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## Cinderella Story? The Social Production of a Forensic “Science”

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# CRIMINOLOGY

## CINDERELLA STORY? THE SOCIAL PRODUCTION OF A FORENSIC “SCIENCE”

GARY EDMOND\* &  
EMMA CUNLIFFE\*\*

*The last decade has witnessed unprecedented criticism of the forensic sciences from academic commentators and authoritative scientific and technical organizations. Simultaneously, podiatrists have begun to promote themselves as forensic scientists, capable of assisting investigators and courts in their endeavors to identify offenders. This article traces the emergence of forensic podiatry, particularly forensic gait analysis. Forensic gait analysis is a practice that involves comparing persons of interest in crime-related images (such as CCTV and surveillance recordings) with reference images of suspects, where the primary focus is on movement and posture. It tends to be applied when other techniques, such as the comparison of facial and body features, are constrained because of disguises (e.g., the use of balaclavas) or the low quality of the images. This article endeavors to explain how forensic podiatry came into being, shed light on forensic field formation, make an assessment of the knowledge base underpinning forensic gait analysis, and reflect on what the legal recognition of forensic gait analysis reveals about the ability of common law courts to regulate expertise.*

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## TABLE OF CONTENTS

INTRODUCTION.....	220
I. TRACKING EMERGING PRACTICES.....	221
A. Clinical Podiatry.....	221
B. “Forensic Podiatry” .....	226
C. Forensic Gait Analysis (and Gait Analysis) .....	232
D. An Emerging Practice .....	234
II. EVIDENTIARY FOOTING: IN THE COMPANY OF PRE-SCIENTIFIC COMPARISON FORENSICS .....	234
A. Feet of Clay: Forensic Podiatry’s Standards of “Scientific Practice”.....	236
B. Sound Footing: The Minimum Requirements for Forensic Sciences .....	242
C. Learn to Crawl Before You Can . . . : The Evidence Base for Forensic Gait Analysis.....	245
D. Foot in Mouth: Expressions and Conclusions.....	251
III. FANCY FOOTWORK: DEMARCATING FORENSIC PODIATRY .....	256
A. Beyond Chiropody: Positioning Forensic Podiatry in Relation to Podiatry .....	256
B. Treading on Toes: Avoiding Trespassing into Existing Forensic Domains .....	258
C. Side-Stepping Technoscientific Approaches: Relations with Biometrics.....	260
D. Best Foot Forward: Securing Public Recognition.....	261
IV. FOOT FETISH: LAW AND THE CO-PRODUCTION OF EXPERTISE, IDENTITY AND GUILT .....	264
UNHAPPY FEET: IS THERE SUCH A THING AS FORENSIC PODIATRY?.....	270

## INTRODUCTION

This article describes and problematizes the *field* of forensic podiatry, and in particular the emerging practice of forensic gait analysis.<sup>1</sup> It is our intention to explain how forensic podiatry came into being, shed light on forensic science field formation, make an assessment of forensic podiatry and its knowledge base, and reflect on what the emergence of forensic podiatry and judicial acceptance of forensic gait analysis reveal about the legal recognition and legitimation of *expertise* in common law criminal

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<sup>1</sup> For a similar treatment of latent fingerprint identification, see SIMON COLE, *SUSPECT IDENTITIES: A HISTORY OF FINGERPRINTING AND CRIMINAL IDENTIFICATION* (1st ed. 2001). This article seeks to accomplish the same goal within the field of forensic podiatry.

justice systems. Forensic podiatry has been promoted as one of the most recent additions to the forensic sciences.<sup>2</sup> Using forensic gait analysis, podiatrists claim to be capable of addressing a conspicuous evidentiary gap confronting the rapidly increasing range of images and videos associated with criminal acts, namely the identification of persons of interest (POI) in recorded images where other forensic methods (such as face and body mapping) cannot assist.<sup>3</sup> Through the analysis of movement (or gait) and posture, podiatrists have insinuated that they are specially situated to assist with the problem of identity.<sup>4</sup>

Our analysis directs attention to the admissibility and probative value of evidence derived through forensic gait analysis. For the purpose of evaluating this “evidence,” we draw upon recommendations by the United States National Academy of Sciences (NAS) and the United States National Institute of Standards and Technology (NIST) as benchmarks against which the performance and abilities of podiatrists, lawyers, and judges might be profitably explored.<sup>5</sup>

## I. TRACKING EMERGING PRACTICES

### A. CLINICAL PODIATRY

In order to understand the advent of forensic podiatry and the legal recognition of forensic gait analysis, it is useful to take a small step back to introduce, respectively, clinical podiatry and forensic podiatry. Clinical podiatry is the domain where most podiatrists operate and from which interest in forensics emerged.<sup>6</sup> Most podiatrists, including so-called

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<sup>2</sup> JOHN DiMAGGIO & WESLEY VERNON, *FORENSIC PODIATRY: PRINCIPLES AND METHODS* 4 (1st ed. 2011); see Kewal Krishan et al., *Emergence of Forensic Podiatry*, 255 *FORENSIC SCI. INT’L* 16 *passim* (2015) (discussing a recent alternative to the genealogy developed herein).

<sup>3</sup> DiMAGGIO & VERNON, *supra* note 2, at 105–06.

<sup>4</sup> *Id.*

<sup>5</sup> See generally NAT’L INST. OF STANDARDS & TECH., *LATENT PRINT EXAMINATION AND HUMAN FACTORS: IMPROVING THE PRACTICE THROUGH A SYSTEMS APPROACH* (David H. Kaye ed., 2012) [hereinafter NIST REPORT], <http://www.nist.gov/oles/upload/latent.pdf>; NAT’L RESEARCH COUNCIL OF THE NAT’L ACADS., *STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD* (2009) [hereinafter NAS REPORT].

<sup>6</sup> Wesley Vernon, *Review: The development and practice of forensic podiatry*, 13 *J. CLINICAL FORENSIC MED.* 284, 284–85 (2006) (locating the origins of modern forensic podiatry with the Canadian podiatrist, Dr. Norman Gunn, in the 1970s, notwithstanding work in the first decades of the previous century by the pathologist Sir Sidney Smith). *But see generally* SIR SYDNEY SMITH, *MOSTLY MURDER* (1st ed. 1959) (discussing earlier incarnations of forensic podiatry); W. v. M. Gerard, *Foot and Finger Prints*, 1920 *THE PEDIC ITEMS* 5; L.J. Lucock, *Identification from Footwear*, 19 *MED. SCI. L.* 225 (1979); L.J.

forensic podiatrists, practice primarily as clinical podiatrists.<sup>7</sup>

Clinical podiatrists “diagnose and treat conditions of the foot, ankle, and related structures of the leg.”<sup>8</sup> In the United Kingdom (U.K.), they are regulated by the Health and Care Professions Council (HCPC).<sup>9</sup> The HCPC publishes standards of proficiency.<sup>10</sup> These standards require podiatrists to operate within the legal and ethical boundaries of their profession.<sup>11</sup> They also require podiatrists to “be able to engage in evidence-based practice.”<sup>12</sup> Familiarity with relevant research (i.e. specialized knowledge) and scientific processes is a formal requirement of continuing registration.<sup>13</sup> Podiatrists are expected to “be aware of the principles and applications of scientific enquiry, including the evaluation of treatment efficacy and the research process.”<sup>14</sup>

In the United States, podiatry is regulated on a state-by-state basis.<sup>15</sup> By way of example, New York regulates podiatrists and chiropodists under Article 141 of the Education Law and the Regulations of the Commissioner of Education.<sup>16</sup> To practice podiatry, an individual must complete a four-year Doctor of Podiatric Medicine program that complies with the Department of Education’s standards, and pass an examination administered by the National Board of Podiatric Medical Examiners (NBPME).<sup>17</sup> The NBPME website explains that the exam is developed in

Lucock, *Identifying the Wearer of Worn Footwear*, 7 J. FORENSIC SCI. SOC’Y 62 (1967); E. Muir, *Chiropody in Crime Detection*, 22 CHIROPODIST 165 (1935).

<sup>7</sup> *Occupations Outlook Handbook: What Podiatrists Do*, U.S. DEP’T OF LABOR, BUREAU OF LABOR STATISTICS, <http://www.bls.gov/ooh/healthcare/podiatrists.htm#tab-2> (last visited July 25, 2016).

<sup>8</sup> *What is a Podiatrist?*, AM. PODIATRIC MED. ASS’N, <http://www.apma.org/learn/content.cfm?ItemNumber=992&navItemNumber=558> (last visited Nov. 14, 2015); *see Chiropodists/Podiatrists*, HEALTH & CARE PROFESSIONS COUNCIL, <http://www.hcpc-uk.org/aboutregistration/professions/index.asp?id=3#profDetails> (last visited June 2, 2016).

<sup>9</sup> *About Us*, HEALTH & CARE PROFESSIONS COUNCIL, <http://www.hcpc-uk.org/aboutus/> (last visited June 2, 2016); *Chiropodists/Podiatrists*, *supra* note 8.

<sup>10</sup> *See generally* STANDARDS OF PROFICIENCY: CHIROPODISTS/PODIATRISTS, HEALTH & CARE PROFESSIONS COUNCIL (2013), [http://www.hpc-uk.org/assets/documents/10000DBBStandards\\_of\\_Proficiency\\_Chiropodists.pdf](http://www.hpc-uk.org/assets/documents/10000DBBStandards_of_Proficiency_Chiropodists.pdf) [hereinafter STANDARDS OF PROFICIENCY].

<sup>11</sup> *Id.*

<sup>12</sup> *Id.* at 10; *see also id.* at 13 (“[R]ecognise the value of research to the critical evaluation of practice.”).

<sup>13</sup> *Id.* at 11.

<sup>14</sup> *Id.*

<sup>15</sup> *See, e.g.*, N.Y. EDUC. LAW §§ 7000-7010 (McKinney 2015); N.Y. COMP. CODES R. & REGS. tit. 8, § 65.1 (2011).

<sup>16</sup> EDUC. §§ 7000-7010; tit. 8, § 65.1.

<sup>17</sup> *See Who is the NBPME*, AM. PODIATRIC MED. LICENSING EXAMINATION, <http://apmle.com/about-us/who-nbpme> (last visited June 3, 2016).

accordance with the *Standards for Educational and Psychological Testing*.<sup>18</sup> The criteria for test development and the principles set out in the *Education Law* and subsequent regulations do not refer to evidence-based practice.<sup>19</sup> Nevertheless, an article published in 2005 in the *Journal of the American Podiatric Medical Association* reported on endeavors to integrate evidence-based approaches into the curriculum at training institutions.<sup>20</sup> In another article published in the same journal within the decade, it was said that podiatrists receive an education that is “virtually equal to that of medical and surgical specialists who hold an unrestricted medical license.”<sup>21</sup>

Regulation and standardization are intended to position podiatry firmly within the biomedical mainstream.<sup>22</sup> However, unlike practice rules promulgated by most medical specialties, the standards promoted by the Health and Care Professions Council for podiatrists in the U.K. contemplate the possibility of derogation.

**Your particular scope of practice may mean that you are unable to continue to demonstrate that you meet all of the standards that apply for the whole of your profession.** As long as you make sure that you are practising safely and effectively within your given scope of practice and do not practise in the areas where you are not

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<sup>18</sup> See *Exam Credibility*, AM. PODIATRIC MED. LICENSING EXAMINATION, <http://apmle.com/about-us/who-nbpme> (last visited July 25, 2016) (citing AM. EDUC. RES. ASS’N, AM. PSYCHOL. ASS’N, & NAT’L COUNCIL ON MEASUREMENT IN EDUC., STANDARDS FOR EDUCATIONAL AND PSYCHOLOGICAL TESTING 161 (Am. Educ. Res. Ass’n ed., 1st ed. 1999)).

<sup>19</sup> See N.Y. COMP. CODES R. & REGS. tit. 8, § 65.1 (2011); PATRICK JONES ET AL., AUDIT PANEL REPORT OF THE JULY 2003 & 2004 NBPME PART I EXAMINATION 8–9 (2007) (discussing an audit commissioned by the NBPME after a spike in the number of candidates who failed their exam suggests that the subjects are determined by practitioner ratings of their relative importance to practice); *Who is the NBPME*, AM. PODIATRIC MED. LICENSING EXAMINATION, <http://apmle.com/about-us/who-nbpme> (last visited June 3, 2016).

<sup>20</sup> Michael L. Green, *A Train-the-Trainer Model for Integrating Evidence-Based Medicine Training into Podiatric Medical Education*, 95 J. AM. PODIATRIC MED. ASS’N 497, 497–98 (2005).

<sup>21</sup> Leonard A. Levy, *Doctors of Podiatric Medicine – On a Pathway to Becoming Fully Licensed Physicians and Surgeons?*, 104 J. AM. PODIATRIC MED. ASS’N 305, 305 (2014) (discussing the Liaison Committee on Medical Education (LCME) and Committee on Accreditation of Canadian Medical Schools (CACMS), which shares responsibility for accrediting medical schools in the USA and Canada, offer a far more comprehensive set of criteria by which the quality of medical education is assessed than is reflected in Levy); see, e.g., Letter from Danielle Blouin et al., LCME and CACMS Members, to Suzanne Fortier, Principal and Vice-Chancellor of McGill University (June 15, 2015), [https://www.mcgill.ca/medicine/files/medicine/2015\\_june\\_-\\_mcgill\\_-\\_full\\_survey\\_-\\_accreditation\\_letter.pdf](https://www.mcgill.ca/medicine/files/medicine/2015_june_-_mcgill_-_full_survey_-_accreditation_letter.pdf) (listing and applying accreditation criteria to McGill University).

<sup>22</sup> Levy, *supra* note 21, at 308–09 (arguing that the training, testing and clinical practice of podiatrists positions them on a par with other medical professionals such as medical doctors and doctors of osteopathic medicine).

proficient to do so, this will not be a problem. If you want to move outside of your scope of practice, you should be certain that you are capable of working lawfully, safely and effectively. This means that you need to exercise personal judgement by undertaking any necessary training or gaining experience, before moving into a new area of practice.<sup>23</sup>

According to these standards, provided podiatrists appropriately restrict the scope of their practice, this represents an acceptable compromise for specialization. It would appear to be a tenet of their nascent professionalization and a condition of recognition from the biomedical mainstream that podiatrists are conversant with their limitations and only practice in areas where they are demonstrably proficient.<sup>24</sup>

The College of Podiatry represents podiatrists and chiropodists in the U.K.<sup>25</sup> It espouses a commitment to evidence-based practice: “We promote guidelines and standards of practice that are evidence based, ensuring patient safety and clinical effectiveness with a focus on outcomes.”<sup>26</sup> In furthering this commitment, the College of Podiatry purports to develop policies with “the support of the U.K.’s most prominent podiatrists, scientists, and researchers.”<sup>27</sup> The United States equivalent is the American Podiatric Medicine Association (APMA).<sup>28</sup> In short, both regulators (such as the HCPC) and leading representative bodies hold podiatry out as a modern field of healthcare.<sup>29</sup> In recent years, a conspicuous emphasis has been placed on evidence-based standards and practice.<sup>30</sup> As one might expect, the HCPC, the College of Podiatry, and APMA are primarily oriented toward certification, patient-podiatrist relationships, and the regulation of clinical practice.<sup>31</sup> Their standards and policies do not

<sup>23</sup> STANDARDS OF PROFICIENCY, *supra* note 10, at 4.

<sup>24</sup> *Id.*

<sup>25</sup> Also known as the Society of Chiropodists and Podiatrists. “Chiropody” was the traditional name, but has been largely abandoned in favor of podiatry with its modern scientific connotations. Michael D. Akers et al., *Public Perceptions of the Podiatrist and the DPM Degree*, 99 J. AM. PODIATRIC MED. ASS’N 223, 223–24 (2009) (noting that chiropody as a label was more prominent in the United Kingdom than other jurisdictions, such as the United States); Wesley Vernon et al., *Issues of Podiatry Status in the UK*, 8 BRIT. J. PODIATRY 6, 7 (2005).

<sup>26</sup> *About Us*, THE C. OF PODIATRY, <http://www.scpod.org/about-us/> (last visited July 7, 2015).

<sup>27</sup> *Id.*

<sup>28</sup> See AM. PODIATRIC MED. ASS’N, <https://www.apma.org/> (last visited June 3, 2016).

<sup>29</sup> See STANDARDS OF PROFICIENCY, *supra* note 10, at 4; *About Us*, *supra* note 26.

<sup>30</sup> See Green, *supra* note 20, at 497–98; *About Us*, *supra* note 26.

<sup>31</sup> See, e.g., STANDARDS OF PROFICIENCY, *supra* note 10 (discussing general standards of proficiency for chiropodists without using the word “forensic”); *About Us*, *supra* note 26 (discussing accreditation but only in respect of the provision of clinical services).

expressly consider forensic work, forensically-oriented techniques, or the special responsibilities of podiatrists acting as expert witnesses in criminal investigation and prosecutions—i.e., so-called forensic podiatry.<sup>32</sup>

In conjunction with regulatory arrangements and the pronouncements of professional bodies, podiatrists have historically emphasized their independence from other health, medical, and therapeutic fields.<sup>33</sup> One definition advanced by exponents of research-based podiatry captures both the focus and the division of responsibility: “Podiatry exists as a clinically independent profession involving the diagnosis and treatment of the whole foot independently of medical practitioners.”<sup>34</sup>

As in many paramedical fields, the organization and regulation of podiatry appears to be driven by two—occasionally conflicting—motivations. On one hand, the drive for professional status, biomedical recognition, and access to healthcare funding (and insurance cover) has prompted leaders and regulators to impose professional standards that parallel (or perhaps mimic) those of medicine in terms of training, scientific rigor, and ethical precepts.<sup>35</sup> On the other hand, the desire to maintain autonomy, in part through differentiation, has led podiatrists to distinguish podiatry from medicine and other cognate fields while maintaining, and perhaps extending, the scope of their practice.<sup>36</sup>

Acting on these professional motivations, clinical podiatry has sought to transform itself from technical certification (and the work of “filing and clipping” historically associated with chiropody) into a degree-based clinical practice that includes surgical intervention, albeit tightly circumscribed.<sup>37</sup> Seeking to promote both the need for a conspicuous evidence base for podiatry and greater methodological sophistication among podiatrists, university-based podiatrists Vernon and Campbell wrote:

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<sup>32</sup> See, e.g., STANDARDS OF PROFICIENCY, *supra* note 10 (discussing without the word “forensic”); *About Us*, *supra* note 26 (discussing but only contemplating provision of clinical services).

<sup>33</sup> Vernon et al., *supra* note 25, at 6 (discussing the status of podiatrists relative to other health professionals, with a focus on podiatrists’ self-image).

<sup>34</sup> *Id.* (discussing the status of podiatrists relative to other health professionals, with a focus on podiatrists’ self-image; note the repetition of “independence”).

<sup>35</sup> See, e.g., STANDARDS OF PROFICIENCY, *supra* note 10.

<sup>36</sup> See, e.g., Jay Levrio, *Podiatric Medicine: A Current Assessment*, 99 J. AM. PODIATRIC MED. ASS’N 65, 69–70 (2009). See generally ANDREW ABBOTT, *THE SYSTEM OF PROFESSIONS: AN ESSAY ON THE DIVISION OF EXPERT LABOR* (1988) (arguing that professions exist within a broader system in which they are constantly competing with one another and seeking to demarcate space for themselves).

<sup>37</sup> See Levrio, *supra* note 36, at 70; Vernon et al., *supra* note 25, at 7–8.

We are constantly told that, as podiatrists, we need to research, but what does this really mean? This question can be particularly problematic in a profession such as podiatry, where there has not been a strong research basis for our practice in the past, where podiatrists were trained by simply being presented with information as the knowledge required to be able to practise.<sup>38</sup>

Simple rhetoric or anecdotally based arguments are no longer adequate when attempting to justify a direction for change, especially when many of the medical and other health-related disciplines are presenting research-based information to justify their own positions. Development without research may therefore no longer be adequate, with the need for an evidence base to be presented in order for new developments to be accepted.<sup>39</sup>

Historically, podiatry has been plagued by “a weak scientific and evidence base.”<sup>40</sup> Statements such as Vernon and Campbell’s are at the vanguard of efforts to drive the professionalization of podiatry and with it to ground clinical practice in biomedical research. The influence of evidence-based medicine, and the threat posed to podiatry by traditional attitudes and regulatory authorities—such as the National Institute for Health and Clinical Excellence (NICE), responsible for the allocation of medical resources in the U.K.—are both apparent in the article from which these quotes are drawn.<sup>41</sup> The Standards of Proficiency published by the HCPC in 2013 (seven years after Vernon and Campbell published this article) embody the expectation that modern podiatry is grounded in scientific and medical research.<sup>42</sup>

Given our interest in forensic podiatry, we are drawn to the contention that extrinsic decision-makers may, in the future, demand better evidence for the efficacy of new developments, and that podiatry must therefore be ready to supply such evidence. In this article, we examine the extent to which forensic science organizations and common law courts have required podiatrists to supply an evidence base as a precondition to extending the scope of clinical practice into forensic applications. We are particularly interested in the scientific research supporting forensic gait analysis.

## B. “FORENSIC PODIATRY”

Proponents of forensic podiatry are primarily engaged in a range of comparison (or pattern matching) activities aiming to link a person or object

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<sup>38</sup> Wesley Vernon & Jackie Campbell, *An Introductory Guide to Putting Research into Practice: 1. The Why, Who and How of Podiatry Research*, 9 *PODIATRY NOW* 18, 19 (2006).

<sup>39</sup> *Id.* at 20.

<sup>40</sup> Vernon et al., *supra* note 25, at 7–8.

<sup>41</sup> See *About Us*, NAT’L INST. FOR HEALTH AND CARE EXCELLENCE, <https://www.nice.org.uk/about/what-we-do> (last visited July 7, 2015).

<sup>42</sup> STANDARDS OF PROFICIENCY, *supra* note 10, at 11–14.

to a source.<sup>43</sup> Apart from, and indeed pre-dating the emergence of forensic gait analysis, podiatrists claimed to be able to assist criminal investigations and prosecutions by identifying dead bodies using treatment records, detecting foot and leg pathologies from foot and shoe prints, and linking shoe wear to particular features of gait and feet.<sup>44</sup>

In their efforts to build the field, proponents of forensic podiatry have sought affiliation with the International Association for Identification (IAI).<sup>45</sup> The IAI claims to be “the world’s oldest and largest forensic science identification association.”<sup>46</sup> It is composed of forensic practitioners, most prominently, from fields involved in attempts to identify a person or object from a “trace”—e.g. latent fingerprints, ballistics, tool marks, bite marks, and handwriting.<sup>47</sup>

The IAI performs a dual role as a representative organization and body which purports to impose ethical and practice standards.<sup>48</sup> It has a “Code of Ethics and Standards of Professional Conduct.”<sup>49</sup> This Code refers to, among other things, obligations to validate “[n]ew and novel techniques . . . prior to implementation in case work,”<sup>50</sup> to testify “to results obtained and conclusions reached only when he/she has confidence that the opinions are based on good scientific principles and methods”<sup>51</sup> and to support “sound scientific techniques and practices.”<sup>52</sup> In theory, violation of these principles offers grounds for expulsion and suspension or revocation of membership or certification or both.<sup>53</sup>

Following the advice of its recently established Forensic Podiatry Sub-

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<sup>43</sup> Bryan Found & Gary Edmond, *Reporting on the Comparison and Interpretation of Pattern Evidence: Recommendations for Forensic Specialists*, 44 AUSTRALIAN J. FORENSIC SCI. 193, 193 (2012) (discussing “comparison forensics” as forensic sciences based around comparison or pattern matching in order to link a recovered trace with a person or object). See generally NAS REPORT, *supra* note 5.

<sup>44</sup> Vernon, *supra* note 6, at 285–86.

<sup>45</sup> Wesley Vernon, *Formal Recognition of Forensic Podiatry by the International Association for Identification (IAI)*, 10 PODIATRY NOW 42, 42 (2007).

<sup>46</sup> INT’L ASS’N FOR IDENTIFICATION, <https://www.theiai.org> (last visited July 7, 2015).

<sup>47</sup> *Forensic Discipline*, INT’L ASS’N FOR IDENTIFICATION, <https://www.theiai.org/disciplines/index.php> (last visited June 4, 2016). We characterize these older forensic disciplines as conventional forensic sciences or pre-DNA comparison forensics.

<sup>48</sup> See INT’L ASS’N FOR IDENTIFICATION, CODE OF ETHICS AND STANDARDS OF PROFESSIONAL CONDUCT, [https://www.theiai.org/about/code\\_of\\_ethics.pdf](https://www.theiai.org/about/code_of_ethics.pdf) [hereinafter CODE OF ETHICS].

<sup>49</sup> *Id.*

<sup>50</sup> *Id.* at § 2.02.

<sup>51</sup> *Id.* at § 3.05.

<sup>52</sup> *Id.* at § 1.11.

<sup>53</sup> *Id.* at § 9.03.

Committee, the IAI adopted the definition of *forensic podiatry* first used by Sub-Committee members advocating a role for podiatrists in criminal investigations and prosecutions.

[F]orensic podiatry [is] . . . ‘the application of sound and researched podiatry knowledge and experience in forensic investigations, to show the association of an individual with a scene of crime, or to answer any other legal question concerned with the foot or footwear that requires knowledge of the functioning foot.’<sup>54</sup>

Key documents published on the IAI website (e.g., “Forensic Podiatry: Role and Scope of Practice”) do not explain what constitutes “sound and researched podiatry knowledge and experience” or provide examples.<sup>55</sup> Presumably, a full definition would draw on literatures from clinical podiatry, comparison forensics, and more generally relevant scientific research and methods (e.g., on validation and human factors).<sup>56</sup>

The IAI offers formal certification “through a series of knowledge and practical application based examinations.”<sup>57</sup> At this stage, the Forensic Podiatry Sub-Committee of the IAI does not appear to have established a certification process or proficiency examinations for forensic podiatrists.<sup>58</sup> Nevertheless, according to IAI documents, those wishing to practice as forensic podiatrists must first be certified (or registered) as clinical podiatrists.<sup>59</sup>

Podiatrists who practice forensically must firstly, by definition have a qualification allowing them to practice as a podiatrist. Next, they must be in a position to show such development as would allow them to practice competently in a medico-legal context. There is more than one route to developing this level of expertise[.]<sup>60</sup>

Those aspiring to become competent forensic podiatrists might supplement their primary qualification with a Bachelor of Science (or other) degree in

<sup>54</sup> See, e.g., Vernon, *Forensic Podiatry: A Review*, 1 *AXIS* 60, 61–66 (2009) (quoting D.W. Vernon & F.J. McCourt, *Forensic Podiatry – A Review and Definition*, 2 *BRIT. J. OF PODIATRY*, 47 (1999); Vernon, *supra* note 6, at 284 (discussing the current scope of forensic podiatry as well as its historical development). See generally *Forensic Podiatry Discipline*, INT’L ASS’N FOR IDENTIFICATION, <https://www.theiai.org/disciplines/podiatry/index.php> (last visited July 7, 2015) (citing Vernon & McCourt, *supra* note 54, at 45–48). This adoption is no coincidence as Vernon and McCourt are among the podiatrists promoting institutional recognition of forensic podiatry.

<sup>55</sup> See, e.g., WESLEY VERNON ET AL., *FORENSIC PODIATRY: ROLE AND SCOPE OF PRACTICE* (2009).

<sup>56</sup> On validation and human factors, see *infra* Part II.B.

<sup>57</sup> *Forensic Podiatry Discipline*, *supra* note 54.

<sup>58</sup> See VERNON ET AL., *supra* note 55, at 4–5 (noting that the development of a certification program in forensic podiatry would be “advantageous”).

<sup>59</sup> *Forensic Podiatry Discipline*, *supra* note 54, at 3–4.

<sup>60</sup> *Id.* at 3.

forensic science, complete an expert witness training course, or participate in forensic podiatry workshops.<sup>61</sup> Self-evidently, some of these paths will offer more rigorous training than others, particularly in relation to key issues such as formal evaluation of techniques, minimizing cognitive and contextual biases, and understanding the legal and ethical responsibilities of expert witnesses.<sup>62</sup>

A central purpose of the IAI's Forensic Podiatry Sub-Committee seems to be identifying and demarcating the boundaries of forensic podiatry.<sup>63</sup> As we explain in Part III, the scope of practice has been developed in a manner that purports to build on the training and clinical knowledge of podiatrists, while scrupulously avoiding conflict with foot and shoe-print specialists already affiliated with the IAI. The basic scope of forensic podiatry is defined on the IAI website as follows:

Forensic podiatrists assist in the identification of perpetrators of crime where barefoot prints, footwear and CCTV [closed-circuit television] evidence are involved. Their expertise is required in identification in the assessment of the effects of foot and lower limb function, the evaluation and matching of wear associated with the foot/shoe interface and in comparisons requiring consideration of shoe size. In their CCTV work, forensic podiatrists compare the gait patterns of individuals captured on CCTV with those of suspected offenders. Forensic podiatrists are also involved in the identification of human remains from comparison of the feet of the deceased with detail listed in the podiatry records of missing individuals.<sup>64</sup>

While this essay is primarily focused on the emergence and legal recognition of forensic gait analysis, a brief introduction to other areas of forensic practice indicates that podiatrists have historically represented their knowledge and abilities in a manner that is conspicuously influenced by conventional (i.e., non-DNA) comparison forensics such as fingerprints, ballistics, tool marks, hair and fibers, bite marks, and handwriting.<sup>65</sup>

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<sup>61</sup> *Id.* at 3–4.

<sup>62</sup> Bryan Kagan, *Forensic Podiatry*, 34 *PODIATRY MGMT. MAG.* 141, 148 (2015); see also DIMAGGIO & VERNON, *supra* note 2, at 15–16 (supplying an example of a textbook that demonstrates some understanding of aspects of the scientific method, but which does not demonstrate any familiarity with contemporary literature regarding cognitive and contextual bias, the shortcomings of comparison forensics, or the risks of wrongful conviction).

<sup>63</sup> On this demarcation of boundaries, see *infra* Part III.

<sup>64</sup> *Forensic Podiatry Discipline*, *supra* note 54 (discussing the current scope of forensic podiatry as well as its historical development, endorsed in Vernon, *supra* note 6, at 284); see Vernon, *supra* note 54, at 61–66; Vernon & McCourt, *supra* note 54, 45–48 (offering an explanation and overview of the forensic dimensions of podiatry).

<sup>65</sup> See VERNON ET AL., *supra* note 55 (setting out the role and scope of forensic podiatry in a manner that mirrors the analytical framework used by other forms of comparison forensics); Kagan, *supra* note 62, at 143; Vernon, *supra* note 54, at 61; Vernon, *supra* note 6, at 285.

Record or card identification uses a patient's medical or treatment record (notably foot type, pathologies, marks, scars, and interventions) to assist with identification, normally of deceased persons.<sup>66</sup> This technique was consciously modeled on the use of dental records for the purpose of identifying human remains.<sup>67</sup> Treatment records might also be used to help identify persons where shoes, orthotics, or lower limbs are recovered.<sup>68</sup> According to the IAI Forensic Podiatry Sub-Committee, because "of the professional language, coding systems, and podiatric conditions involved, this work would be the exclusive domain of the podiatry profession."<sup>69</sup>

Analysis of barefoot and shoe prints focuses on features of these impressions in order to assist with identification and movement.<sup>70</sup> Features of interest include size and aging, pathologies, type and sequence of movement (e.g., walking or running), and other information that might be derived from foot and shoe-prints.<sup>71</sup> For example:

Podiatrists' involvement in barefoot identification is both descriptive and interpretive. The particular emphasis is on the recognition and utilization of foot-related conditions and foot dimensions in this process. As podiatrists recognize a condition, state or pathology in an unknown barefoot print, this would then be described and compared with the recognized presence or absence of such a condition, state or pathology in a known barefoot print.<sup>72</sup>

Analysis of foot- and shoe-prints is characterized as "complimentary" to the friction ridge (from bare feet) and shoe-print analysis conducted by institutionalized forensic practitioners—usually police specialists.<sup>73</sup> The complementary analyses performed by podiatrists are to be "carried out at

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<sup>66</sup> Vernon, *supra* note 6, at 285.

<sup>67</sup> See, e.g., I. Doney & P. Harris, *Mass Disaster Identification: Can Chiropodists Help?*, 25 POLICE SURGEON 14, 15 (1984).

<sup>68</sup> *Forensic Podiatry Discipline*, *supra* note 54.

<sup>69</sup> VERNON ET AL., *supra* note 55, at 5.

<sup>70</sup> See generally SCOPE OF WORK RELATING TO FORENSIC FOOTWEAR AND/OR TIRE TREAD EXAMINERS (03/2005), SCI. WORKING GROUP FOR SHOEPRINT AND TIRE TREAD EVIDENCE, [http://www.swgtread.org/images/documents/standards/published/swgtread\\_06\\_scope\\_of\\_work\\_200503.pdf](http://www.swgtread.org/images/documents/standards/published/swgtread_06_scope_of_work_200503.pdf) (setting out the scope of work for shoeprint and footwear analysts); Robert B. Kennedy, *Uniqueness of Bare Feet and Its Use as a Possible Means of Identification*, 82 FORENSIC SCI. INT'L 81, 82–83 (1996); *International Association for Identification Footwear and Tire Track Examination Sub-Committee Scope of Practice*, INT'L ASS'N FOR IDENTIFICATION, [https://www.theiai.org/disciplines/footwear\\_tiretrack/index.php](https://www.theiai.org/disciplines/footwear_tiretrack/index.php) (last visited July 25, 2016) [hereinafter *International Association*] (setting out the range of work performed by this community of forensic specialists).

<sup>71</sup> DIMAGGIO & VERNON, *supra* note 2, at 77–79; *International Association*, *supra* note 70.

<sup>72</sup> VERNON ET AL., *supra* note 55, at 5.

<sup>73</sup> *Id.* at 7, 10; DIMAGGIO & VERNON, *supra* note 2, at 78–79.

the request of marks examiners and other professional groups working in the field.”<sup>74</sup> In the absence of a pre-existing monopoly on footprint sequencing and movement, podiatrists have signaled a willingness to assist with attempts to determine the order and type of movement associated with a crime scene.<sup>75</sup> They are, however, cautioned to avoid analyzing ridge detail of footprints or shoe marks unless used to reveal pathologies or features not within the remit of other forensic practitioners.<sup>76</sup>

When engaged in footwear analysis or “identification,” podiatrists endeavor to assess the relationship between a foot and a shoe.<sup>77</sup> Tasks might include interpreting functional pathologies of the foot and gait as they manifest in wear patterns (both on the inside and outside of the shoe) and fit of shoe.<sup>78</sup> “The process of footwear *identification* is based on a belief that feet are highly individual, even unique.”<sup>79</sup> The commitment to uniqueness, and the derivative belief that podiatry might enable positive identification (sometimes described as individualization), are unproven premises.<sup>80</sup> The correlate expectation, that distinctive characteristics and movement patterns translate into wear features on footwear enabling positive identification,<sup>81</sup> seems to have been undermined by actual research. For example, a recent study found that “general wear alone is not sufficient evidence for individualization.”<sup>82</sup>

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<sup>74</sup> VERNON ET AL., *supra* note 55, at 5. On the performance of foot and shoe-print examiners, see NAS REPORT, *supra* note 5, at 145.

<sup>75</sup> DiMAGGIO & VERNON, *supra* note 2, at 73–74; see Virginia L. Naples & Jon S. Miller, *Making Tracks: The Forensic Analysis of Footprints and Footwear Impressions*, 279B THE ANATOMICAL RECORD 9 (2004).

<sup>76</sup> See, e.g., VERNON ET AL., *supra* note 55, at 7; Part III, *infra*.

<sup>77</sup> Vernon, *supra* note 6, at 285 (suggesting that a podiatrist might conduct something in the order of 387,000 footwear examinations over the course of their working life). Of significance, none of these examinations are oriented to issues pertaining to identity. *Id.*

<sup>78</sup> DiMAGGIO & VERNON, *supra* note 2, at 89–101; VERNON ET AL., *supra* note 55, at 9.

<sup>79</sup> Vernon, *supra* note 6, at 285 (citing Kennedy, *supra* note 70, at 81 (emphasis added)); see also Ivan Birch, et al., *The Identification of Individuals by Observational Gait Analysis Using Closed Circuit Television Footage*, 53 SCI. & JUST. 339, 341 (2013) (suggesting that “gait is a unique feature of an individual during ambulation”).

<sup>80</sup> See Michael J. Saks & Jonathan J. Koehler, *The Individualization Fallacy in Forensic Science Evidence*, 61 VAND. L. REV. 199, 205–06, 217 (2008). See generally Simon A. Cole, *Forensics without Uniqueness, Conclusions without Individualization: The New Epistemology of Forensic Identification*, 8 LAW, PROBAB. & RISK 233 (2009) (criticizing claims of individualization in forensic science from an epistemological standpoint).

<sup>81</sup> Vernon, *supra* note 6, at 285; see also Wesley Vernon et al., *A Theory of Shoe Wear Pattern Influence Incorporating a New Paradigm for the Podiatric Medical Profession*, 94 J. AM. PODIATRIC MED. ASS’N 261 *passim* (2004).

<sup>82</sup> William J. Bodziak et al., *Determining the Significance of Outsole Wear Characteristics During the Forensic Examination of Footwear Impression Evidence*, 62 J.

## C. FORENSIC GAIT ANALYSIS (AND GAIT ANALYSIS)

The IAI Forensic Podiatry Sub-Committee defines “forensic gait analysis” as the “identification of a person or persons by their gait or features of their gait, usually from CCTV footage and in comparison to footage of a known individual.”<sup>83</sup> Forensic gait analysis lays claim to being “the most recent subspecialty of forensic podiatry.”<sup>84</sup> In practice, it usually entails the analysis of images obtained by CCTV, or other security and surveillance, cameras (i.e., crime-related images) in order to examine the movement and posture of a person of interest so as to compare them with features exhibited by a person in reference images collected by investigators (where identity is known).<sup>85</sup> Recourse to forensic gait analysis has been most prominent in conditions where the face, head, or body are obscured or disguised such that other forms of forensic image interpretation (e.g., face and body mapping) are constrained.<sup>86</sup> Podiatrists claim monopoly rights over forensic gait analysis.<sup>87</sup>

It is important to distinguish forensic gait analysis from analysis of gait in clinical practice. Clinical podiatrists use gait analysis to identify and interpret biomedical abnormalities and to monitor interventions.<sup>88</sup> Some podiatrists (and sports scientists) also use gait analysis to enhance the performance of sportsmen and women, notably elite athletes.<sup>89</sup> In the clinic, podiatrists may employ sophisticated technical equipment (e.g., electrodes, force platforms, and computer interfaced videos).<sup>90</sup> Recording, observation, and analysis are ordinarily conducted in controlled or artificial conditions where the subject (a known “patient”) is required to comply with

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FORENSIC IDENTIFICATION 254, 260 (2012).

<sup>83</sup> VERNON ET AL., *supra* note 55, at 11.

<sup>84</sup> DiMAGGIO & VERNON, *supra* note 2, at 103.

<sup>85</sup> See generally R. v. Aitken, 2008 BCSC 1423 (Can.); R v. Otway, [2011] EWCA (Crim) 3, [2011] All. E.R. 75 (Eng.) (cases where the admissibility of gait analysis was challenged and considered by appellate courts); WESLEY VERNON ET AL., *supra* note 55, at 11–12.

<sup>86</sup> On face and body mapping, see Gary Edmond et al., *Law's Looking Glass: Expert Identification Evidence Derived from Photographic and Video Images*, 20 CURRENT ISSUES IN CRIM. JUST. 337 (2009).

<sup>87</sup> VERNON ET AL., *supra* note 55, at 11 (“This work is currently the exclusive domain of forensic podiatrists.”). However, in practice, a range of cognate disciplines also use gait analysis. See DiMAGGIO & VERNON, *supra* note 2, at 105–106.

<sup>88</sup> See generally JACQUELIN PERRY & JUDITH M. BURNFIELD, *GAIT ANALYSIS: NORMAL AND PATHOLOGICAL FUNCTION* (2d ed. 2010); WHITTLE'S *GAIT ANALYSIS* (David Levine, Jim Richards & Michael W. Whittle eds., 5th ed. 2012) (analyzing gait).

<sup>89</sup> See, e.g., Sarah A. Curran & Howard J. Dananberg, *The Future of Gait Analysis: A Podiatric Medical Perspective*, 103 J. AM. PODIATRIC MED. ASS'N 130, 131 (2013).

<sup>90</sup> *Id.* at 132–34.

instructions in order to yield useful information.<sup>91</sup> This might require walking or running, or demonstrating other types of movement, in conditions that are highly conducive to recording, observation, and analysis.<sup>92</sup> Where movement is recorded, perspectives are invariably ideal.<sup>93</sup> Gait analysis is primarily diagnostic and in clinical practice is never used to assist with identification.<sup>94</sup>

Podiatrists involved in criminal investigations do not have access to the apparatus associated with the analysis of gait in clinical contexts, and are rarely supplied with high quality images taken from angles most conducive to assessing and evaluating movement (See Figure 1).<sup>95</sup> Interpretations of CCTV (and other) images are qualitative or subjective impressions often based on exposure to poor-quality, staccato recordings of short duration.<sup>96</sup> That is, “non-numerical evaluation of a movement,” performed without the favorable conditions—proximity, clarity, perspective(s), repetition, duration and feedback—available in the clinic or laboratory.<sup>97</sup>

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<sup>91</sup> *Gait and Biomechanics Laboratory*, PENN MED., <https://www.pennmedicine.org/for-patients-and-visitors/find-a-program-or-service/physical-medicine-and-rehabilitation/gait-and-biomechanics-laboratory> (last visited June 13, 2016).

<sup>92</sup> *See, e.g., id.*

<sup>93</sup> *See, e.g.,* Susan Stacpoole-Shea & Graham Shea, *Use of a Computerized Digital Camera in Podiatric Medical Practice*, 89 J. AM. PODIATRIC MED. ASS'N 131, 133–34 (1999) (describing the risks of error in using digital images in clinical practice, and explaining how to reduce that risk by camera and patient positioning).

<sup>94</sup> *See* Imed Bouchrika, Michaela Goffredo, John Carter & Mark Nixon, *On Using Gait in Forensic Biometrics*, 56 J. FORENSIC SCI. 882, 882 (2011) (“Although there is a wealth of gait studies in the literature aimed for medical use, none is concerned for the use of gait for biometrics within forensics.”). For examples of images of gait analysis, see David Levine, *A Closer Look at Case Studies in Gait Analysis*, PODIATRY TODAY (Aug. 8, 2005), <http://www.podiatrytoday.com/article/4433>; *Gait Analysis and Foot Biomechanics*, FOOT & ANKLE CENTER OF WASHINGTON, <https://www.footankle.com/biomechanics-gait-analysis/> (last visited Nov. 6, 2016); *Podiatric Gait Analysis*, PAIN FREE FEET, [http://www.painfreefeet.ca/site/ywd\\_painfreefeet/assets/pdf/Podiatric\\_GAIT\\_ANAL.pdf](http://www.painfreefeet.ca/site/ywd_painfreefeet/assets/pdf/Podiatric_GAIT_ANAL.pdf) (last visited Nov. 6, 2016).

<sup>95</sup> DIMAGGIO & VERNON, *supra* note 2, at 107–08. *See infra* p. 50 for Figure 1.

<sup>96</sup> *Id.*

<sup>97</sup> *Id.* at 107; DIMAGGIO & VERNON, *supra* note 2, at 104. *See generally* Michiel Crommelinck & Frederik Anseel, *Understanding and Encouraging Feedback-Seeking Behavior: A Literature Review*, 47 MED. EDUC. 232 (2013) (describing feedback and learning and noting that cognitive scientists include reliable feedback as an essential ingredient in the acquisition of the skills necessary to become an expert in any domain).

## D. AN EMERGING PRACTICE

Forensic podiatry emerged from the clinical discipline of podiatry.<sup>98</sup> Ostensibly, it represents an attempt to hybridize podiatric knowledge and skills with the practices and knowledge base of comparison forensics.<sup>99</sup> Authoritative bodies in these domains, such as the HCPC, the College of Podiatrists, the NBPME, the APMA, and the IAI, claim to promote scientific approaches to their respective tasks, and insist that proficiency in scientific and biomedical practice is a pre-condition to membership of their respective communities.<sup>100</sup> In addition, modern podiatry has committed itself to the tenets of evidence-based practice.<sup>101</sup> Those promoting forensic podiatry leverage these commitments in their claim to apply “sound and researched” knowledge and experience to forensic practice.<sup>102</sup> However, podiatrists are yet to adopt clear standards for certification and practice in forensics.<sup>103</sup> Moreover, the nascent community does not appear to have a clear understanding of the complexities and risks attending comparison forensics.<sup>104</sup> In the following section, we consider the extent to which the foundations of forensic podiatry actually live up to the postulated commitment to scientific principles and evidence-based practice.

II. EVIDENTIARY FOOTING: IN THE COMPANY OF PRE-SCIENTIFIC  
COMPARISON FORENSICS

Notwithstanding the espoused commitment to evidence-based practice and scientific principles, it is relatively easy to find expressions of concern about the epistemic foundations of practices associated with podiatry’s forensic expansion. In *Forensic Podiatry*, the first and only text dedicated to the subject, DiMaggio and Vernon write:

The knowledge available to podiatrists is therefore not only that with a scientific basis, but also that which can be described as ‘pre-scientific’ or that concerned with everyday practice which in podiatry may not have developed to the level expected. Given this scenario, caution is needed in the practice of forensic podiatry in order to

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<sup>98</sup> See *supra* note 6 and accompanying text.

<sup>99</sup> VERNON ET AL., *supra* note 55, at 1.

<sup>100</sup> See discussion and sources cited *supra* Part I.A., I.B.

<sup>101</sup> See Green, *supra* note 20, *passim*; STANDARDS OF PROFICIENCY, *supra* note 10, at 10.

<sup>102</sup> VERNON ET AL., *supra* note 55, at 2.

<sup>103</sup> *Id.* at 2–5 (setting out the standards that are presently applied by the IAI for membership of the Forensic Podiatry Sub-Committee).

<sup>104</sup> *Id.* at 11. See generally NAS REPORT, *supra* note 5 (discussing the complexities and risks attending comparison forensics); Saks & Koehler, *supra* note 80, at 199 (analyzing and discussing the inadequate research basis underlying claims made by traditional comparison forensics to be capable of reaching conclusions that a given mark was left by a specified individual).

ensure that the knowledge used is that which is scientific and robust and not those aspects of a podiatrist's knowledge which are tacit and also may be undeveloped.<sup>105</sup>

These comments reveal a level of awareness, among (mainly academic) podiatrists, of the limited research support underpinning some areas of podiatric practice.<sup>106</sup> The “pre-scientific” nature of this *knowledge* base is an issue of general import, but, as DiMaggio and Vernon appear to acknowledge, it has particular salience in relation to forensic podiatry, and whether forensic gait analysis is scientific and ought to be relied upon.<sup>107</sup>

DiMaggio and Vernon also draw attention to differences between the “pre-scientific,” non-propositional (or tacit) experiential and practical knowledge acquired by podiatrists in clinical settings, where feedback and diagnostic adjustments are typically available, against the need for scientific rigor in forensic practice (where correct answers and feedback are not available):

Fundamentally, although the scientific aspects of the podiatry knowledge base are used in clinical practice, in forensic podiatry work, the context of practice and the way science is used in forensic work are fundamentally different. For example, in clinical diagnosis, the propositional knowledge approach predominates, with scientific adjustments and excursions being required where that approach is not immediately successful. Conversely, in forensic practice, the approach must use the principles of applied science from the start, with there being no potential for “diagnostic” adjustments as the work progresses. *Forensic podiatry work therefore needs to be approached cautiously due to the fact that the use of science for forensic purposes requires a different overall approach than that of clinical practice.*<sup>108</sup>

DiMaggio and Vernon insist that “forensic practice must . . . be that component of their knowledge base, which can be described as scientific.”<sup>109</sup> They lament that “[f]orensic podiatry is currently practiced outside this context” but conclude that this merely affirms the need for “the approach” to “remain scientific.”<sup>110</sup>

The research base supporting the capacity of podiatric techniques to perform their intended functions is surprisingly limited. Apart from a few

<sup>105</sup> DIMAGGIO & VERNON, *supra* note 2, at 15 (citation omitted).

<sup>106</sup> See generally STEPHEN HILGARTNER, SCIENCE ON STAGE: EXPERT ADVICE AS PUBLIC DRAMA (2000) (discussing how the production of expert advice often takes place “backstage,” where uncertainties and other contingencies not usually disclosed in public are negotiated).

<sup>107</sup> DIMAGGIO & VERNON, *supra* note 2, at 15.

<sup>108</sup> *Id.* at 16 (emphasis added). Investigations and convictions do not provide credible feedback. The outcomes are not based on ground truth, even though most criminal outcomes are presumably correct. NAS REPORT, *supra* note 5, at 110 (placing emphasis on the need for validation research across the forensic sciences).

<sup>109</sup> DIMAGGIO & VERNON, *supra* note 2, at 13.

<sup>110</sup> *Id.* at 16.

preliminary and tentative studies (discussed in Part II.C), podiatrists appear to primarily rely on experience as clinical practitioners, collective participation in previous criminal investigations, and the adoption (or mimicking) of processes used by more established comparison forensics—such as those employed by latent fingerprint examiners—as sources of support for their capacity to provide reliable comparison-based evidence.<sup>111</sup>

#### A. FEET OF CLAY: FORENSIC PODIATRY’S STANDARDS OF “SCIENTIFIC PRACTICE”

Proponents of forensic podiatry repeatedly claim to have emulated the systematic methods and research base associated with scientific practice. However, their models for “scientific practice” include fields of forensic comparison that have been revealed through more rigorous research to be highly subjective and prone to error. DiMaggio and Vernon insist that forensic science:

refers not only to the typical services offered by the main forensic science providers, such as those involving toxicology, drug and document analysis, DNA, hair, fiber, footwear, tool mark, and firearms comparisons; but *also to the research that underpins the development, testing, and introduction of new forensic technology.*<sup>112</sup>

In the section from which this passage is drawn, the authors situate forensic podiatry among the comparison forensics.<sup>113</sup> In so doing, they appeal to the importance of research and testing.<sup>114</sup> Simultaneously, they invoke practices such as hair, fiber, footwear, tool mark, and firearm comparisons as part of the forensic tradition in which they locate forensic gait analysis.<sup>115</sup> The references are revealing because many comparison practices, notably around hair, fiber, bite marks, tool marks, shoe-prints, voice recordings, and bullet lead, were not historically grounded in scientific research and have been implicated in numerous wrongful convictions.<sup>116</sup>

Kagan adopts a similar posture in an article on forensic podiatry published as part of a continuing medical education program for podiatrists:

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<sup>111</sup> See *id.* at 77–101 (modeling an approach based on the ACE-V approach used by fingerprint examiners). See generally NAS REPORT, *supra* note 5, at 105–06, 139, 142–44 (describing ACE-V and criticism of its shortcomings).

<sup>112</sup> DIMAGGIO & VERNON, *supra* note 2, at 16 (emphasis added).

<sup>113</sup> *Id.*

<sup>114</sup> *Id.*

<sup>115</sup> *Id.*

<sup>116</sup> See M. Chris Fabricant & William Tucker Carrington, *The Shifted Paradigm: Forensic Science’s Overdue Evolution from Magic to Law*, 4 VA. J. CRIM. L. 1, 19–23 (forthcoming 2016); Brandon Garrett, *Judging Innocence*, 108 COLUM. L. REV. 55 (2007).

“[f]orensic science is the compilation of systematic methodologies to understand the physical world through observation and experimentation. It links people, places, and things that are involved in and with criminal activities.”<sup>117</sup> Notwithstanding the emphasis on systematic methods and empirical foundations, neither Kagan nor DiMaggio and Vernon devote significant attention to the research (or experimentation) supporting techniques relied upon by forensic podiatrists.

In the absence of relevant research, these authors recommend—though, effectively reproduce—procedures employed by latent fingerprint examiners, namely Analysis, Comparison, Evaluation, Verification and Review (i.e., ACE-V or ACE-V(R)), as the “methodological outline for the *identification process* . . . to assist the podiatrist in making and justifying decisions.”<sup>118</sup> The utility and suitability of ACE-V is supported by reference to IAI documentation and convention.<sup>119</sup> However, IAI description reveals little about how the adequacy of images should be determined, the amount of gait required, the effects of image artifacts, or the basis upon which significance can be attributed to apparent features, let alone how to actually perform any analysis, comparison, and evaluation.<sup>120</sup> We return to the ACE-V methodology in the following sub-section. For now, we note that notwithstanding its presentation as a methodology suited to forensic practice, ACE-V reveals nothing about the validity, reliability, and limitations of forensic gait analysis.

Core publications also refer to the United States Supreme Court decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,<sup>121</sup> as relevant to establishing the reliability of forensic podiatry’s methods and techniques.<sup>122</sup> However, references do not necessarily capture, or take seriously, the majority’s emphasis on validity and reliability and factors that might assist

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<sup>117</sup> Kagan, *supra* note 62, at 141–42 (emphasis added) (citing also that hair and fiber analysis as an exemplary form of forensic science).

<sup>118</sup> *Id.* at 144 (emphasis added); *see also* discussion *infra* Part II.B (describing ACE-V); DIMAGGIO & VERNON, *supra* note 2, at 21–22; NAS REPORT, *supra* note 5, at 137–45.

<sup>119</sup> VERNON ET AL., *supra* note 55, *passim* (explaining the steps involved in forensic gait analysis).

<sup>120</sup> *Id.* at 12. We might ask: what, for example, does “in-depth assessment” involve? What is “appropriate qualitative and quantitative analysis?” What does it mean to evaluate “the significance of the use of scale(s) of support for matched and unmatched features?” How does the analyst consider the significance of “apparent” differences? How does the analyst collect “observational population data?” Similarly, how does the analyst deal with clothing, carrying, shoes, surfaces, type of motion, injury, disguise, and intoxication?

<sup>121</sup> 509 U.S. 579 (1993).

<sup>122</sup> *See* DIMAGGIO & VERNON, *supra* note 2, at v; *see also* Michael Nirenberg, *Meeting a Forensic Podiatry Admissibility Challenge: A Daubert Case Study*, 61 J. FORENSIC SCI. 833, 834–35 (2015).

with their evaluation.<sup>123</sup> In *Daubert*, Justice Blackmun wrote:

Ordinarily, a key question to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested. . . . Another pertinent consideration is whether the theory or technique has been subjected to peer review and publication. . . . Additionally, in the case of a particular scientific technique, the court ordinarily should consider the known or potential rate of error . . . and the existence and maintenance of standards controlling the technique's operation. . . . Finally, "general acceptance" can yet have a bearing on the inquiry.<sup>124</sup>

In their publications, podiatrists have subtly diluted the *Daubert* factors. Justice Blackmun's question—whether a technique can be (and has been) tested—becomes, in Kagan's treatment, a principle of testability.<sup>125</sup> No caution is offered about using techniques that are testable but not yet tested.<sup>126</sup> DiMaggio and Vernon, likewise, invite forensic podiatrists to consider whether their techniques can be tested, but do not insist that they should be tested prior to forensic use.<sup>127</sup> Similarly, a "known or potential rate of error" becomes simply a "potential rate of error," with no guidance about how to determine or convey such limitations.<sup>128</sup> Kagan's insistence that "[s]tandards and controls . . . must exist and be maintained" is striking.<sup>129</sup> There is, however, no explanation of how such standards might be established and what research they ought to be based upon. DiMaggio and Vernon's recommendation that podiatrists "*find information to support* the scientific theory or method being accepted within a relevant scientific community" is internally focused and raises a significant risk of confirmation bias.<sup>130</sup> Neither Kagan nor DiMaggio and Vernon cite the IAI requirement that new techniques be validated *prior to use in casework*.<sup>131</sup> Rather, the main thrust is concerned with whether a technique might be tested.<sup>132</sup> The authors do not address the question of who bears the responsibility for undertaking testing or what kinds of uncertainties, limitations, and error rates might preclude forensic application.

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<sup>123</sup> See e.g., Nirenberg, *supra* note 122, at 836 ("[I]f a forensic podiatrist is challenged on the reliability of the scientific principles he or she has employed, it does not necessarily mean the testimony fails to meet the *Daubert* standard.").

<sup>124</sup> *Daubert*, 509 U.S. at 593–94.

<sup>125</sup> Kagan, *supra* note 62, at 147.

<sup>126</sup> *Id.* at 147–48 ("The theory or technique must be refutable, testable and falsifiable.").

<sup>127</sup> DIMAGGIO & VERNON, *supra* note 2, at 21.

<sup>128</sup> *Id.*

<sup>129</sup> Kagan, *supra* note 62, at 148.

<sup>130</sup> DIMAGGIO & VERNON, *supra* note 2, at 21 (emphasis added).

<sup>131</sup> CODE OF ETHICS, *supra* note 48, § 2.02.

<sup>132</sup> See DIMAGGIO & VERNON, *supra* note 2, at 21; Kagan, *supra* note 62, at 147–48.

Despite these shortcomings, the recitation of factors derived from *Daubert* suggests that some podiatrists accept that techniques become authentically scientific when specific tests have been performed, or to put this in more conventional scientific terms, when techniques have been formally validated.<sup>133</sup> DiMaggio and Vernon seem to anticipate that research should precede attempts to introduce forensic podiatry evidence into the courtroom.<sup>134</sup> However, in forensic practice, strict compliance is again diluted: “[i]n producing a scientifically grounded report, it is probable that references will be required. While a number of mainstream disciplines would assume that their science is accepted, because forensic podiatry is relatively new, that assumption cannot be made; therefore, the use of appropriate references should be carefully considered.”<sup>135</sup>

The authors do not explain what references or qualifications are required, why research is fundamental, or whether citation to published literature serves a purpose beyond advocating for the legitimacy of forensic podiatry.<sup>136</sup> DiMaggio and Vernon do not instruct the aspiring forensic podiatrist on how to assess the quality of research, nor do they explain how validation tests and error rates inform the process and conclusions of comparison forensics. Overall, key publications devote limited attention to the fundamental question of whether techniques employed by forensic podiatrists have actually been tested, to limitations and error rates, to the development of empirically-predicated standards, and to terms for expressing opinions.<sup>137</sup>

To be fair, DiMaggio and Vernon discuss the relative strengths and potential risks associated with some techniques. For example, in a chapter on assessment of footprints, the authors indicate that for one prominent method of measuring footprint geometry “personal experience has suggested that human error, when this approach is used manually, can create a higher level of ambiguity than” an alternative approach.<sup>138</sup> Elsewhere, they caution that assessments of foot length should be reported as approximations because the research underpinning such estimates had a

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<sup>133</sup> See DiMAGGIO & VERNON, *supra* note 2, at 21; Kagan *supra* note 62.

<sup>134</sup> DiMAGGIO & VERNON, *supra* note 2, at 15.

<sup>135</sup> *Id.* at 176–77.

<sup>136</sup> *Id.*

<sup>137</sup> President’s Council of Advisors on Sci. & Tech., Exec. Office of the President, Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Models 27 (2016) (“Without appropriate estimates of accuracy, an examiner’s statement that two samples are similar—or even indistinguishable—is scientifically meaningless: *it has no probative value*, and considerable potential for prejudicial impact.”).

<sup>138</sup> *Id.* at 60.

“small sample size and . . . wide confidence intervals.”<sup>139</sup> Attention to the quality of the research base is spasmodic; it is almost always couched as recommendation rather than an essential feature of forensic practice.

Turning to forensic gait analysis, DiMaggio and Vernon refer to “two methods,” namely qualitative and quantitative approaches.<sup>140</sup> For podiatrists, forensic gait analysis is qualitative, although these authors acknowledge ongoing attempts to develop quantitative techniques.<sup>141</sup> They characterize qualitative gait analysis as a routine skill of clinical podiatry, but caution that “subjective gait analysis . . . can be prone to error.”<sup>142</sup> In a chapter dedicated to forensic gait analysis, DiMaggio and Vernon describe a subjective process for determining whether CCTV images are of sufficient quality to form the basis for an assessment where features are analyzed, compared, and evaluated (i.e., “ACE”).<sup>143</sup> They adapt a template for “*objectively* assessing the quality of a recording” which invites the forensic podiatrist to consider the recording in terms of open scales such as “Too bright” to “Too dark” and “Very sharp” to “Very blurred.”<sup>144</sup> These are not credible standards. There are no technical specifications or benchmarks relevant to their application. Moreover, there is no guidance on how a podiatrist might determine whether images are suitable for analysis or the implications of specific features, such as “brightness,” for the strength of conclusions.<sup>145</sup> Likewise, podiatrists are enjoined to ensure that the effects of clothing and type of movement are accounted for, but no standards, criteria, or mechanisms are supplied to assist with potential distortions and corrections.<sup>146</sup> DiMaggio and Vernon offer a more technical discussion of frame rates, suggesting that a lapse of more than one second between images “*may* be unreliable.”<sup>147</sup> Although, even this advice leaves considerable room for interpretive maneuver.

Under the heading of “Cautions,” DiMaggio and Vernon observe that:

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<sup>139</sup> *Id.* at 65.

<sup>140</sup> *Id.* at 11, 103–04.

<sup>141</sup> VERNON ET AL., *supra* note 55, at 11; *see* discussion *infra* Part III.C.

<sup>142</sup> DIMAGGIO & VERNON, *supra* note 2, at 103–05.

<sup>143</sup> *Id.* at 21–22; *see* NAS REPORT, *supra* note 5 (describing the ACE-V process and explaining limitations).

<sup>144</sup> DIMAGGIO & VERNON, *supra* note 2, at 109.

<sup>145</sup> *Id.* (stating that this scale is adapted from Ivan Birch’s abstract submitted to the International Federation of Podologie (FIP) for presentation at the 2010 FIP Conference entitled, “A tool to assess the quality of CCTV material for the purpose of forensic gait analysis”); *see also* Kagan, *supra* note 62, at 147 (“CCTV images contain variables that need to be taken into account.”); Part II.D, *infra*.

<sup>146</sup> DIMAGGIO & VERNON, *supra* note 2, at 109–10.

<sup>147</sup> *Id.* at 110 (emphasis added).

*The forensic podiatrist should not extend the opinion expressed in their reports beyond the point at which any competent forensic podiatrist would agree with their findings.* Here, the only safe way to practice forensic gait analysis is to adhere to agreed levels of understanding. Podiatric gait analysis has an abundance of competing ‘theories’ and differences of opinion, few of which are truly research based. As with all areas of forensic expertise, the forensic podiatrist should confine the opinion within their reports to the facts, which by definition will be that level which is at that moment beyond dispute. This would avoid adopting any of the debated and disputed podiatric biomechanical theories, which are yet to be validated. It is, however, also important to note that when acting as an expert witness in court, any expert witness can be asked to give an opinion based on their expertise and experience. The point being made here, however, is that when reporting a case, this report should be mindful of the scientific basis of the profession.<sup>148</sup>

This passage is a revealing mix of parts. While offering a clear directive—that forensic gait analysis should be carefully based on shared standards—the authors do not identify what knowledge or approaches should be used by “any competent forensic podiatrist.”<sup>149</sup> Rather, the grounds for expressing an opinion are, as the first sentence makes clear, tautological. Podiatrists, we are told, should only do what a competent forensic podiatrist would do.<sup>150</sup> While validation is invoked as a relevant barometer of a technique’s value, no validation studies are cited.<sup>151</sup> Likewise, no citations are offered to a reader who might be interested in identifying the debates and differences of opinion to which the authors allude.<sup>152</sup>

In summary, neither an aspiring forensic podiatrist who reads Kagan or DiMaggio and Vernon or the IAI website, nor a legal actor interested in learning about the state of research supporting forensic gait analysis is offered clear guidance in these foundational sources. In the absence of such guidance, we turn in the next section to authoritative reports issued by the

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<sup>148</sup> *Id.* at 114 (emphasis in original). This advice may be inappropriate in some jurisdictions. In most Australian states, for example, those presenting opinions that are scientific or technical should not base their opinions on their experience. Rather, there is a need for the “expert” to identify the “specialised knowledge” on which the opinions is “wholly or substantially” based. See *Dasreef Pty Ltd. v Hawchar* (2011) 243 CLR 588, 605 (Austl.); *HG v The Queen* (1999) 197 CLR 414, 429 (Austl.).

<sup>149</sup> DIMAGGIO & VERNON, *supra* note 2, at 114 (emphasis in original).

<sup>150</sup> *Id.*

<sup>151</sup> *Id.*

<sup>152</sup> *Id.* (drawing a distinction between a report, in which a podiatrist should express him or herself cautiously, and testimony, in which they seem to allow for more leeway to express “an opinion” though this distinction does not conform to any legal rule). See generally EMMA CUNLIFFE, *THE ETHICS OF EXPERT EVIDENCE* 1–18 (Tom D. Campbell ed., 2016) (arguing that expert witnesses have a duty to articulate the nature of controversy and the sources of disagreement with respect to an opinion offered by any means to a court).

NAS and NIST regarding comparison-based forensic sciences. In the following section, we draw on the principles emerging from these reports when reviewing the available evidence for forensic podiatry.

#### B. SOUND FOOTING: THE MINIMUM REQUIREMENTS FOR FORENSIC SCIENCES

In order to assess *forensic podiatry* and its approach to comparison and identification, we draw upon the findings of a seminal review of the forensic sciences in the United States conducted under the auspices of the NAS. In a detailed assessment of comparison and pattern recognition techniques—that is, latent fingerprint evidence, blood spatter, comparisons based on hair and fibers, voices, bite marks, documents and handwriting, tires and shoes, and so on—an eminent multi-disciplinary committee produced the following conclusion:

With the exception of nuclear DNA analysis . . . no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source. . . . The simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity. *This is a serious problem.*<sup>153</sup>

These comments are directed at the very techniques upon which podiatrists have modeled forensic gait analysis.<sup>154</sup> Although forensic gait analysis was not before the committee responsible for the NAS Report, in the absence of evidence to the contrary, these sentiments would seem to apply to comparison and pattern recognition activities undertaken by those presenting themselves as forensic podiatrists.

Comments by a co-chair of the committee responsible for the NAS Report provide some insight into these findings.

Not only were we trying to understand how the forensic science disciplines operate, we were also trying to determine the extent to which there is any peer-reviewed, scientific research to support the validity and reliability of existing forensic disciplines; in particular, we were looking for scientific studies that address the level of accuracy of forensic disciplines that rely on subjective assessments of matching characteristics. We invited experts in each discipline to refer us to any such research; however, apart from the materials on nuclear and mitochondrial DNA and drug analysis, we received little in the way of compelling scientific research assessing the accuracy of forensic science disciplines.<sup>155</sup>

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<sup>153</sup> NAS REPORT, *supra* note 5, at 7–8 (emphasis added).

<sup>154</sup> See DiMAGGIO & VERNON, *supra* note 2, at 16; Kagan, *supra* note 3, at 142.

<sup>155</sup> Harry T. Edwards, Solving the Problems that Plague the Forensic Science Community, Keynote Address to the Conference on Forensic Science for the 21st Century:

The NAS Report recommended that validation studies and proficiency tests be undertaken for all types of comparison forensics in order to determine and disclose uncertainties, limitations, and error rates as well as develop empirically-based standards and expressions.<sup>156</sup> Building upon these insights, a key purpose of this article is to investigate whether forensic gait analysis—a technique that emerged parallel to the concerns leading to the NAS inquiry and has been represented as authentically scientific in its aftermath—satisfies the type of epistemic foundations outlined by Judge Edwards and the NAS. To the extent that forensic gait analysis has not met these expectations, we are interested in how courts have responded to the shortfall.

The NAS was critical of many of the conventional methods, practices, and assumptions underpinning comparison forensics.<sup>157</sup> Even widespread reliance on ACE-V was not immune from criticism.<sup>158</sup> The NAS Report explains that:

ACE-V provides a broadly stated framework for conducting friction ridge analyses [i.e., fingerprint comparison].<sup>159</sup> However, this framework is not specific enough to qualify as a validated method for this type of analysis. ACE-V does not guard against bias; is too broad to ensure repeatability and transparency; and does not guarantee that two analysts following it will obtain the same results. For these reasons, merely following the steps of ACE-V does not imply that one is proceeding in a scientific manner or producing reliable results.<sup>160</sup>

Moreover, the NAS Report and another report prepared by the NIST criticized the identification paradigm and recommended that fingerprint examiners—who developed ACE-V—not equate matches with positive identification.<sup>161</sup> These criticisms and limitations are not disclosed or even referenced by podiatrists.

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The National Academy of Sciences Report and Beyond (April 3, 2009), in 50 JURIMETRICS J. 5, 6 (2009)

<sup>156</sup> See Jennifer Mnookin et al., *The Need for a Research Culture in the Forensic Sciences*, 58 UCLA L. REV. 725, 732–41, 744–60 (2011) (discussing the National Research Council’s conclusions, recommendations and their implications for comparison-based forensic sciences). See generally David A. Harris, FAILED EVIDENCE: WHY LAW ENFORCEMENT RESISTS SCIENCE 78–127 (2012) (reviewing cognitive, social and institutional impediments to police engagement with scientific research and methods).

<sup>157</sup> NAS REPORT, *supra* note 5, at 7–8, 42–44.

<sup>158</sup> *Id.* at 137–45.

<sup>159</sup> *Id.* at 137 (stating that ACE-V, which stands for “Analysis, Comparison, Evaluation, and Verification,” is the dominant friction ridge “method”).

<sup>160</sup> *Id.*; see NIST REPORT, *supra* note 5, at 39 (stating that the “focus on ACE-V is not intended as an endorsement of ACE-V as a ‘methodology’”).

<sup>161</sup> See NAS REPORT, *supra* note 5, at 7, 87, 100; NIST REPORT, *supra* note 5, at 72 (creating Recommendation 3.7).

The NAS Report also recommended studying and eliminating threats to cognition.<sup>162</sup> Numerous studies in the forensic sciences (and biomedicine) document that many procedures, especially those involving difficult interpretations, are vulnerable to cognitive biases—e.g., suggestion, anchoring and confirmation.<sup>163</sup> These threats to cognition and accuracy cannot be overcome through awareness of the problem, critical thinking, or training and experience. Rather, there is a need to develop procedural mechanisms to address potentially insidious “human factors.”<sup>164</sup> Yet, most podiatrists involved in forensic gait comparison undertake their analyses in conditions that are highly suggestive and insensitive to risks that are notorious in other areas of biomedicine, science, and some forensic disciplines.

Podiatrists enlisted in criminal investigations are routinely presented with only one, and at best, perhaps a few, reference images (or videos) to compare with the POI.<sup>165</sup> In most cases podiatrists are provided with information about the case and a particular suspect that is highly suggestive (e.g., admissions, prior misconduct, or investigator beliefs about identity) and potentially prejudicial, though with no relevance to gait or comparative analysis.<sup>166</sup> Furthermore, the CCTV images used by podiatrists include information beyond gait, such as clothing, vehicles, locations, associates, and anti-social behavior, that might influence interpretations, whether consciously or unconsciously.<sup>167</sup> To the extent that there is any review (i.e.,

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<sup>162</sup> NAS REPORT, *supra* note 5, at 122–24.

<sup>163</sup> See e.g., 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, 78–87 (2003). See generally INST. OF MED., TO ERR IS HUMAN: BUILDING A SAFER HEALTH SYSTEM (Linda T. Kohn, Janet M. Corrigan & Molla S. Donaldson eds., 1999).

<sup>164</sup> Itiel Dror & Simon Cole, *The Vision in “Blind Justice”: Expert Perception, Judgment, and Visual Cognition in Forensic Pattern Recognition*, 17 PSYCHONOMIC BULLETIN & REV. 161, 161–67 (2010) (concluding that “[r]esearch shows that various factors affect the perception and comparison of fingerprint patterns and that judgments and decisions are subjective and susceptible to influences”); NIST REPORT, *supra* note 5, at 22–24, 43–44; NAS REPORT, *supra* note 5, at 24, 122–24 (pointing out numerous sources of human bias).

<sup>165</sup> This occurred in the appeals reviewed in Part IV, *infra*. Additional images are occasionally presented to podiatrists, though this usually occurs when police are investigating groups, such as where there has been a joint robbery or assault. Investigators tend to supply images of suspects, and so podiatrists are not presented with images of suspects and potential foils. Mistaken “identifications” are likely to implicate persons who are already suspects or otherwise known to investigators.

<sup>166</sup> See e.g., Emma Cunliffe & Gary Edmond, *Gaitkeeping in Canada: Mis-steps in Assessing the Reliability of Expert Evidence*, 92 CANADIAN BAR REV. 327, 366–67 (2014).

<sup>167</sup> See *id.* There is a danger that some of these, such as clothing similar to that

the “V” and “R” in ACE-V(R)) of interpretations and conclusions, it tends to be conducted in circumstances where the earlier findings are disclosed to those purporting to review them.<sup>168</sup>

The podiatric literature we have so far discussed does not refer to the NAS and NIST reports, and the variety of destabilizing epistemological issues leading to the inquiries and ventilated in the reports.<sup>169</sup> These lacunae suggest major shortcomings in the community’s awareness of risks involved in comparison forensics that extend well beyond the (mis)use of terminology. Our concern about this lack of scientific awareness is heightened by the fact that foundational texts invoke discredited practices—such as those used in traditional hair, fiber, and bite mark analysis—known for more than a decade to be implicated in large numbers of wrongful convictions. The literature produced by podiatrists identifies factors such as validation tests and the determination of error rates, where they discuss them, as aspirational targets for future development, rather than as pre-conditions to the formation of a scientific practice or participation in criminal investigations and prosecutions.<sup>170</sup> We believe that the failure to assimilate insights from authoritative scientific bodies should threaten, and perhaps disqualify, the admissibility of opinions derived through forensic gait analysis.

### C. LEARN TO CRAWL BEFORE YOU CAN . . . : THE EVIDENCE BASE FOR FORENSIC GAIT ANALYSIS

Revealingly, the small body of research literature that is available does

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recovered, may influence the podiatrist’s interpretation even though they have no obvious relationship with forensic gait analysis (and may be treated as an independent strands of evidence in investigations and prosecutions). *See also* EMMA CUNLIFFE, MURDER, MEDICINE AND MOTHERHOOD 198–201, 206–07 (2011).

<sup>168</sup> *See* Cunliffe & Edmond, *supra* note 166; *see also* PRESIDENT’S COUNCIL OF ADVISORS ON SCI. & TECH., *supra* note 137, at 89–90.

<sup>169</sup> *See generally* D. Michael Risinger, Mark P. Denbeaux & Michael J. Saks, *Exorcism of Ignorance as a Proxy for Rational Knowledge: The Lesson of Handwriting “Expertise,”* 137 U. PA. L. REV. 731, 731–35 (1989) (demonstrating that expert witnesses who claimed to be capable of handwriting identification never subjected that claim to empirical testing, and courts did not require this testing); Michael Saks & Jonathan J. Koehler, *The Coming Paradigm Shift in Forensic Identification Science*, 309 SCI. 892, 892–95 (2005) (showing that even though the NAS Report post-dates some of the articles we discuss, the report was published in 2009, two years before the publication of DiMaggio and Vernon’s *Forensic Podiatry* and that most of the issues considered by the NAS report had been identified in the decades leading up to the inquiry and issuing of the report); Saks et al., *supra* note 163, 83–87 (tracing potential sources of context effects in forensic science).

<sup>170</sup> *See, e.g.,* DIMAGGIO & VERNON, *supra* note 2, at 114.

not uniformly support the posited abilities of podiatrists.<sup>171</sup> The few studies do not confirm that so-called forensic podiatrists are able to do what has been claimed or even demonstrate a level of performance substantially better than ordinary persons. By way of example, Bodziak et al. recently summarized “the studies” in relation to footwear analysis as not providing “support for the identification of shoe impressions based on general wear alone.”<sup>172</sup> Against expectations, this research concluded that it is not always possible to determine who wore a shoe based on the way the inner and outer shoe deteriorate.<sup>173</sup>

Vernon characterizes wear impressions “including foot impressions formed on the shoe insole/sock liner” as “one particular strength of forensic podiatrists.”<sup>174</sup> Noting that the “supportive evidence is,” however, “somewhat limited,” he continues:

Although many podiatrists use shoe wear features within their clinical examinations, this knowledge has tended to be of the tacit intuitive type of professional understanding as opposed to comprehensively researched propositional knowledge. Research on forensic podiatry aspects of shoe wear has been limited in more recent times to consideration of the shoe outsole wear. Ironically, this research has done more to limit the use of outsole wear in identification through showing its limitations . . . .<sup>175</sup>

Where Vernon invokes irony, we observe a validation study operating precisely as intended—to disclose areas in which experience and claimed expertise might not translate into heightened abilities and accurate performance. The results are revealing because they might be considered counterintuitive. These are, after all, some of the capabilities that podiatrists had aggregated to themselves and, by and large, seem to have been accepted as reasonable by podiatrists and others (such as the IAI).

When it comes to forensic gait analysis, experimental support is also limited. Putting aside the hyperbole, and notwithstanding the continuing use of forensic gait analysis in investigations and prosecutions, the authors of an article published in 2013 observed that “[d]espite the increasing use of this strategy, there remains a lack of substantive scientific evidence to support the notion that gait can be used as a means of identification.”<sup>176</sup>

<sup>171</sup> See, e.g., Birch et al., *supra* note 79, at 340; Bodziak et al., *supra* note 82, at 261.

<sup>172</sup> Bodziak et al., *supra* note 82, at 261.

<sup>173</sup> Vernon, *supra* note 54, at 66; see *R. v. Dimitrov*, (2003) 181 C.C.C. 554 (Can. Ont. C.A.), para. 33 (a Canadian case discussing how a police expert testified that it was “likely” that the accused had worn a given pair of boots, but he could not exclude the possibility that someone else had worn them).

<sup>174</sup> Vernon, *supra* note 54, at 65.

<sup>175</sup> *Id.* (internal citations omitted).

<sup>176</sup> Birch et al., *supra* note 79, at 339.

Recognizing that “aspects of CCTV footage, including frame rate, resolution, and positioning of the CCTV camera . . . are likely to affect the usefulness of the footage in visual gait analysis” the authors noted that “little research has been conducted into the confounding effects of these factors.”<sup>177</sup> Lack of research and corresponding standards appear indirectly in the recognition that “it is *generally agreed* that comparative analysis is hampered if the recorded footage has been filmed from a less than ideal recording angle.”<sup>178</sup>

Aiming to provide support for forensic gait analysis, consultant Birch and colleagues tested seven “experienced analysts” by asking them to compare video of a “target” walker with video of five suspects.<sup>179</sup> All of the walkers were selected because they showed “obvious pathological gait.”<sup>180</sup> The study tended to downplay the small sample size, the lack of a genuine comparator group (i.e., whether podiatrists are more accurate than laypersons), the high quality of the images, and reliance on information extending well beyond the feet and legs (such as upper body movement).<sup>181</sup> The number of correct determinations of a match (at 71%)<sup>182</sup> was described as unambiguous confirmation of ability, probative value, and utility.<sup>183</sup> The rate of false positives, based on a very small sample size (n=35) of non-matching comparators in which the target was of a different gender from the suspect, was six percent.<sup>184</sup> Curiously, in light of podiatrists’ training and professional boundaries, this study suggested that upper body movements were more useful for discriminating between individuals than the movement of feet and legs.<sup>185</sup>

Notwithstanding the modest scale of the study and level of performance, the article summarizes the results in a manner designed to advance the cause of forensic podiatry: “individuals with experience in gait

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<sup>177</sup> *Id.*

<sup>178</sup> *Id.* at 339–40 (emphasis added).

<sup>179</sup> *Id.*

<sup>180</sup> The analysts had backgrounds in podiatry, physiotherapy, and biomechanics. *Id.* at 340.

<sup>181</sup> *Id.* at 341–42 tbl.3.

<sup>182</sup> *Id.* at 339.

<sup>183</sup> *Id.* at 340 (stating that some evidence was presented for the proposition that experience improves performance) (citing Sarah V. Stevenage, Mark S. Nixon & Kate Vince, *Visual Analysis of Gait as a Cue to Identity*, 13 APPLIED COGNITIVE PSYCHOL. 513–26 (1999)). *But see* David White et al., ‘Passport Officers’ Errors in Face Matching, 9 PLoS ONE 1, 2 (2014) (cautioning against linking experience, including long experience, with ability).

<sup>184</sup> Birch et al., *supra* note 79, at 340.

<sup>185</sup> *Id.*

analysis perform well in the comparative identification of suspects from CCTV footage, and therefore do have a role to play as expert witnesses in this field.”<sup>186</sup> Two additional studies suggest that in some conditions, podiatrists had a success rate of between 85% and 97%. These studies were undertaken about two decades ago, and “because of the basic nature of these studies in conjunction with the non-existent follow-up for further development purposes, the technique can still be seen as being in its’ infancy.”<sup>187</sup> The small sample size was inoculated through the “need” to “be considered in the context of the numbers [of] experienced gait analysts.”<sup>188</sup> It is not clear that these limited studies shed much light on actual abilities, especially in forensic contexts. Moreover, the experimental task seems to have provided quite a bit of anatomical information that the analysts were asked to disregard.<sup>189</sup>

Another study, which looked at the impact of frame rate on gait comparison, also by Birch, found that “short and rapid events during the gait cycle are impossible to detect with any reliability at low frame rates, the movements potentially occurring between frames. The lower the frame rate the fewer events will be reliably detectable.”<sup>190</sup> At their highest, these studies might be read to suggest that in favorable conditions (where recordings are of pathological gait and include upper body movement), podiatrists perform better than chance when asked to link a gait cycle (or part thereof) to a person from a limited set of candidates. Though, even in these conditions the error rate is around one in three (false negatives) and one in seventeen (false positives). The studies do not directly compare the performance of podiatrists with the performance of laypersons (or others, such as anatomists or orthopedic surgeons). Consequently, we do not know if podiatrists perform better than these others and whether their impressions will actually assist law enforcement and courts (and ought to be admitted and relied upon in criminal proceedings).<sup>191</sup>

One additional dimension of comparisons forensics, applicable to

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<sup>186</sup> *Id.* at 339, 341.

<sup>187</sup> Vernon, *supra* note 54, at 62.

<sup>188</sup> Birch et al., *supra* note 79, at 339, 341.

<sup>189</sup> *Id.* at 340; *see* Vernon, *supra* note 54, at 62.

<sup>190</sup> Birch et al., *supra* note 79, at 163.

<sup>191</sup> *See* Peter K. Larsen, Erik B. Simonsen & Niels Lynnerup, *Gait Analysis in Forensic Medicine*, 53 J. FORENSIC SCI. 1149, 1149–53 (2008) (attempting to systematize the process of comparing gait features); NAS REPORT, *supra* note 5, at 142–45. However, as with ACE-V, this process might help an analyst to work systematically but it offers no insight into interpretations of the images and, correspondingly, no guarantee that conclusions will be accurate. Such checklists might prove helpful, but they cannot substitute for validation testing and indicative error rates.

forensic gait analysis and occasionally referenced in the literature, is the need for information about the frequency or prevalence of gait features (and their interdependence) in order to attach significance to features apparently shared across crime-related and reference images: “[f]orensic gait analysis as currently practiced by podiatrists is the recognition and comparison of particular forms or classes of gait, or of different class characteristics of the components of gait, using known prevalence data to show how distinct the recognized features would be in the population.”<sup>192</sup> While commentators have recognized this issue, there have been few attempts to assemble databases with information about the distribution of gait features and pathologies or to provide insight into the practical implications of not having access to such databases.<sup>193</sup> Consequently, there is no explanation of how podiatrists move from allegedly discerning features of gait (e.g., abduction) in low quality images to attaching evidentiary significance to those features.

DiMaggio and Vernon acknowledge the lack of information on the frequency of features and pathologies, noting that this may require additional work for podiatrists if they intend to produce a numerical conclusion.<sup>194</sup> Though not addressed, the same concerns apply to non-numerical expressions of the strength of the evidence.<sup>195</sup> In all attempts to attribute significance to apparent similarities, there are, whether made explicit or not, assumptions about the independence and frequency of gait features. There is a need to know about the distribution of, and relationships between, features in order to attribute a number (i.e., quantitative) or form of words (i.e., qualitative) designed to convey probative value when two things are said to be similar.<sup>196</sup>

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<sup>192</sup> DIMAGGIO & VERNON, *supra* note 2, at 106, 113 (stating it may be that the use of “would be” disguises the lack of information about prevalence; one early reference to gait analysis suggested that the “bow-legged” “style of gait” of the offender was “estimated” to be exhibited in “only 5% of the population”); *see* Vernon, *supra* note 54, at 65.

<sup>193</sup> DIMAGGIO & VERNON, *supra* note 2, at 106. Indeed English law has not required an actual database, merely disclosure that no database is available. This is exemplified in the English case of *R v. Atkins and Atkins*, 1 Cr. App. R. 8 (2010) (Eng.), [22]–[23.]

<sup>194</sup> DIMAGGIO & VERNON, *supra* note 2, at 113.

<sup>195</sup> *See generally* Saul M. Kassim et al., *The Forensic Confirmation Bias: Problems, Perspectives, And Proposed Solutions*, 2 J. APPLIED RES. MEMORY & COGNITION 42 (2013); Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics And Biases*, 185 SCI. 1124 (1974) (discussing cognitive processes and noting that the ease with which a person can bring to mind instances of an event might affect their estimates of actual occurrence).

<sup>196</sup> NAS REPORT, *supra* note 5, at 24, 144. Lack of information about performance leads to guessing. Podiatrists might claim that guesses are based on their clinical experience, but there is no evidence that podiatrists (or any other forensic scientists) have accurate recall of

These problems are compounded by the lack of standards around image quality and interpretation. DiMaggio and Vernon state that “care is required in determining whether the images allow such comparisons to be made,” that CCTV image “variables” should be “taken into account” and that there is a need “to determine whether or not the images are of sufficient quality to allow meaningful analysis.”<sup>197</sup> As foreshadowed above, no research seems to have been conducted to determine minimum standards, and no such standards have been promulgated. Instead podiatrists are admonished to be careful without being given clear guidance about what the dangers are, and what measures they should take to avoid them.<sup>198</sup>

There are no available studies that address the central issue of whether podiatrists are capable of interpreting low quality images in order to identify actual gait features. No studies address the basis on which podiatrists move from apparent similarities in observed gait features to a conclusion of their significance based on frequency in relevant populations.

In the absence of appropriate validation, case reports have assumed a prominent position within the published literature on forensic gait analysis.<sup>199</sup> Within evidence-based medicine, such reports provide the lowest “level” of evidentiary support, where levels indicate the “degree” to which a “study can be trusted.”<sup>200</sup> Case reports do not offer evidence of validity, reliability, or proficiency, and at most demonstrate the circumstances in which podiatrists have been willing to testify and courts have proven willing to listen. By definition, it is not possible to know whether a forensic podiatrist’s conclusion in a given case aligns with ground truth. Nonetheless, in testimony and in publications, these anecdotal accounts have been relied upon as evidence of the capabilities, inherent reliability for forensic applications, and legal admissibility of the opinions of podiatrists.

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the prevalence of features they encounter in practice. This applies to ballistic and fingerprint examiners. The difficulty might be accentuated for podiatrists because their clinical practice is exclusively focused on those with abnormal gait and medical conditions of the lower limbs. It is unclear on what basis they could extrapolate from this population to a normal distribution.

<sup>197</sup> DIMAGGIO & VERNON, *supra* note 2, at 107–08.

<sup>198</sup> *Id.* at 15; Kagan, *supra* note 62, at 146, 148.

<sup>199</sup> Case reports tend to be descriptions of “successful” involvement (i.e., convictions) in individual cases. See e.g., Niels Lynnerup & Jens Vedel, *Person Identification by Gait Analysis and Photogrammetry*, 50 J. FORENSIC SCI. 1–7 (2005); Michael S. Nirenberg, *Forensic Methods and the Podiatric Physician*, 79 J. AM. PODIATRIC MED. ASS’N 247–53 (1989); DIMAGGIO & VERNON, *supra* note 2, at 137–66; Larsen et al., *supra* note 191, at 1149–53.

<sup>200</sup> TRISHA GREENHALGH, *HOW TO READ A PAPER: THE BASICS OF EVIDENCE-BASED MEDICINE* 17–18 (5th ed. 2014).

## D. FOOT IN MOUTH: EXPRESSIONS AND CONCLUSIONS

Because their involvement in criminal investigations and prosecutions is primarily linked to questions of identity, the way podiatrists use terms such as “identification,” “class and individual characteristics,” and “unique” is important.

Physical evidence can express different levels of individuality; from those features that a large proportion of the population demonstrates, and from those features that the probability of a chance match is so remote as to be considered impossible. Class level characteristics are not unique but demonstrate incontrovertible compatibility between similar items, i.e. bunions, hammertoes. There is no evidence considered and utilized by forensic podiatrists that has been demonstrated to exhibit unique individual identification; however, the evidential weight of evidence differs considerably. . . . The individuality of the features is determined by considering the prevalence in the population.<sup>201</sup>

Yet, podiatrists share many of the commitments of other pre-scientific comparison forensics built around individuality and uniqueness. They tend to assume that gait, footprints, and the way feet interact with shoes are unique or produce unique results.<sup>202</sup> Many podiatrists, including leaders, exhibit a tendency to use “unique” and “identification” in potentially misleading ways.<sup>203</sup> For example, when discussing wear and marks on the outsoles of shoes, Vernon suggests that accidental and randomly formed patterns are “unique and these are therefore extremely powerful sources of evidence.”<sup>204</sup> Here, unique is formally defined to mean a “feature or features . . . so individual that they represent the only example anywhere in the natural world.”<sup>205</sup>

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<sup>201</sup> Kagan, *supra* note 62, at 146 (citing DIMAGGIO & VERNON, FORENSIC PODIATRY: METHOD AND PRINCIPLES 19, 20, 35, 103, 169–171, 172–73 (2011)).

<sup>202</sup> DIMAGGIO & VERNON, *supra* note 2, at 132–33; VERNON ET AL., *supra* note 55, at 7, 9, 11.

<sup>203</sup> See VERNON ET AL., *supra* note 55; see also DIMAGGIO & VERNON, *supra* note 2, at 18–19 (“[S]uch characteristics are as unique as it is possible to be within the natural world.”); Bodziak et al., *supra* note 82, at 255 (using a concept of “sufficient uniqueness”); Bouchrika et al., *supra* note 94, at 882, 884 (“[G]ait is unique for every subject if all gait movements are considered”) (citing M. Pat Murray, A. Bernard Drought & Ross C. Kory, *Walking Patterns of Normal Men*, 46 J. BONE & JOINT SURGERY 335–60 (1964)); Larsen et al., *supra* note 191, at 1150 (“[T]hese methods did not constitute identification on the same level of certainty as, say, DNA typing or fingerprinting”).

<sup>204</sup> DIMAGGIO & VERNON, *supra* note 2, at 78.

<sup>205</sup> *Id.* The issue of uniqueness can be distracting. Like latent fingerprint examiners, podiatrists have a strong commitment to “uniqueness.” The issue, however, is not whether gait is (or friction ridges are) unique. This is not susceptible to proof. Rather, the fundamental issue is whether podiatrists can reliably distinguish between gait produced by different people and determine when gait is made by the same person, or similar to gait where the frequency of features is known. For latent fingerprint examiners there is a need to

The IAI's articulation of forensic podiatry's scope of practice suggests that forensic podiatry is capable of "the identification of perpetrators of crime."<sup>206</sup> One could infer from this statement a claim that the techniques of forensic podiatry are capable of individualization in the sense of person recognition. However, in "Role and Scope of Practice," the Forensic Podiatry Sub-Committee appears to adopt a different usage of "identification," at least for the purposes of forensic gait analysis. In a footnote, it states "[i]dentification in this context [i.e., forensic gait analysis] is used in the common sense of the meaning, namely that defined in the Oxford English Dictionary as "sharing characteristics with another person."<sup>207</sup> It appears from this footnote that podiatrists (sometimes) use the term "identification" to mean something less than person recognition or individualization.<sup>208</sup> This represents an important caveat on the claims made by this community outside the courtroom. The proposition that the stipulated meaning constitutes the "common sense" of identification is at the very least controvertible.<sup>209</sup> Inconsistent use suggests, at best, a naivety about legal usage and about the dangers of miscommunication.<sup>210</sup> A recent report on eyewitness identification evidence, by the NAS (U.S.) stipulated,

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be able to reliably distinguish between prints left by different fingers and prints left by the same finger. In both domains, dangers arise where very similar gait or prints are produced by different persons. NAS REPORT, *supra* note 5, at 43.

<sup>206</sup> See *Forensic Podiatry FAQs*, INT'L ASS'N FOR IDENTIFICATION, <https://theiai.org/disciplines/podiatry/faq.php> (last visited June 13, 2016); see also *Identification*, OXFORD ENGLISH DICTIONARY ONLINE, <http://www.oed.com/view/Entry/90995?%20redirectedFrom=identification> (last visited July 8, 2015) (defining "identification" in the following ways: "(1) The action or process of regarding or treating one thing as identical *with* another, or two or more things as identical with one another; the fact of being identical. . . . (2) The determination of identity; the action or process of determining what a thing is or who a person is; discovery and recognition. . . . [a]lso: an instance or result of this. . . . (5) Documentary or symbolic means of proving one's identity or credentials; something such as a passport, driving licence, health card, disc, badge, or mark that can be used to establish identity"); VERNON ET AL., *supra* note 55, at 6 ("Barefoot prints can be associated with scenes of a crime creating the potential to link such footprints with the perpetrator of that crime.").

<sup>207</sup> VERNON ET AL., *supra* note 55, at 11 n.8. While the version of the OED that we consulted does not include this definition, we accept that another edition may well include this language. (No further citation is given.). See Larsen et al., *supra* note 191, at 1150 ("[T]hese methods did not constitute identification on the same level of certainty as, say, DNA typing or fingerprinting.").

<sup>208</sup> VERNON ET AL., *supra* note 55, at 11.

<sup>209</sup> *Id.* at 11.

<sup>210</sup> See STEPHEN T. GOUDGE, FINAL REPORT OF THE INQUIRY INTO PEDIATRIC FORENSIC PATHOLOGY SERVICES IN ONTARIO 433–35 (2008) (suggesting that pathologists should avoid misleading language).

“the term *identification* denotes person recognition.”<sup>211</sup>

Significantly, the opinions of podiatrists are not necessarily qualified in reports and oral testimony. There is, notwithstanding some qualifications in published texts, often slippage in the use and intended meaning in expert reports and oral testimony.<sup>212</sup> In criminal proceedings, sloppy or inconsistent usage seems likely to mislead judges and juries who ordinarily work with a concept of identification much closer to that given by the NAS.<sup>213</sup>

Nevertheless, several of the podiatrists championing forensic podiatry do seem ambivalent about the “identification paradigm” and, as the extract at the beginning on this sub-section implies, appear reluctant to identify an individual (to the exclusion of all others).<sup>214</sup> This reticence may be attributable to the pre-eminence of DNA profiling, the validation of its procedures, and reliance of probabilities derived from databases (informed by population genetics).<sup>215</sup> The differences between DNA profiling and forensic gait analysis are striking in terms of sophistication, and yet, forensic biologists have been unwilling to use the language of identification.<sup>216</sup> Unlike a person’s DNA and fingerprints, gait is not stable over time and space and can easily be disguised, and the way images are collected, stored and replayed, may change appearances.<sup>217</sup> Reliance on gait and images introduces problems that do not confront DNA profiling and much latent fingerprint comparison.<sup>218</sup> This makes probabilistic

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<sup>211</sup> NAT’L RES. COUNCIL, IDENTIFYING THE CULPRIT: ASSESSING EYEWITNESS IDENTIFICATION, 1 n.1 (2014) (emphasis in original).

<sup>212</sup> See, e.g., Cunliffe & Edmond, *supra* note 166, at 335–36.

<sup>213</sup> NAT’L RES. COUNCIL, *supra* note 211, at 1.

<sup>214</sup> Kagan, *supra* note 62 at 141, 146; see also DIMAGGIO & VERNON, *supra* note 2, at 19.

<sup>215</sup> See NAS REPORT, *supra* note 5, at 7. See generally DAVID H. KAYE, THE DOUBLE HELIX AND THE LAW OF EVIDENCE 98–104 (2010) (This ambivalence appears to inform thinking and practice, though it is unclear whether the reticence it engendered came from insights into the mixed experiences of facial mapping witnesses, recommendations by forensic science groups (such as the FSS, but not the IAI), some awareness of criticisms of the identification paradigm flowing from the NAS Report, sensitivity to the probabilistic approaches associated with DNA evidence, an awareness of epistemic limitations or some combination of all of these.); NAT’L RES. COUNCIL, THE EVALUATION OF FORENSIC DNA EVIDENCE (1996); NAT’L RES. COUNCIL, DNA TECHNOLOGY IN FORENSIC SCIENCE (1992).

<sup>216</sup> NAS REPORT, *supra* note 5, at 87, 101, 121.

<sup>217</sup> Cunliffe & Edmond, *supra* note 166, at 363–67.

<sup>218</sup> But see Larsen et al., *supra* note 191, at 1152 (“[I]t is at present difficult to improve the analysis with quantifiable measures because the quality of the surveillance material is normally too low to measure. . . . Furthermore, we do not find it possible to identify a perpetrator positively based on analyses of images because we cannot state—to the point of exclusion—in court that no other person could have the same gait pattern based on a given

approaches to forensic gait analysis little more than a remote aspiration and introduces difficult questions about validity and reliability, standards, performance, and how podiatrists should express their impressions.

Revealingly, proponents of forensic podiatry have been insufficiently attentive to notorious problems with “the identification paradigm” and related expressions.<sup>219</sup> Whereas leaders such as DiMaggio, Vernon, and Kagan claim to be pursuing scientific forensic podiatry, the comparison techniques employed by those acting as forensic podiatrists appear primarily to consist of non-reflexive adaptations of the processes used by latent fingerprint analysts and others—albeit applied in conditions that are more complex than most DNA and latent fingerprint comparisons.

In this vein, podiatrists have persisted with ACE-V(R) despite authoritative criticisms and limitations notorious among forensic scientists, and seemingly oblivious to the fingerprint community’s (uneven and incomplete) evolution towards a more scientific approach.<sup>220</sup> Rather than engage with the insights and experience obtained through the refinement of DNA profiling evidence and the probabilistic forms in which that evidence is expressed, those purporting to be forensic podiatrists have largely embraced the techniques and attitudes of pre-scientific forensic sciences questioned by the NAS. The main distinction is some formal ambivalence about positive identification.<sup>221</sup> Notwithstanding some reluctance to positively identify persons, podiatrists expressing opinions, even opinions derived from a few low quality images (see Figure 1), have, on occasion, expressly linked the gait of a POI to a specific suspect or come precariously close.<sup>222</sup>

In legal settings and reports, in the absence of validation studies and databases, podiatrists have occasionally elided limitations by adapting

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set of characteristics. At present, there is no database to compare such features. . . . As such, gait analysis will probably never be evidence as strong as fingerprint of DNA, but may be useful if no conclusive evidence is available.”).

<sup>219</sup> NIST REPORT, *supra* note 5, at 72–74 (showing that the NAS and NIST reports advise against positive identification, preferring probabilistic approaches and conclusions that include references to uncertainties, limitations and error rates); NAS REPORT, *supra* note 5, at 7, 184; *see* SIR ANTHONY CAMPBELL, THE FINGERPRINT INQUIRY REPORT 682–84 (2011); GOUDGE, *supra* note 210, at 433–35.

<sup>220</sup> *See also* Jason Tangen, Matthew Thompson & Duncan McCarthy, *Identifying Fingerprint Expertise*, 22 PSYCHOL. SCI. 995, 995–97 (2011). *See generally* Brad Ulery et al., *Accuracy and Reliability of Forensic Latent Fingerprint Decisions*, 108 PROCEEDINGS NAT’L ACADEMY SCI. U.S. 7733, 7733–38 (2011) (reporting a large-scale study of the accuracy and reliability of fingerprint examiners’ decisions).

<sup>221</sup> Kagan, *supra* note 62, at 146; *see also* DiMAGGIO & VERNON, *supra* note 2, at 19.

<sup>222</sup> R v. Otway, [2011] EWCA (Crim) 3, [15] (Eng.); Cunliffe & Edmond, *supra* note 166, at 340–41.

scales and terminologies developed by empirically quantified forensic sciences.<sup>223</sup> A typical version, which purports to provide a means of converting numerical values to verbal terms, was promoted by the now defunct Forensic Science Service (U.K.) and is reproduced below.<sup>224</sup>

Numerical Range for the Value V	Verbal Convention
$1 < V < 10$	Limited evidence to support
$10 < V < 100$	Moderate evidence to support
$100 < V < 1000$	Moderately strong evidence to support
$1000 < V < 10,000$	Strong evidence to support
$10,000 < V$	Very strong evidence to support

These scales, developed in response to evidence that is susceptible to quantification (such as DNA profiles and refractive indices for glass), were designed to capture and convey the strength of probabilistic evidence in non-numeric form.<sup>225</sup> In circumstances where techniques have not been formally evaluated (i.e., validated), opinions expressed using such verbal formulations are speculative and potentially misleading.<sup>226</sup> That is, when it comes to forensic gait analysis, the relationship between the data (i.e., the images), the interpretations, and the their correspondence to reality is simply unknown. The terms selected from such scales only capture the podiatrist's impression of the strength of the evidence, not a strength based on a technique known to work in specific conditions with a specific level of reliability, and not an impression informed by systematic knowledge of the prevalence of features. The use of scales and conventional phrases is likely to disguise the impressionistic nature of analysis by presenting opinions in a

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<sup>223</sup> See, e.g., J. DiMaggio, *The Emerging Science of Forensic Podiatry*, 24 *PODIATRY MGMT.* 147, 147-151 (2005) (providing a scale).

<sup>224</sup> I.W. Evett, *Towards a Uniform Framework for Reporting Conclusions in Forensic Science Casework*, 38 *SCI. & JUST.* 198, 198 (1998) (showing that there is no evidence that audiences understand the selected terms to mean what is suggested by proponents; this is a top-down approach). See generally Kristy A. Martire, Richard I. Kemp & Ben R. Newell, *The Psychology of Interpreting Expert Evaluative Opinions*, 45 *AUSTRALIAN J. FORENSIC SCI.* 305 (2013).

<sup>225</sup> See, e.g., Evett, *supra* note 224, at 198.

<sup>226</sup> See Dawn McQuiston-Surrett & Michael J. Saks, *The Testimony of Forensic Identification Science: What Expert Witnesses Say and What Factfinders Hear*, 33 *LAW & HUM. BEHAV.* 436, 448-51 (2009) (explaining that jurors and judges do not necessarily understand what forensic scientists intend to convey by their use of terms and testimony).

structured and implicitly scientific guise.

### III. FANCY FOOTWORK: DEMARCATING FORENSIC PODIATRY

In this section, we consider how proponents of forensic podiatry have defined their emergent *field* (i.e., practices, knowledge, abilities, training, and organizational profile) in relation to clinical podiatry and established forensic sciences. Here we can observe carefully erected boundaries, the demarcation of professional spaces populated—and even monopolized—by podiatrists, and respect for the activities of non-podiatrists.<sup>227</sup> In the following sections, we trace the way forensic podiatry and its purported capabilities were constituted, demarcated, and authorized through recognition by organizations and institutions (e.g., the IAI and courts)—so-called co-production—and how these very processes shaped and constrain the pretensions of the “field.”<sup>228</sup>

Podiatrists endeavoring to erect and police professional boundaries have been careful to distinguish the non-scientific and non-glamorous dimensions of podiatry (and chiropody) and to avoid trespassing on roles and abilities already claimed by non-podiatric forensic scientists.<sup>229</sup> These twin concerns—differentiating forensic podiatry from clinical podiatry and carefully allocating responsibilities vis-à-vis other forensic sciences—operate alongside a conspicuous lack of engagement with the recommendations of peak scientific organizations (such as the NAS and NIST), and a selective disregard for the parallel endeavors of research scientists and engineers attempting to develop technological solutions to the interpretation of images.

#### A. BEYOND CHIROPODY: POSITIONING FORENSIC PODIATRY IN RELATION TO PODIATRY

There are two significant dimensions in the relations between podiatry and forensic podiatry. First, experience as a podiatrist appears to feed directly into forensic podiatry. The second dimension is in tension with the first. Podiatrists, we are told, are not by ordinary training, qualification, and experience, sufficiently competent to practice forensic podiatry.<sup>230</sup> The podiatrists seeking to establish and expand forensic podiatry have imposed

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<sup>227</sup> ABBOTT, *supra* note 36, at 86–114.

<sup>228</sup> See STATES OF KNOWLEDGE: THE CO-PRODUCTION OF SCIENCE AND THE SOCIAL ORDER 1–13 (Sheila Jasanoff ed., 2004).

<sup>229</sup> See THOMAS F. GIERYN, CULTURAL BOUNDARIES OF SCIENCE: CREDIBILITY ON THE LINE 4–6, 12–18 (1999) (exploring the creation and maintenance of boundaries, so-called boundary work, in and around the sciences).

<sup>230</sup> DIMAGGIO & VERNON, *supra* note 2, at 15; VERNON ET AL., *supra* note 55, at 3–5.

barriers (or costs) designed to regulate growth while reinforcing their roles as gatekeepers who are able to define the field, the appropriate training, the experience, and perhaps even certification—as well as manage potentially precarious relations with proximate forensic sciences.<sup>231</sup>

An important aspect of the demarcation between clinical podiatry (and chiropody) and forensic podiatry centers around the claim (by its proponents) that forensic podiatry is, unlike much of podiatry, concerned with identification. “Forensic podiatry does, however, need to be approached by the profession with caution. Some podiatrists with an interest in human identification may have difficulty in achieving the shift from the clinical paradigm to the *identification paradigm*.”<sup>232</sup> Those engaged in the creation of forensic podiatry seem to be imposing barriers to restrict the ability of ordinary podiatrists interested in taking up forensic roles by projecting an image of forensic podiatry as peculiarly scientific and concerned with identification.<sup>233</sup> These projections operate simultaneously to assist with recognition from forensic science organizations, investigators, and the courts.<sup>234</sup> They are interesting because scientific research and the responsibilities of expert witnesses do not seem to conspicuously discipline the performance of those presenting themselves as forensic podiatrists.<sup>235</sup> The adoption of scientific methods and attention to published research has not been a pre-condition to engaging in criminal investigations and prosecutions.<sup>236</sup>

When podiatrists testify, the dearth of scientific research and uncertainties around abilities and relevant expertise tend to be mediated by recourse to training and long experience as a clinical podiatrist.<sup>237</sup> Where forensic gait analysis is relied upon, podiatrists tend to invoke the routine use of gait analysis as a diagnostic technique in clinical practice.<sup>238</sup> Courts have accepted that the skills of clinical podiatry transfer seamlessly into the identification paradigm.<sup>239</sup> Neither judges and prosecutors, nor podiatrists in their reports and testimony, have addressed the conspicuous differences

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<sup>231</sup> DIMAGGIO & VERNON, *supra* note 2, at 15; VERNON ET AL., *supra* note 55, at 3–5.

<sup>232</sup> Vernon, *supra* note 6, at 286 (emphasis added).

<sup>233</sup> See DIMAGGIO & VERNON, *supra* note 2, at 15.

<sup>234</sup> Cunliffe & Edmond, *supra* note 166, at 357–61, 365.

<sup>235</sup> *Id.* at 337–42.

<sup>236</sup> *Id.* at 335–36, 346–49.

<sup>237</sup> *Id.* at 339, 342–44; see R v. Otway, [2011] EWCA (Crim) 3, [10] (Eng.).

<sup>238</sup> Cunliffe & Edmond, *supra* note 166, at 339, 342–44; see R v. Otway, [2011] EWCA (Crim) 3, [10] (Eng.).

<sup>239</sup> Proponents of forensic podiatry have tended to downplay legal reliance on clinical experience as the basis for admission. DIMAGGIO & VERNON, *supra* note 2, at 15; VERNON ET AL., *supra* note 55, at 3–5.

between diagnosing and treating pathologies of the foot and comparing images of varying quality to assist with the identification of offenders.

#### B. TREADING ON TOES: AVOIDING TRESPASSING INTO EXISTING FORENSIC DOMAINS

Another type of boundary work involves self-regulation and restraint as podiatrists endeavor to secure external recognition from the established forensic sciences and their institutional embodiments, such as the IAI, the British Association of Human Identification (BAHID), and the U.K.'s short-lived Council for the Registration of Forensic Practitioners. Enrollment and recognition requires podiatrists to clearly explain and demarcate the scope of forensic podiatry in relation to forensic sciences already operating in the area.<sup>240</sup> One part of this involves securing formal endorsement and recognition through inclusion in professional associations (discussed previously) and another relates to how forensic podiatry is to articulate with pre-existing forensic disciplines, their techniques and claimed abilities.<sup>241</sup> In large part, perhaps with the exceptions of forensic gait analysis (and the use of medical records relating to the foot), forensic podiatry is characterized as a supplementary or allied discipline.<sup>242</sup> It is defined responsively—that is, in relation to established forensic practices and interpretive spaces.<sup>243</sup> Recognition from organizations purporting to represent and regulate comparison forensics operates to preserve the boundaries of established fields, and the monopolies maintained by their practitioners, while helping to legitimize podiatry's expansion into largely unoccupied forensic territory.

Podiatrists have been careful to map out the scope of their forensic involvement to avoid trespassing on the practices of other forensic scientists already working in adjacent domains.<sup>244</sup> We can clearly see this in relation to the interpretation of foot and shoe prints. Rather than compare ridge detail or sole patterns, podiatrists interpret these prints in order to extract additional information (see e.g., shoe size, fit, and wear marks) that might assist with identification.<sup>245</sup> Formal efforts at promoting forensic podiatry scrupulously avoid interpreting skin detail and shoe prints in ways that

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<sup>240</sup> VERNON ET AL., *supra* note 55, at 5, 7.

<sup>241</sup> *Id.*

<sup>242</sup> *Id.* at 7, 9.

<sup>243</sup> *Id.*

<sup>244</sup> See generally ABBOTT, *supra* note 36 (discussing how “trespassing” can actually lead to professional and epistemic disputes). These are likely to be resolved through appeals to organizations such as IAI and, more indirectly, appellate courts.

<sup>245</sup> DIMAGGIO & VERNON, *supra* note 2, at 77–101.

might trespass onto professional territories already inhabited by shoe, foot, and fingerprint examiners.<sup>246</sup>

So, in relation to footprint impressions, we can observe a clear distinction and a rationale based around supplementation: “[t]he added value podiatrists bring into the process is their understanding of the functioning foot and the effects which that function may have on the form of the human footprint.”<sup>247</sup> Where there is ridge detail in a footprint, “the podiatrist normally forwards such information to an appropriate expert, as expertise in the examination of such features falls outside the specialised knowledge of podiatrists.”<sup>248</sup> However, this has not prevented podiatrists from claiming an ability to compare footprints by other means (e.g., using linear measurements and overlays).<sup>249</sup> Similarly, podiatrists are reluctant to tread on the toes of footwear and marks examiners who specialize in shoe tread patterns: “it would not be usual for podiatrists to become involved in linking the shoe to the scene of crime, as the knowledge base required for this task is solely that of the forensic footwear or marks examiner.”<sup>250</sup> Forensic podiatrists, we are informed, have a role “in cases involving footwear where the task is to link the footwear to the suspected wearer, or where a complex question concerning ownership has arisen.”<sup>251</sup> The precise boundaries seem to have been resolved in correspondence with the IAI.<sup>252</sup>

Enlisting the IAI gives forensic podiatry, one of the newest of the forensic “sciences,” the legitimacy conferred by recognition from the oldest forensic science society. Recognition by the IAI does not involve a stringent review of the methods used by forensic podiatrists and the scientific research supporting them. Rather, IAI endorsement of the carefully bounded claims of podiatrists reinforces its own authority as an organization capable of recognizing, legitimizing, and even accrediting forensic disciplines while simultaneously protecting the interests of current members, such as shoe and footprint specialists.

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<sup>246</sup> DIMAGGIO & VERNON, *supra* note 2, at 55 (stating that latent fingerprints and foot examiners compare the friction ridges on feet); VERNON ET AL., *supra* note 55, at 7, 13.

<sup>247</sup> DIMAGGIO & VERNON, *supra* note 2, at 52.

<sup>248</sup> *Id.* at 55, 72, 101, 175.

<sup>249</sup> *Id.* at 51–76.

<sup>250</sup> *Id.* at 77–78.

<sup>251</sup> *Id.* at 78–79 fig.5.1.

<sup>252</sup> *Id.* at 79.

### C. SIDE-STEPPING TECHNOSCIENTIFIC APPROACHES: RELATIONS WITH BIOMETRICS

Attempts to establish forensic podiatry and to monopolize forensic gait analysis assume an added significance when we appreciate that there are simultaneous, though largely independent, efforts to identify persons in images being pursued by scientists, engineers, physical anthropologists, and computer scientists. These research efforts, undertaken in public, defense, and commercial spheres, are endeavoring to develop technological solutions (based largely on algorithms) to assist with identification on the basis of body features (such as facial morphology) or movement and posture, or both.<sup>253</sup>

Claims associated with technologically-driven approaches share the optimism of podiatrists on the considerable potential of gait, movement, and posture to assist with identification.<sup>254</sup>

Gait is in theory as individual as a fingerprint and photogrammetry, and gait analysis (i.e. an analysis of how a perpetrator walks and stands) has been used in cases where other identification markers, such as face and fingerprint, are in shortage. The advantage of gait analysis in forensic investigations is that gait is hard to conceal. Additionally, gait movement may be extracted from low-resolution images from afar, and gait data from possible suspects<sup>255</sup> may be obtained without direct interaction or without the suspect's knowledge.

Notwithstanding shared belief in the potential of gait for purposes of identification, an important difference with biometric approaches is that they tend to be rigorously tested in controlled conditions such that we are reasonably conversant with their current limitations. At present, successful algorithms have error rates of about ten percent when operating in favorable conditions (see e.g., using clear images at a high frame rate).<sup>256</sup>

<sup>253</sup> See, e.g., Bouchrika et al., *supra* note 94, at 884–89.

<sup>254</sup> *Id.* at 888–89; Mark S. Nixon & John N. Carter, *Automatic Recognition by Gait*, 94 PROCEEDINGS IEEE 2013, 2022 (2006).

<sup>255</sup> Sylvia X. M. Yang et al., *Influence of Velocity on Variability in Gait Kinematics: Implications for Recognition in Forensic Science*, 59 J. FORENSIC SCI. 1242, 1242 (2014) (citations omitted); see also Bouchrika et al., *supra* note 94, at 882 (“Gait recognition has the potential to overcome most of the limitations that other biometrics suffer from such as face, fingerprints, and iris recognition, which can be obscured in most situations where serious crimes are involved.”); Nixon & Carter, *supra* note 254, at 2013 (“A unique advantage of gait as a biometric is that it offers potential for recognition at a distance or at low resolution when the human subject occupies too few image pixels for other biometrics to be perceivable.”).

<sup>256</sup> David White et al., *Error Rates in Users of Automatic Face Recognition Software*, 10 PLOS ONE 1, 1–23 (2015) (recounting figures between 80% and 97% accuracy, depending on the algorithm, and reporting on the continuing role of humans in image interpretation). See generally SECOND GENERATION BIOMETRICS: THE ETHICAL, LEGAL AND SOCIAL CONTEXT

It might be considered ironic that biometric approaches, developed by research scientists and engineers, are currently considered insufficiently reliable for use in most forensic contexts, though most conspicuously in courts, whereas the subjective impressions of clinical podiatrists have been relied upon when identity is in issue.<sup>257</sup> The unknown abilities of podiatrists, acting as forensic gait analysts, seem to be preferred to techno-scientific assemblages with known limitations and indicative error rates. Courts seem to have placed confidence in the experience of clinical podiatrists, but disregarded their inability to provide evidence of validity, proficiency, and accuracy.<sup>258</sup> Unacknowledged uncertainties and experience (with clinical gait analysis) are preferred to algorithms that produce non-trivial, but known and declared errors when comparing images.<sup>259</sup>

#### D. BEST FOOT FORWARD: SECURING PUBLIC RECOGNITION

Until this point, our discussion has focused on the efforts of podiatrists to position forensic podiatry within the broader expert communities of podiatrists, forensic scientists and, to a lesser degree, biometrics. Podiatrists have taken additional steps to secure public interest and recognition of their work. Sensing that forensic podiatry is more likely to receive legal recognition if accepted by a broad audience, several podiatrists have gone to considerable lengths to secure acclamation.<sup>260</sup>

In these endeavors, the efforts of one podiatrist stand out. Haydn Kelly, among the earliest of qualitative forensic gait analysts, is listed in the *Guinness Book of Records* for the “first use of forensic gait analysis evidence in court.”<sup>261</sup> Until 2014, this claim to a Guinness World Record was featured prominently on Kelly’s professional website and is repeated in DiMaggio and Vernon’s account of *R v. Saunders*.<sup>262</sup> Kelly’s curriculum

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(Emilio Mordini & Dimitrios Tzovaras eds., 2012).

<sup>257</sup> See, e.g., *R. v. Aitken*, 2008 BCSC 1423 (Can.); *R. v. Otway*, [2011] EWCA (Crim) 3, [21] (Eng.).

<sup>258</sup> Cunliffe & Edmond, *supra* note 166, at 338–39, 349–53.

<sup>259</sup> DiMAGGIO & VERNON, *supra* note 2, at 105; Cunliffe & Edmond, *supra* note 166, at 342, 346–48.

<sup>260</sup> See, e.g., *First Use of Forensic Gait Analysis Evidence in Court*, GUINNESS WORLD RECORDS, <http://www.guinnessworldrecords.com/world-records/first-use-of-forensic-gait-analysis-evidence-in-court> (last visited May 18, 2016).

<sup>261</sup> *Id.*

<sup>262</sup> DiMAGGIO & VERNON, *supra* note 2, at 160–63 (discussing *R v. Saunders* [2000] VSCA 58 (Unreported, Court of Appeal, 4 Apr. 2000) (Austl.), <https://jade.io/article/70451>; see also *Useless Disguise – News In Brief*, THE TIMES., July 13, 2000, at 2 (reporting on the conviction of Saunders based on his walk on security video films).

vitae lists several news articles that supply favorable accounts of his work as an expert witness in criminal proceedings, all under the heading “Publications.”<sup>263</sup>

Even more striking, a character by the name of “Haydn Kelly” plays a central role in the Peter James novel *Not Dead Yet*.<sup>264</sup> The character Kelly solves the case when pronounced abilities enable him to appreciate that the perpetrator is in fact a man dressed as a woman.

‘I’ve cracked it!’ he shouted across the room at Roy Grace, beaming like an exuberant kid and brandishing two CD cases in the air.

‘What? What have you cracked? Anna Galicia?’ Grace asked.

....

Haydn Kelly pointed at the left screen. ‘See our mysterious Anna Galicia?’

Grace nodded.

‘There’s a good reason why no one’s been able to find her.’

‘Which is?’

Kelly pointed at the right-hand screen. At the balding man in the business suit. ‘Because that’s *her*.’

Grace looked at the forensic podiatrist’s face for a moment, in case he was joking. But he appeared deadly serious. ‘How the hell do you know?’

‘Gait analysis. See all those computations on the screen? I can do the analysis visually to a pretty high degree of accuracy because I’ve done it for so long, but these calculations done by the algorithm I developed add certainty. There is a very minor variation because the woman is on high heels and the man is wearing conventional male shoes. But they’re the same person. No question.’<sup>265</sup>

As of January 2015, *Not Dead Yet* had sold eleven million copies.<sup>266</sup>

While it might be tempting to dismiss such reference as irrelevant to the main course of forensic science, this best selling book follows the formula adopted by such shows as Crime Scene Investigation (CSI) and Naval Criminal Investigative Service.<sup>267</sup> The forensic podiatrist is depicted

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<sup>263</sup> Home, HAYDN D KELLY, <https://web.archive.org/web/20140516192649/http://podiatry.co.uk/>; *R. v. Aitken*, British Columbia Court of Appeal registry number CA36854, Victoria Registry (containing Haydn Kelly’s *curriculum vitae* among the court records) (copy on file with authors and may be accessed on application from the BC Court of Appeal).

<sup>264</sup> PETER JAMES, *NOT DEAD YET* (2012).

<sup>265</sup> *Id.* at 377–78.

<sup>266</sup> *Id.* at back cover.

<sup>267</sup> Edwards, *supra* note 155, at 6–7 (hinting at the power of popular support for forensic sciences in an account of the challenges of writing the NAS Report: “When it came time to

as having nearly magical abilities that permit him to penetrate surface appearances to positively identify a person by their gait, even where the person is a man whose disguise includes wearing high heels.<sup>268</sup> The techniques and abilities depicted in this fictitious work are more robust than those available for actual casework. At the root of the claims being made in the novel is the proposition that forensic podiatry enables investigators to identify persons and to crack otherwise insoluble cases.<sup>269</sup> These claims, featuring a named forensic podiatrist, have presumably been absorbed—at least in general terms—by millions of readers. Sir Arthur Conan Doyle performed a similar service for the nascent technique of fingerprint comparison in his Sherlock Holmes story, “The Adventure of the Norwood Builder.”<sup>270</sup> Such popular consciousness-raising is used to leverage an institutional role for the implicitly probative evidentiary products produced by forensic podiatrists.

Proceeding in tandem, several podiatrists have been promoting the capabilities of forensic podiatry to attentive publics. These began with single lectures in undergraduate courses in order to generate interest in graduate study.<sup>271</sup> Efforts at “raising awareness of the discipline and what it could offer to human identification” were simultaneously promoted through wider educational initiatives, specifically guest lectures to forensic science students and offering forensic podiatry subjects in the Worshipful Society of Apothecaries Diploma in Forensic Human Identification in the U.K. and through continuing professional education and the establishment of the American Society of Forensic Podiatry in the United States.<sup>272</sup>

Another form of mobilization manifests in the appearance of specialist publications on the subject of forensic podiatry. *Forensic Podiatry*, by Vernon and DiMaggio,<sup>273</sup> is a seminal effort in field building and boundary

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write the report, the committee had to summon its collective skills to ‘tell the truth’ about what we had found, even as we knew that we would face resistance from some institutions that have an interest in forestalling change. We also knew that we would face disbelief from CSI addicts who assume that the forensic disciplines and practitioners are infallible.”)

<sup>268</sup> JAMES, *supra* note 264, at 458–60.

<sup>269</sup> *Id.*

<sup>270</sup> SIR ARTHUR CONAN DOYLE, *The Norwood Builder*, in *THE RETURN OF SHERLOCK HOLMES* 31, 13–60 (1905).

<sup>271</sup> See Vernon, *supra* note 54, at 61.

<sup>272</sup> See *id.* at 60; Kagan, *supra* note 62, at 286; see also AMERICAN SOCIETY OF FORENSIC PODIATRY, <http://www.theasfp.org> (last visited Nov. 12, 2015) (showing that DiMaggio (President), Kagan (Secretary/Treasurer) and Vernon are among the six directors of the American Society of Forensic Podiatry).

<sup>273</sup> DIMAGGIO & VERNON, *supra* note 2.

work.<sup>274</sup> The text describes the diverse practices of the nascent “field,” offers insights into how to practice as a forensic podiatrist, reinforces the importance of training and acquiring experience presumably working with the authors or other experienced “forensic podiatrists,” as well as publicly demarcating the limits of forensic podiatry to avoid disputes with potential rivals (e.g., shoe-print examiners).<sup>275</sup> *Forensic Podiatry* embodies the pretensions and anxieties of field building. Simultaneously, it provides those presenting themselves as forensic podiatrists with a foundational text that might be referenced and invoked to supplement claims that are largely predicated on experience as a clinician.

#### IV. FOOT FETISH: LAW AND THE CO-PRODUCTION OF EXPERTISE, IDENTITY AND GUILT

While those aspiring to be forensic podiatrists benefit from recognition by peak forensic science organizations and the public, they are ultimately dependent on the courts for their status as legally-recognized forensic scientists.<sup>276</sup> Like many forensic scientists, podiatrists tend to believe that involvement in investigations, recognition by those in the criminal justice system (e.g., police, prosecutors, and judges), and successful prosecutions provide rigorous, independent evidence of actual expertise. In reality, the admission of forensic gait analysis evidence in a courtroom does not substitute for independent scientific support.<sup>277</sup>

In the case of forensic gait analysis, legal recognition seems to have pre-dated, and perhaps even stimulated, field formation.<sup>278</sup> Earlier we noted that forensic gait analysis was first admitted in a criminal trial in 2000, in the unreported English decision of *Saunders*.<sup>279</sup> The major efforts to promote forensic podiatry followed, or appear to have been encouraged by,

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<sup>274</sup> Of interest, Amazon lists Haydn D. Kelly’s forthcoming book *Forensic Gait Analysis* online to be released in October 2016. Online Product Listing of HAYDN D. KELLY, FORENSIC GAIT ANALYSIS (forthcoming Oct. 2016), AMAZON, <https://www.amazon.co.uk/Forensic-Gait-Analysis-Haydn-Kelly/dp/1466504145> (last visited July 11, 2016).

<sup>275</sup> See *R v. T.*, [2010] EWCA (Crim) 2439, [21]–[29] (Eng.) (discussing shoe-print comparison and the need for disclosure by forensic scientists).

<sup>276</sup> Gary Edmond et al., *Admissibility Compared: The Reception of Incriminating Expert Evidence (i.e., Forensic Science) in Four Adversarial Jurisdictions*, 3 U. DENV. CRIM. L. REV. 31, 102–07 (2013).

<sup>277</sup> CUNLIFFE, *supra* note 167, at 62–63, 199–201; see also Keith A. Findley et al., *Shaken Baby Syndrome, Abusive Head Trauma, and Actual Innocence: Getting It Right*, 12 HOUS. J. HEALTH L. & POL’Y 209, 276 (2012).

<sup>278</sup> See DIMAGGIO & VERNON, *supra* note 2, at 103–35; Cunliffe & Edmond, *supra* note 166, at 335–36.

<sup>279</sup> See DIMAGGIO & VERNON, *supra* note 2, at 160–63; see also *supra* note 261 and accompanying text.

legal recognition in *Saunders*.<sup>280</sup> However, sustained engagement and recognition by appellate courts is more recent.

In 2011, the admissibility of forensic gait analysis formed the basis of an appeal to the English Court of Appeal in *R v. Otway*.<sup>281</sup> In 2012, the British Columbia (B.C.) Court of Appeal ruled on the admissibility of forensic gait analysis under Canadian law in *R v. Aitken*.<sup>282</sup> Trial and appellate judges in both jurisdictions found the opinions of podiatrists to be admissible expert evidence.<sup>283</sup> The reasons issued by the two appeal courts offer insight into the strategies used by prosecutors and podiatrists to persuade courts (and juries) that forensic gait analysis is a well-grounded and sufficiently reliable domain of comparison forensics.

In *Otway*, podiatrist David Blake characterized the tasks performed by forensic podiatrists as a new application of the quotidian skills of the clinical podiatrist.<sup>284</sup> He also relied upon the recognition granted to forensic podiatrics by presumptively authoritative forensic science organizations to support the contention that forensic gait analysis is a reputable branch of comparison forensics: “[p]odiatrists use gait analysis virtually every day in their practice. Recently that science has been applied forensically. The Council for the Registration of Forensic Practitioners recognizes gait analysis and footprint identification as important components in identification of individuals. A podiatric section has recently been set up.”<sup>285</sup>

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<sup>280</sup> *Id.* at 103.

<sup>281</sup> *R v. Otway*, [2011] EWCA (Crim) 3, [2] (Eng.).

<sup>282</sup> *R v. Aitken*, 2008 BCSC 1423, paras. 63–92 (Can.).

<sup>283</sup> *R v. Otway*, [2011] EWCA (Crim) 3, [23] (Eng.); *R v. Aitken*, 2008 BCSC 1423, para. 96 (Can.); *see also* Edmond et al., *supra* note 276. Traditionally, English admissibility standards for expert opinion evidence were very liberal, focusing on whether the evidence would assist the trier of fact. This approach is reflected in the *Otway* decision. In the last two years, following a report by the Law Commission in 2012, new procedural rules encourage forensic practitioners, lawyers and judges to consider issues more closely related to validity and reliability. The practical implications of these reforms are unclear. In Canada, following a series of Supreme Court decisions dating to 2000, trial judges have been encouraged to carefully apply *Daubert* criteria to contested opinion evidence, including non-novel procedures. *See R. v. J.-L.J.*, 2000 SCC 51, para. 33 (Can.); *R. v. Trochym*, 2007 SCC 6, paras. 36–37; *White Burgess Langille Inman v. Abbott & Halliburton*, 2015 SCC 23, para. 21 (Can.).

<sup>284</sup> *R v. Otway*, [2011] EWCA (Crim) 3, [12] (Eng.).

<sup>285</sup> *Id.* at [10] (witness statement of Mr. David Blake); *see id.* [12]. The Council for the Registration of Forensic Practitioners was a short-lived organization that tried to regulate forensic scientists in the U.K. through a formal scheme of registration. Like the other forensic organizations considered in this essay—such as IAI and BAHID—recognition and registration did not require scientific evidence of abilities; *see also* CHRISTOPHER LAWLESS, FORENSIC SCIENCE: A SOCIOLOGICAL INTRODUCTION 47, 54–56 (2016).

In *Aitken*, the trial judge relied on a whiggish version of podiatry's long history, along with the use of gait analysis in clinical practice, to support the conclusion that forensic gait analysis is not a novel form of expertise:

Podiatry has been in existence for a thousand years and the expertise of a podiatrist to analyze an individual's gait has long been accepted and practiced in a clinical setting. After carefully viewing the video frame by frame, many, many times, with his trained and practiced eye, he is able to point out *fairly unique characteristics* of the gait and stance of the individuals depicted in the video. The features *are akin to individual identifiers* to some extent.<sup>286</sup>

Confirming this assessment, the Court of Appeal held that it is unnecessary to apply the *Daubert* factors to assess the reliability of forensic gait analysis.<sup>287</sup> The Court of Appeal concluded that "the *Daubert* factors are not essential to the reliability inquiry where the proffered evidence is based on specialized knowledge acquired through training or experience in a particular discipline."<sup>288</sup> Accordingly, within the B.C. courts, the fact that podiatrists located the roots of forensic gait analysis within clinical practice, suggesting an isomorphism with gait analysis grounded in experience, justified admitting its forensic extension without close assessment of validity and reliability.<sup>289</sup>

In *Otway*, the podiatrist, who did not restrict his evidence to the lower limbs, "estimated that only in about 7% of his practice population did he find 'the slight neck flexion or head poke where the head is projected excessively forward'" which he observed in both sets of recordings.<sup>290</sup> Defense counsel's expert relied expressly on the NAS Report in challenging the admissibility of Blake's evidence.<sup>291</sup> In particular, the defense submitted that forensic gait analysis is not sufficiently advanced to merit admission and that there was no statistical basis on which Blake could assist the jury to assess the probability that features seen in the POI would be

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<sup>286</sup> R. v. Aitken, 2008 BCSC 1423, para. 34 (Can.) (emphasis added).

<sup>287</sup> R. v. Aitken, 2012 BCCA 134, paras. 79–80 (Can.); *see also* R. v Trochym, 2007 SCC 6 (indicating that the *Daubert* factors might be used to assist Canadian judges with the determination of threshold reliability).

<sup>288</sup> R. v. Aitken, 2012 BCCA 134, para. 79 (Can.).

<sup>289</sup> *Id.* at para. 74. We observe that, if courts universally adopted this approach, the *Daubert* factors would not apply to any forensic science or technique where the individual had received formal training or had repeatedly used a technique (even if the technique had not been tested).

<sup>290</sup> R v. Otway, [2011] EWCA (Crim) 3, [12] (Eng.) (relying on head and neck movement in the podiatrist's conclusion).

<sup>291</sup> *Id.* at [18].

shared by a random suspect.<sup>292</sup> The defense sought to introduce expert testimony (from a non-podiatrist) regarding the need for independent validation and appropriate criteria demonstrating scientific support.<sup>293</sup> This evidence was rejected on the basis that the proponent of this orthodox methodological explanation and critique was not a podiatrist.<sup>294</sup> According to the court, there was “no attempt . . . by expert evidence, to challenge the accuracy of . . . Mr. Blake’s evidence.”<sup>295</sup>

Rather than require the prosecutor or the podiatrist to demonstrate actual expertise in the specific domain, the court in *Otway* placed an onus upon defense counsel to demonstrate that Blake was in fact wrong.<sup>296</sup> The English court restated the conditions for admissibility of expert testimony: first, that the expertise is based on study or experience, and second, that the witness is qualified to express the opinion.<sup>297</sup> The court found Blake’s gait evidence admissible, and characterized defense concerns about his “ability to *compare* the walking gait of two individuals” as “untenable.”<sup>298</sup>

Returning to *Aitken*, the real Hadyn Kelly was willing to testify that two features—namely, abduction and eversion—placed the offender within a small group comprising about one percent of the population.<sup>299</sup> This opinion was based on features he claimed to be able to observe by watching a single, partially-obscured gait cycle from a poor quality CCTV recording and extrapolating from his clinical experience with patients and pathologies in another country (see Figure 1).<sup>300</sup> The B.C. Court of Appeal relied upon the English Court of Appeal’s decision in *Otway* to bolster its conclusion that Kelly’s evidence was sufficiently reliable to warrant admission.<sup>301</sup> It concluded that the English approach to admissibility incorporated a

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<sup>292</sup> *Id.* at [17], [18].

<sup>293</sup> *Id.* at [18].

<sup>294</sup> *Id.* at [19] (citing *R v. T.*, [2010] EWCA (Crim) 2439, [92]–[96] (Eng.); see also Simon A. Cole, *A Cautionary Tale About Cautionary Tales About Intervention*, 16 *ORG.* 121, 127–30 (2009).

<sup>295</sup> *R v. Otway*, [2011] EWCA (Crim) 3, [10] (Eng.).

<sup>296</sup> *Id.* at [21].

<sup>297</sup> *Id.* at [17] (citing *R. v. Luttrell*, [2004] EWCA (Crim) 1344 (Can.)); see also *id.* at [20] (mentioning three criteria, namely the need to “establish the existence of (1) the science or expertise, (2) the witness’ proficiency in it, and (3) the foundation for the witness’s opinion”).

<sup>298</sup> *Id.* at [21] (emphasis in original).

<sup>299</sup> *R. v. Aitken*, 2012 BCCA 134, para. 63 (Can.) (“Abduction” means that feet turn out at the toes during the gait cycle, and “eversion” translates roughly to flat footedness and means that the foot rolls forward during the gait.).

<sup>300</sup> *R. v. Aitken*, 2008 BCSC 1423, para. 10 (Can.).

<sup>301</sup> *R. v. Aitken*, 2012 BCCA 134, para. 88 (Can.).

reliability analysis equivalent to that required under Canadian law.<sup>302</sup> This interpretation of the English approach is inconsistent with that offered by commentators, including a report by the Law Commission of England and Wales. Significantly, at that stage English courts did not consider reliability as part of their admissibility gatekeeping.<sup>303</sup> Indeed, the Law Commission described English admissibility practice as effectively “laissez faire.”<sup>304</sup> Nonetheless, the B.C. Court of Appeal relied on the admission of forensic gait analysis in English courts to support its conclusion that a more searching reliability inquiry was not required in Canada.<sup>305</sup>



**Figure 1.** Image taken from the court record in *R v Aitken* (BCCA Registry number CA36854, Victoria). The bottom half of a person is visible in the top left hand corner. The image corresponds to Exhibit 17, Tab 2 at 89-96. CCTV footage date and time stamp 28.12.2004/ 23:11:23:234 – 23:11:24:175.

We find it revealing that the two courts tasked with assessing the admissibility of forensic gait analysis have conspicuously failed to undertake a credible assessment of the validity and reliability of that evidence. Remarkably, in the post-NAS Report era, and even with the benefit of well-informed defense arguments (and, in *Otway*, an expert

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<sup>302</sup> *Id.* See discussion *supra* note 283.

<sup>303</sup> The need for “reliability” was first incorporated in English criminal practice in The United Kingdom’s Criminal Procedure Rules 2014. Criminal Procedure Rules, 2014, S.I. 2014/26 (U.K.).

<sup>304</sup> THE LAW COMMISSION, EXPERT EVIDENCE IN CRIMINAL PROCEEDINGS IN ENGLAND AND WALES 3 (2011), [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/229043/0829.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229043/0829.pdf).

<sup>305</sup> See Cunliffe & Edmond, *supra* note 166, at 327–68 (describing the *Aitken* case).

witness available to educate the court about the importance of validation testing and the inadequacy of the underlying research base), these courts accepted the self-serving claims of podiatrists at face value and trusted their opinions to the trial and the jury. Both courts pointed to the fact that the defense failed to call an opposing forensic podiatrist as relevant to assessing the value of the methodological objections,<sup>306</sup> wholly overlooking the substance of the objections as well as the resource constraints under which legal aid operates, and the tiny pool of methodologically sophisticated podiatrists who might in theory be called (and be willing to criticize forensic podiatry and its research foundations). This accommodating attitude stands in stark contrast to DiMaggio and Vernon's prediction that a research base will be required before forensic podiatry evidence will be admitted.<sup>307</sup>

Some podiatrists seem eager to participate in criminal investigations and prosecutions regardless of whether appropriate research has been conducted.<sup>308</sup> Accommodating legal responses undermine efforts by more sophisticated actors within the podiatry community to establish rigorous standards and validate core techniques before moving into criminal casework. The receptive approach of courts rewards entrepreneurialism, speculation, and enthusiasm more than research, rigor, and restraint. Legal recognition and reliance come relatively early in our genealogy. *Saunders*, *Otway*, and *Aitken* are important because—as the reasoning in *Aitken* demonstrates—they establish admissibility as precedent.<sup>309</sup>

These cases reveal how courts, even in jurisdictions purportedly concerned about the reliability of forensic science evidence and wrongful convictions, have not required evidence that techniques work and that those admitted as experts are actually proficient—i.e., expert in the specific activity. Courts have conflated or substituted training, qualifications, and experience as a podiatrist with the ability to reliably compare gait to assist with, and perhaps resolve, uncertainty around the identity of offenders. In this way, the courts seem to have accepted—sometimes merely rehearsing—the claims advanced by proponents of forensic podiatry. These decisions do not engage with the epistemic foundations of forensic podiatry and tend to leave questions about the value of opinions to the defense and the lay decision-makers responsible for evaluating the evidence in trials and appeals. Simultaneously, these decisions ignore or trivialize the advice of

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<sup>306</sup> See *R. v. Aitken*, 2012 BCCA 134, para. 69 (Can.); *R v. Otway*, [2011] EWCA (Crim) 3, [21] (Eng.).

<sup>307</sup> DIMAGGIO & VERNON, *supra* note 2, at 16, 21, 23.

<sup>308</sup> Cunliffe & Edmond, *supra* note 166, at 335–36.

<sup>309</sup> *R. v. Aitken*, 2012 BCCA 134, paras. 87–96 (Can.).

authoritative scientific and technical organizations.

#### UNHAPPY FEET: IS THERE SUCH A THING AS FORENSIC PODIATRY?

Forensic gait analysis has been presented and accepted as a solution to a current problem—identifying people who are disguised or partially obscured in the ever-expanding number of images related to criminal acts.<sup>310</sup> Podiatrists have been willing to offer interpretations of images where others (see e.g., familiars and facial mappers) have been reluctant or unable to tread. In doing so, podiatrists have tended to proffer incriminating testimony in conditions that are generally of low personal risk. That is, they tend to address the question of whether two things are similar (or, in theory, dissimilar) knowing what the investigators believe, and often much more, about the identity of the suspect(s). In this highly suggestive environment, claims about identity are predicated upon the assumption that gait is unique and that apparently similar things are the same or highly uncommon—as in the one percent of the population claim from *Aitken*.

Forensic gait analysis might be useful as a technology capable of assisting with identification or exclusion. This, however, assumes that technical problems associated with validation, image quality, duration of view, frame rates, different types of movement (e.g., walking, running, dancing, carrying objects, moving with injuries, moving while intoxicated, trying to disguise gait, or walking towards somebody with the intention of shooting), frequency and interrelatedness of features, and cognitive bias can be overcome. As things stand, forensic gait analysis can merely suggest that a person could be included within a set of similar persons where the apparent or alleged similarities are of unknown frequency, so the size of the set is unknown.<sup>311</sup> Variations and limitations are such that apparent similarities in gait might not even warrant inclusion. By the same token, apparent differences might not warrant exclusion.

The epistemic frailties of forensic gait comparison are not necessarily recognized or effectively conveyed in criminal investigations and prosecutions. Rather than focus on evidence of actual ability to reliably compare images and provide an accurate indication of similarities (and their implications for identification), courts have tended to focus on the qualifications and experience of individual podiatrists.<sup>312</sup> The fact that

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<sup>310</sup> DIMAGGIO & VERNON, *supra* note 2, at 105–06.

<sup>311</sup> See ANTHONY CAMPBELL, THE FINGERPRINT INQUIRY REPORT 426, 623 (2011), [http://www.aridgetoofar.com/documents/TheFingerprintInquiryReport\\_Low\\_res.pdf](http://www.aridgetoofar.com/documents/TheFingerprintInquiryReport_Low_res.pdf).

<sup>312</sup> See *R. v. Aitken*, 2012 BCCA 134, para. 80 (Can.); *R v. Otway*, [2011] EWCA (Crim) 3, [12].

podiatrists use gait analysis, sometimes in conjunction with controlled video recordings and the use of other equipment in their clinical practice, tends to loom large. Courts have recognized and legitimated the field of forensic podiatry, and techniques such as forensic gait analysis, prematurely. In so doing, courts, and organizations such as the IAI and BAHID, have liberated forensic podiatrists from the need to undertake scientific research before proffering incriminating opinions about the identity of offenders. Conspicuously, neither courts nor professional associations have required the kinds of studies or precautions recommended by peak scientific and technical organizations such as the NAS and NIST.<sup>313</sup>

Insulated from mainstream scientific discourses and research, investigators, courts (both prosecutors and judges), professional forensic science associations, and podiatrists have co-produced the field of forensic podiatry and made forensic gait comparison a legally recognizable form of knowledge and expertise. Now that English and Canadian judges have reified forensic podiatry and found its evidentiary products sufficiently reliable for admission, responsibility for identifying and explaining epistemic frailties has shifted from prosecutors and podiatrists (who claim to be scientific and rigorous) onto impecunious defendants and their publicly funded lawyers. Rather than require podiatrists to demonstrate claimed forensic abilities and proactively disclose uncertainties and limitations, technically illiterate defense lawyers, judges, and accused persons are expected to identify and explain methodological frailties in the course of adversarial legal proceedings.<sup>314</sup> Moreover, juries (and judges) are expected to understand and assess such limitations while exposed to ambiguous images narrated by the suggestive interpretations of prosecutors and podiatrists—recognized as experts.

Of interest, those recognized as forensic podiatrists have not demonstrated much methodological prowess or proactive disclosure of limitations and uncertainties in expert reports and testimony. Rather than disclose the lack of underpinning research and the very serious limitations with their interpretive claims, as *expert* witnesses podiatrists have elided or discounted methodological issues through omission, unsubstantiated appeals to clinical experience, and even the misrepresentation of orthodox scientific practices.<sup>315</sup>

Premature recognition of forensic gait analysis is symptomatic of more widespread problems with the legal regulation of forensic science evidence.

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<sup>313</sup> See NIST REPORT, *supra* note 5, at 197–206; NAS REPORT, *supra* note 5, at 22–23.

<sup>314</sup> See Edmond et al., *supra* note 276, at 94–97.

<sup>315</sup> See Cunliffe & Edmond, *supra* note 166, at 337–41 (describing the *Aitken* case).

The issue is not resolved by the availability of training courses or certificates in expert witnessing. Similarly, acceptance or endorsement by professional associations (and even courts) has not proven particularly helpful. Institutional recognition has not directed attention to the primary issue, namely whether the techniques used by podiatrists are valid and reliable. That is, do they work? Can forensic podiatrists do what they claim, how well, and in what kinds of conditions? Specifically, can forensic podiatrists usefully compare gait in low quality images or where individuals are disguised? Is their performance considerably better than the performance of ordinary persons—i.e., judges and jurors? Do the quality of the image, the amount of the body displayed, the amount of movement captured, and perhaps other parameters matter? If so, in what ways? In addition, how have podiatrists responded to notorious threats to interpretation (and cognition) from human factors? Judges and juries need to know about these things in order to rationally evaluate the admissibility and probative value of opinions proffered by podiatrists.<sup>316</sup>

We have endeavored to explain how the legal system has been (perhaps unwittingly) involved in the co-production of a “knowledge” domain—specifically forensic gait analysis. Our concern is that legal imprimatur, here and in many other cases, is granted with insufficient scrutiny and insufficient reflexivity. Over-confidence in legal abilities to assess scientific claims, and in the capacity of trial processes and safeguards (e.g., cross-examination, warnings to the jury, and potential for rebuttal by other podiatrists) to expose and convey limitations with technical and scientific practices, has lured non-technical lawyers and judges into thinking that contemporary trial practices are up to the tasks of regulation and evaluation.

Forensic practitioners should not look backwards to pre-scientific forensics or sideways to courts for epistemic legitimacy. They should, as a recent review of criminal procedure by a senior English judge concluded, base claims and abilities on rigorous scientific research.

The credibility of the criminal justice system depends on the quality of the science underpinning the forensic evidence: it is necessary in order to preserve confidence in experts and the scientific evidence they present. **In relation to the more esoteric areas of science, more research as to its validity is needed. This is so in particular**

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<sup>316</sup> Ronald J. Allen & Joseph S. Miller, *The Common Law Theory of Experts: Deference or Education?*, 87 NW. L. REV. 1131, 1132–33 (1993); Scott Brewer, *Scientific Expert Testimony and Intellectual Due Process*, 107 YALE L. J. 1535, 1596–616 (1998) (discussing the information required to enable decision-makers to produce credible decisions); Gary Edmond, *The Conditions for Rational (Jury) Evaluation of Forensic Science Evidence*, 39 MELB. U. L. REV. 1, 81–83 (2015).

**in relation to those disciplines where there is very little peer reviewed, published evidence.** For example, gait analysis and facial mapping.<sup>317</sup>

The emergence of forensic podiatry and the admission of opinions based on forensic gait analysis reveal systemic frailties with the way common law legal systems respond to new *knowledge* claims.

This essay helps to explain why courts should be reluctant to confer their imprimatur, by recognizing “fields” and admitting opinions in circumstances where techniques could have been formally evaluated and standardized, but have not been. Forensic gait analysts have attempted to mimic the practices of older, legally accepted forensic “sciences” in the standards they have promulgated and through the techniques by which they have sought legitimacy. These older forensic fields have, in many cases, themselves begun the difficult work of scientific validation—but forensic gait analysis has not followed this trend.

Commentators have properly identified the difficulties of ensuring that criminal justice continues to function while forensic comparison transforms itself into a scientific field.<sup>318</sup> As Judge Harry Edwards of the D.C. Circuit has observed, in the meantime “[e]ach ill-informed [admissibility and reliability] decision becomes a precedent binding on future cases.”<sup>319</sup> However complicated the admissibility questions associated with existing fields of forensic science may be, the questions associated with nascent fields are simple. If courts disavow any new forensic technique that espouses an approach that is based on outdated early twentieth century techniques or that appears ignorant about the insights of authoritative scientific and medical research bodies, proponents of that technique will have compelling reasons to evolve towards a more rigorous paradigm.

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<sup>317</sup> BRIAN LEVESON, REVIEW OF EFFICIENCY IN CRIMINAL PROCEEDINGS 228 (2015), <https://www.judiciary.gov.uk/wp-content/uploads/2015/01/review-of-efficiency-in-criminal-proceedings-20151.pdf> (emphasis in original); *see also id.* at 223–27. Before Leveson, comedians had as much to say as scientists. *See, e.g.*, Feature Skit “Bronstein: Police Chiropodist,” *Alas Smith and Jones: Episode 1* (BBC television broadcast 1984); Feature Skit “Ministry of Silly Walks,” *Monty Python’s Flying Circus: Face the Press* (BBC television broadcast Sept. 15 1970) (“[That walk is] not particularly silly, is it? I mean, the right leg isn’t silly at all and the left leg merely does a forward aerial half turn every alternate step.”).

<sup>318</sup> Harry T. Edwards, Reflections on the Findings of the National Academy of Sciences Committee on Identifying the Needs of the Forensic Science Community, Speech at the First Public Meeting of the National Commission on Forensic Science 3 (Feb. 3, 2014), <https://www.justice.gov/sites/default/files/ncfs/legacy/2014/05/13/harry-edwards.pdf>.

<sup>319</sup> *Id.*

