the ABO blood group system and occur with different frequencies in different ethnic populations.[16] ABO blood group markers can be detected in blood, of course, but approximately 80% of the population also secretes blood group substances in their other bodily fluids (e.g., saliva, semen, vaginal fluid).[17] If a sample of bodily fluid contains a mixture of a relatively large amount of the victim's biological material and a relatively small amount of the perpetrator's biological material (as is often the case in instances of rape), the victim's contribution can overwhelm the perpetrator's, rendering the perpetrator's blood type unidentifiable or masked.[18] Therefore, while ABO blood grouping is a scientifically valid and reliable way to narrow down the pool of possible donors of a biological sample, suggesting that someone is a possible contributor without clarifying that, in instances of potential masking, literally *anyone* could be the donor is misleading and is a misapplication of forensic science. This is exactly what happened in the most recent (343d) DNA exoneration.[19] Similarly, flawed DNA evidence was involved in nine cases in

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13 NAS REPORT, *supra* note1, at 128.

14 *See* Brandon L. Garrett & Peter J. Neufeld, *Invalid Forensic Science Testimony and Wrongful Convictions*, 95 VA. L. REV. 1, 4 (2009).

15 *Blood Types*, AM. RED CROSS, http://www.redcrossblood.org/learn-about-blood/blood-types (last visited Nov. 3, 2016).

16 *Id.*

17 *See* Garrett & Neufeld, *supra* note 14, at 35.

18 *See id.* at 35–42.

19 *Dion Harrell*, INNOCENCE PROJECT, http://www.innocenceproject.org/cases/dion-harrell-exoneration-profile/ (last visited Nov. 3, 2016). Dion Harrell was wrongfully convicted of a 1988 rape in New Jersey and was officially exonerated on August 3, 2016, after DNA testing excluded him as the donor of sperm recovered from the victim's evidence collection kit. *Id.* His conviction was based on a mistaken eyewitness identification and incorrect serology testimony. *Id.* At the time of trial, it was determined that Dion and the victim were both Type O secretors. Mem. in Supp. of Mot. for Post-Conviction DNA Testing at 7, New Jersey v. Harrell, No. 89-08-1402 (on file with the author). H antigens (indicating Type O blood) were found in the evidence. *Id.* The serologist should have testified that any male could have contributed the semen in this mixed sample because of the phenomenon of masking. Instead, the serologist testified that only a percentage of the population could have deposited the biological material, and then he reduced that percentage further by considering only the black male population (the perpetrator was reportedly black). The serologist ultimately concluded that Dion, who is black, was within the 2% of the population who could have contributed the sample when, in fact, the correct conclusion was that 100% of the male population could have contributed it. *Id.* This type of misleading testimony can have devastating consequences. Dion was 22 when he was arrested and 50 when he was finally

this sample.[20] In these cases, DNA samples were accidentally switched; an analyst claimed that a sample was too small for testing but it was, in fact, testable *with the technology available at the time*, and DNA mixtures were misinterpreted (e.g., a mixture was said to have been contributed by two males when in actuality it was contributed by a male and a female).[21]

The remaining disciplines in these cases (e.g., hair microscopy, forensic odontology/bite mark analysis, dog scent evidence, fingerprint analysis) are even *more* prone to misapplication than the established sciences of DNA and serology because they lack agreed-upon standards for comparison and identification, and their error rates are unknown.[22] While DNA analysis was "originally developed in research laboratories in the context of life sciences research,"[23] other forensic disciplines were "developed in crime laboratories to aid in the investigation of evidence from a particular crime scene, and researching their limitations and foundations was never a top priority," and, consequently, they "have never been exposed to stringent scientific scrutiny."[24] Hair microscopy was the second most common type of flawed forensic evidence in this sample of DNA exonerations, with 74 cases involving hair analysis and/or testimony that incorrectly suggested an innocent person was guilty.[25] After several exonerations involving erroneous testimony given by different FBI hair examiners came to light, the FBI and the Department of Justice decided to conduct a review of criminal cases involving

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cleared. *Id.* He served four years in prison but was burdened with the enduring consequences of being required to register as a sex offender for decades more. *Id.*

20 *Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/all-cases/#exonerated-by-dna,forensic-dna (last visited Nov. 3, 2016) (cases filtered by type of forensic science problem—here, DNA).

21 *Dana Holland*, BLUHM LEGAL CLINIC CTR. ON WRONGFUL CONVICTIONS, http://www.law.northwestern.edu/legalclinic/wrongfulconvictions/exonerations/il/dana-holland.html (last visited Nov. 3, 2016); *Dwayne Jackson*, INNOCENCE PROJECT, http://www.innocenceproject.org/cases/dwayne-jackson/ (last visited Nov. 3, 2016); *Ronjon Cameron*, THE NAT'L REGISTRY of EXONERATIONS, https://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=4802 (last visited Nov. 3, 2016).

22 Although fingerprints "have been used to identify people for more than a century in the United States," the practice has been characterized as "subjective;" even assuming that each person's fingerprints are unique, "[u]niqueness does not guarantee that prints from two different people are always sufficiently different that they cannot be confused, or that two impressions made by the same finger will also be sufficiently similar to be discerned as coming from the same source." NAS REPORT, *supra* note 1, at 136, 139, 144. Notably, "black box" studies to establish false positive and false negative rates in latent print examinations under testing conditions *have* been published since the 2009 NAS Report. *See* Bradford T. Ulery et al., *Accuracy and Reliability of Forensic Latent Fingerprint Decisions*, 108 PROC. NAT'L ACAD. SCI. U.S. 7733, 7734 (2011).

23 NAS REPORT, *supra* note1, at 41.

24 *Id.* at 42.

25 *Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/all-cases/#exonerated-by-dna,hair-analysis (last visited Nov. 3, 2016) (cases filtered by type of forensic science problem—here, hair analysis).

microscopic hair analysis in collaboration with the National Association of Criminal Defense Lawyers and the Innocence Project.[26] The preliminary results of their review of trial transcripts with examiner testimony found that at least 90% contained erroneous statements.[27] In a similar development, the Texas Forensic Science Commission[28] recently evaluated the practice of bite mark analysis and recommended a moratorium on the use of bite mark evidence in future criminal prosecutions in Texas until the technique can be scientifically validated.[29] Misleading bite mark evidence was found in ten DNA exoneration cases nationwide.[30] Six cases involved flawed dog scent evidence, three involved flawed fingerprint evidence, and ten involved incorrect testimony about "other" less-common disciplines like shoe print and fiber analysis.[31]

[26] *FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review*, FED. BUREAU OF INVESTIGATION (Apr. 20, 2015), https://www.fbi.gov/news/pressrel/press-releases/fbi-testimony-on-microscopic-hair-analysis-contained-errors-in-at-least-90-percent-of-cases-in-ongoing-review.

[27] *Id.*

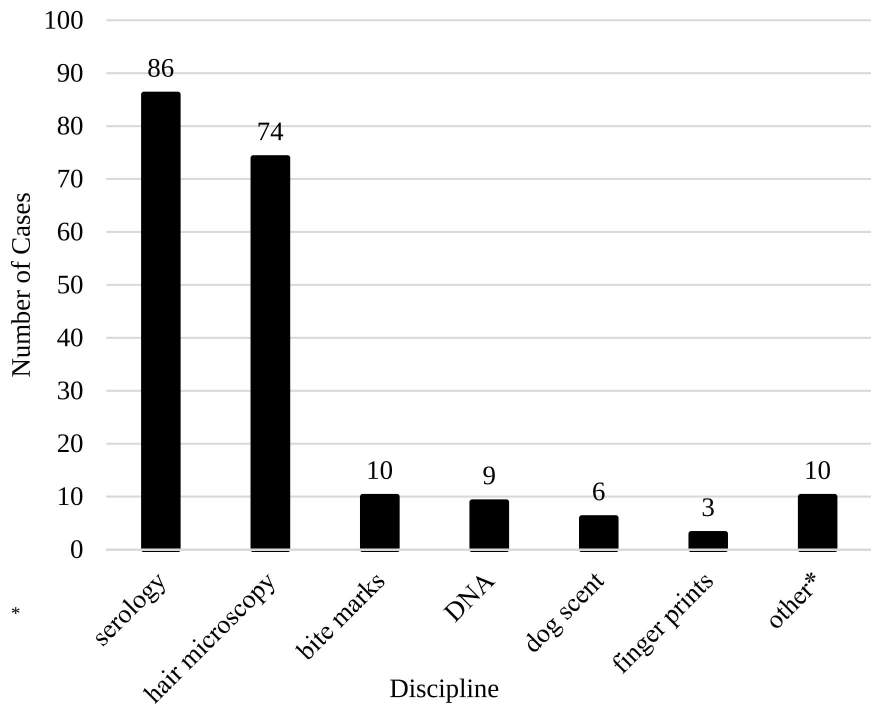
[28] The Texas Forensic Science Commission, created by the state legislature in 2005 in the wake of a major crime laboratory scandal, is a group of scientists and attorneys appointed by the governor, who are committed to justice through science. *About Us*, TEX. FORENSIC SCI. COMM'N, http://www.fsc.texas.gov/about (last visited Nov. 3, 2016). It is tasked with investigating complaints of misapplied forensic science around the state. *Id.*

[29] *See* TEX. FORENSIC SCI. COMM'N, FORENSIC BITEMARK COMPARISON COMPLAINT FILED BY NATIONAL INNOCENCE PROJECT ON BEHALF OF STEVEN MARK CHANEY—FINAL REPORT (2016), http://www.fsc.texas.gov/sites/default/files/FinalBiteMarkReport.pdf.

[30] *Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/all-cases/#exonerated-by-dna,bitemark-analysis (last visited Nov. 3, 2016) (cases filtered by type of forensic science problem—here, bitemark analysis).

[31] *Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/all-cases/#exonerated-by-dna,forensic-other (last visited Nov. 3, 2016) (cases filtered by type of forensic science problem—here, other).

Figure 1: Misapplication of Forensic Science Cases by Discipline[32]



It is also important to acknowledge that many scientists have provided responsible analysis and testimony over the years. There are plenty of examples of proper forensic evidence among these DNA exoneration cases.[33] For instance, early DNA testing in 1989 correctly *included* Christopher Ochoa—along with 16% of the population—as a potential donor of the biological material recovered from a Texas rape/murder.[34] Later, as DNA testing technology advanced, Christopher was excluded as a possible contributor and his wrongful conviction

32 "Other" disciplines include geology, metallurgy (one case with both), soil, fabric impression (one case with both), shoe print (two cases), polygraph improperly admitted at trial/presented as scientific evidence (two cases), dog hair (one case), rubber/foam (one case), voice comparison (one case), and fiber (one case). The numbers in this figure sum to greater than the total number of DNA exoneration cases involving the misapplication of forensic science (158) because some cases involved a misapplication of forensic science in more than one discipline.

33 *Cases*, INNOCENCE PROJECT, http://www.innocenceproject.org/all-cases/#unvalidated-or-improper-forensic-science,exonerated-by-dna (last visited Nov. 3, 2016) (cases filtered by contributing cause of conviction).

34 Mark Donald, *Lethal Rejection*, DALLAS OBSERVER (Dec. 12, 2002, 4:00 AM), http://www.dallasobserver.com/news/lethal-rejection-6389579; Forensic Science Associates lab report (on file with author).

was finally righted in 2002.[35] Similarly, Andrew Johnson was convicted of a rape in Wyoming in 1989 when a serology expert *correctly* testified that he was within the 5% of the population who could have contributed the seminal fluid found in the victim's evidence collection kit.[36] Ultimately, DNA testing showed that, in fact, Andrew was not the donor of the seminal fluid and he was exonerated in 2013.[37] The DNA testing in Christopher Ochoa's case and the serology testing in Andrew Johnson's case were not counted as misapplications of forensic science in the Innocence Project's database of contributing factors.[38]

Fortunately, there have been significant advances in forensic science in recent years. Since the comprehensive NAS assessment of the state of forensic science in 2009, groups like the Center for Statistics and Applications in Forensic Evidence ("CSAFE"), the Statistical and Applied Mathematical Sciences Institute ("SAMSI"), the President's Council of Advisors on Science and Technology ("PCAST"), the National Commission on Forensic Science ("NCFS"), and the Organizational Scientific Area Committees ("OSAC"), have made tremendous progress in both improving forensic science and making relevant policy recommendations and changes.[39] However, this does not mean that all the problems related to forensic science have been solved.

Some have noted a decline in DNA exoneration cases involving misapplied forensic science in recent years.[40] While an initial look at this trend may suggest that forensic science is no longer being misapplied, a deeper investigation does not support this conclusion. Notably, the *total* number of DNA exoneration cases is also decreasing.[41] One reason for this trend may be that the wider use of DNA testing is now helping forestall potential wrongful convictions.[42] We have certainly seen examples of that in recent years. In addition, available data suggest that the apparent decrease in wrongful

[35] *Christopher Ochoa*, INNOCENCE PROJECT, http://www.innocenceproject.org/cases/christopher-ochoa/ (last visited Nov. 3, 2016).

[36] Johnson v. State, 806 P.2d 1282 (Wyo. 1991).

[37] *Andrew Johnson*, INNOCENCE PROJECT, http://www.innocenceproject.org/cases/andrew-johnson/ (last visited Nov. 3, 2016).

[38] *Christopher Ochoa*, *supra* note 355; *Andrew Johnson*, *supra* note 377.

[39] *See Center for Statistics and Applications in Forensic Evidence*, IOWA ST. UNIV., http://forensic.stat.iastate.edu; THE STATISTICAL & APPLIED MATHEMATICAL SCIS. INST., https://www.samsi.info/; *Office of Science and Technology Policy*, THE WHITE HOUSE, https://www.whitehouse.gov/administration/eop/ostp/pcast; *National Commission on Forensic Science*, DEP'T OF JUSTICE, https://www.justice.gov/ncfs; *Organization of Scientific Area Committees for Forensic Science*, NAT'L INST. OF STANDARDS AND TECH., https://www.nist.gov/forensics/organization-scientific-area-committees-forensic-science.

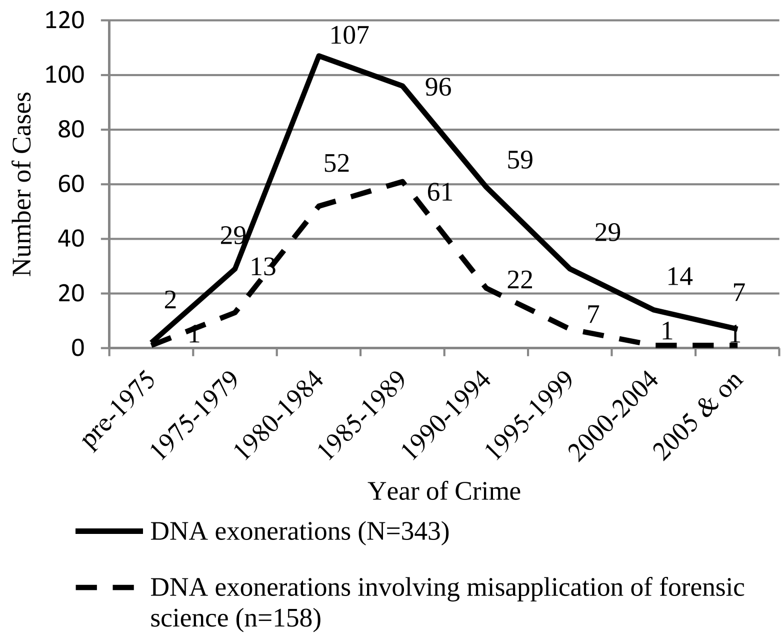
[40] *See infra* Figure 2.

[41] EXONERATIONS IN 2013, THE NAT'L REGISTRY of EXONERATIONS (2014), https://www.law.umich.edu/special/exoneration/Documents/Exonerations_in_2013_Report.pdf.

[42] *Id.*

convictions (and wrongful convictions involving misapplied forensic science) may be an artifact of the exoneration *process.*[43]

Figure 2: DNA Exonerations Involving Misapplication of Forensic Science, Over Time



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The road to exoneration is long. An internal Innocence Project analysis of over 10 years' worth of closed client cases revealed that, on average, it takes: (1) over a year and a half for an innocent person to be convicted; (2) 10 years for them to write to the Innocence Project for help; (3) four years for their case to be evaluated and accepted (the demand for representation is far greater than the capabilities of the community of innocence advocates and, at least at the Innocence Project, there is a backlog); and (4) nearly six more years to find and test evidence, litigate, and secure exoneration and release.[45] Thus, even assuming that defendants write for assistance more immediately now that the Innocence Project's name is well-known and the larger innocence movement is well-established, if a crime occurred in 2005, a person convicted of that crime may not reach exoneration until the year 2016 or later. Given this timeline, it is likely

[43] Closed Client Cases January 2004–June 2015 Analysis (unpublished presentation) (on file with the Innocence Project).

[44] *Cases*, *supra* note 6.

[45] *See infra* Table 1; Closed Client Cases January 2004–June 2015 Analysis, *supra* note 433.

that the data for crimes that occurred within the last 20 years are incomplete. Consequently, we cannot draw conclusions about an improvement in forensic evidence in these more recent cases because the data are unknown. We do, however, have anecdotal examples demonstrating that misapplication is still happening, even in the age of DNA testing.[46]

Table 1: Process of Exoneration[47]

Step	Average number of years[48]
Crime to conviction	1.5
Conviction to first letter	10
First letter to case acceptance	4
Case acceptance to exoneration	6
Total	21.5

Advocates will continue to exonerate the wrongfully convicted using DNA evidence and may continue to uncover misapplied forensic science in some of these cases. *But DNA exonerations are merely a starting point.* These cases have shown us that the forensic analysis and testimony that we once took for granted can be flawed. Although DNA testing is unlikely to prove innocence in wrongful convictions resulting from testimony regarding Shaken Baby Syndrome, arson, or comparative bullet lead analysis, for instance, the same types of potential problems exist (e.g., lack of scientific foundation, overstatement, misconduct). What we have learned about the limitations of serology, hair microscopy, and other forensic science disciplines through the

[46] *See, e.g.*, *James Ochoa*, THE INNOCENCE PROJECT, http://www.innocenceproject.org/cases/james-ochoa/ (last visited Nov. 3, 2016). In 2005, police responded to a carjacking in California. *Id.* They thought that the victims' descriptions of the perpetrator sounded like James Ochoa, a person they had encountered earlier sitting with friends outside his house a few blocks from the crime scene. *Id.* A bloodhound was called in and followed the scent from a swab from the perpetrator's hat, recovered from the stolen car, to James' front door. *Id.* After James was charged and pled guilty, a routine search of the FBI's Combined DNA Index System ("CODIS"), a national database of DNA samples, produced a match to a different man who was in custody for a separate carjacking and who subsequently confessed to the crime for which James was wrongfully convicted. *Id.* James was exonerated in 2006 and the flawed dog scent evidence was revealed. *Id.*

[47] Closed Client Cases January 2004–June 2015 Analysis, *supra* note 433. The Innocence Project conducted an internal analysis of client cases that closed between January, 2004, and June, 2015. Closed Client Cases January 2004–June 2015 Analysis, *supra* note 433. Sixty of the 429 cases in this sample were closed because of exoneration. *Id.* The numbers in this table are based on the 60 exoneration cases. *Id.* Notably, for the sake of comparison, the average time from crime to conviction in the Innocence Project's database of DNA exonerations nationwide (i.e., not just Innocence Project clients) is also one and a half years. We do not have access to data on the other points in the exoneration process for non-Innocence-Project-client cases for comparison purposes.

[48] Rounded to the nearest half-year.

DNA exoneration cases encourages us to critically inspect other disciplines as well.

Finally, we must consider something that affects *all* forensic science disciplines: the human brain. Despite ever-advancing technology, people still play an integral role in the collection, analysis, and interpretation of physical evidence. Consequently, understanding human factors is an essential part of ensuring the integrity of forensic science. Cognitive psychologists have been investigating mental processes like perception, attention, and decision-making for years, and taken together, their scholarship teaches us that the human brain has a limited capacity.[49] We cannot process every piece of stimuli that surrounds us on a daily basis, so instead we have adapted for efficiency by attuning to patterns and developing heuristics—mental shortcuts or rules of thumb—to help us navigate the world (e.g., we automatically gather contextual clues, we make assumptions based on past experiences).[50] Generally, these heuristics serve us well, but they can undermine the scientific goal of objectivity.

While contextual clues may help us in everyday life, they can interfere with an objective scientific analysis of evidence from a crime scene. Various studies have shown that it is not actually the stimulus that matters, but how we process it: experts evaluating stimuli as seemingly-objective as bones, fingerprints, or DNA can be influenced by extraneous contextual information.[51] Depending on the context that examiners are given, they draw different conclusions about these pieces of physical evidence.[52] These types of errors (e.g., mistakenly asserting that female skeletal remains are male) are not due to a lack of proper training, motivation, or overt misconduct; rather, these types of errors are the result of the limitations of our human brains, and we are universally at risk. The 2009 NAS report acknowledged this pattern when it stated, "we unconsciously pick up cues from our environment and factor them in an unstated way into our mental analyses."[53] Researchers have written extensively about this phenomenon and numerous other ways in which the human element impacts

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49 On Amir, *Tough Choices: How Making Decisions Tires Your Brain*, SCI. AM. (July 22, 2008), https://www.scientificamerican.com/article/tough-choices-how-making/; *Cognitive Psychology*, AM. PSYCHOLOGICAL ASS'N, http://www.apa.org/research/action/glossary.aspx?tab=3 (last visited Nov. 3, 2016).

50 *Heuristics*, AM. PSYCHOLOGICAL ASS'N, http://www.apa.org/research/action/glossary.aspx?tab=8 (last visited Nov. 3, 2016).

51 *See, e.g.*, Itiel E. Dror & Greg Hampikian, *Subjectivity and Bias in Forensic DNA Mixture Interpretation*, 51 SCI. & JUST. 204, 204–08 (2011); Itiel E. Dror et al., *Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications*, 156 FORENSIC SCI. INT'L. 74, 74–78 (2006); Sherry Nakhaeizadeh et al., *Cognitive Bias in Forensic Anthropology: Visual Assessment of Skeletal Remains is Susceptible to Confirmation Bias*, 54 SCI. & JUST. 208, 208–14 (2014).

52 Nakhaeizadeh et al., *supra* note 51.

53 NAS REPORT, *supra* note 1, at 122.

forensic science.[54] Unfortunately, we cannot overcome these inadvertent biases by simply being *aware* of our tendencies. In the same way that we take precautions to avoid *physical* contamination, we must embrace concrete, practical solutions to reduce the likelihood of *psychological* contamination.

One strategy to protect evidence from psychological contamination is based on the idea that there is some information that a forensic analyst never needs. For instance, a fingerprint analyst does not need to know the race of the victim in order to do her job of analyzing a print recovered from the crime scene; likewise, a hair analyst never needs to know whether or not the suspect confessed in order to perform his job. This type of information is irrelevant and analysts should be insulated from it. Of course, sometimes an analyst *does* need to be exposed to potentially biasing information (e.g., a fingerprint analyst may need to compare an unidentified print with a known suspect's print, which could potentially bias the analyst). In situations like these, laboratories could employ a technique dubbed Linear Sequential Unmasking.[55] Essentially, this means providing analysts with all the information needed, but doing it as late in the analysis process as possible.[56] For example, a fingerprint examiner does not need to view a questioned print and suspect's print side by side—at least initially. She could first examine the questioned print, document the notable characteristics and features, and only *then* compare it to the suspect's print, rather than looking at them simultaneously. In this way, the suspect's print will not be able to shape her initial interpretation of the questioned print.

These types of biases are not unique to forensic experts. Indeed, human factors come into play at all points in the criminal justice system.[57] But implementing laboratory protections that ensure independent analysis, and demanding replicable and falsifiable forensic science, are meaningful ways to respect what these 158 innocent people endured and to prioritize justice.

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[54] *See, e.g.*, Itiel E. Dror, *Cognitive Neuroscience in Forensic Science: Understanding and Utilizing the Human Element*, 370 PHIL. TRANSACTIONS ROYAL SOC'Y B 1, 2–7 (2015).

[55] Dan E. Krane et al., *Sequential Unmasking: A Means of Minimizing Observer Effects In Forensic DNA Interpretation*, 53 J. FORENSIC SCI. 1006, 1006–67 (2008).

[56] Itiel Dror, *Context Management Toolbox: A Linear Sequential Unmasking (LSU) Approach for Minimizing Cognitive Bias in Forensic Decision Making*, 53 J. FORENSIC SCI. 1111–12 (2015).

[57] *See, e.g.*, Keith Findley & Barbara O'Brien, *Psychological Perspectives: Cognition and Decision Making*, *in* EXAMINING WRONGFUL CONVICTIONS: STEPPING BACK, MOVING FORWARD 35–54 (Allison D. Redlich et al. eds., 2014).