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Winter 2018 Newsletter
Volume 4, Issue 1

Welcome Message

Welcome to the Winter 2018 NYS IAI Newsletter! In this issue, there is an introduction to your 2018 Board Members, along with a special feature on one of our longtime members, information on how to renew your membership or invite prospective members to join, and a complete list of our business sponsors. The featured article is based on current events and how forensic investigations and technology are being considered in court decisions. Also, mark your calendars for the Division's upcoming conference in October!

PRESIDENT'S MESSAGE

Greetings to the New York Division of the International Association for Identification. It is my honor and privilege to serve you as President. No board positions were contended, therefore all current board members will remain for 2018. I have appointed LisaMarie Catapano as our Editor/Historian. Thank you, LisaMarie, for volunteering and creating this newsletter for our members and supporters.

Your 2018 Board Members are as follows: Ret./Det. Bill Rathjen, President (Suffolk County PD); Det. Nickolas Pistilli, 1st VP (NYPD); Det. John Kellman, 2nd VP (Suffolk County PD); Det. Glenn Perigaut, Secretary/Treasurer (Suffolk County PD); Det. Christopher Ng, Sgt. at Arms (NYPD); P.O. LisaMarie Catapano, Editor/Historian (NYPD); and Chairman of the Board, Cathryn Lahm, M.S.F.S, Forensic photography consultant and Professor at Syracuse University, who also served as a previous president for the New York Division.

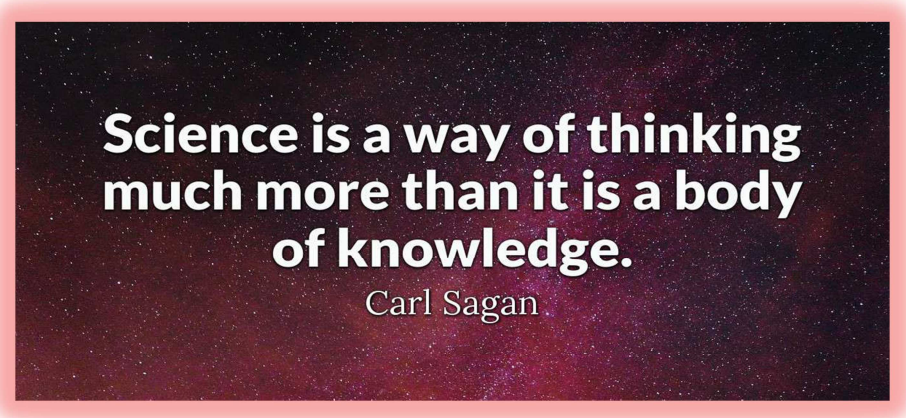
On October 1-3, 2018, we will be having the Division's educational conference at the Radisson Hotel, on Long Island, in Hauppauge, New York. This is the first conference the division has offered in over two years. We plan to have experts from New York and around the country offering a variety of workshops and lectures. I will be reaching out to vendors to attend and to showcase the latest equipment and technologies. If you know of anyone that would like to present an educational workshop or give a lecture please contact me. We will keep you informed as the agenda develops.

Thirty-three new members joined the Division in 2017; thank you, Nick Pistilli, our 1st VP, for signing up members from the NYPD Latent Unit. I am asking every member to reach out to our crime scene units, latent print, footwear and other forensic practitioners in local, state and federal agencies and labs to have them join.

Please download the membership application and sign someone up.

Thank you to our sponsors for supporting the Division by advertising on our website and newsletters. I hope to see you all at our upcoming conference.

Bill Rathjen
President



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Featured 2018 Board Member

Cathryn Lahm, M.S.F.S.

Ms. Lahm is currently the NYS IAI's Chairman for the Board of Directors, and previously served as President.

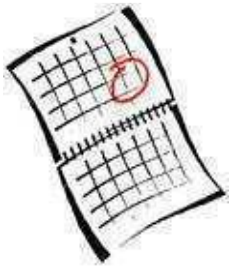
Ms. Lahm has advanced degrees in Forensic Science, Medicolegal Death Investigations, Fine Art Photography, and has prior extensive experience working in the medical field as a nurse. She has used her credentials and experience as a casework consultant in civil and criminal matters, as well as an adjunct professor at Syracuse University teaching forensic photography.

In 2015, Ms. Lahm co-authored the journal article, "The Use of Coloured Barrier Filters in Forensic Photography," published in the International Journal of the Fingerprint Society (accessible online at http://www.fingerprintsociety.com, Vol. 40 No. 158). She also lectures and publishes columns on similar topics of expertise.

When not working, Ms. Lahm enjoys time with family, friends, and travel.

October 1-3, 2018

Mark your Calendar & Save the Date!

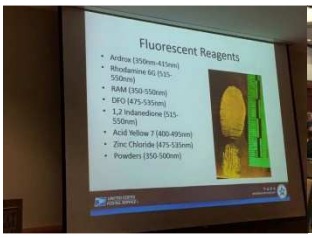


2018 NY IAI CONFERENCE

To be held at the

Radisson Hotel
110 Vanderbilt Motor Parkway
Hauppauge, NY 11788
631-231-1100

More information to follow in upcoming 2018 Newsletters



For information on:

- Presenting an educational workshop
- Giving a lecture at the conference
- Vendors who would like to attend and showcase

Email NYIAIPresident@gmail.com

Review Article

The Shifting Landscape of Latent Print Testimony: An American Perspective

Heidi Eldridge[1,2]

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Abstract

Friction ridge comparison testimony in the United States has long been characterized by speaking in absolutes: fingerprints are unique, the Analysis, Comparison, Evaluation, and Verification methodology has a zero-error rate, and the testimony presented by the expert should be regarded as an incontrovertible fact. Once the National Research Council released their watershed report in 2009, questioning and criticizing these clear overstatements of the strength of the evidence, many commentators and professional organizations recommended that the friction ridge community rethink the way their evidence was presented in reports and in court. Yet, change has been slow to come. While some agencies have begun a shift in the way they present their findings, many others still testify the same way they always have. This paper presents the historical context of where American friction ridge testimony has been, lays out the arguments for why it needs to change, describes some recent efforts to improve, and highlights some likely directions for the future of friction ridge reporting and testimony in the United States.

Keywords: Friction ridge, latent prints, testimony

Introduction

The first recorded criminal trial in the United States to use fingerprint evidence to secure a conviction was People v. Jennings, in 1910. Since then, fingerprint evidence has been a mainstay of the American criminal justice system and has largely enjoyed a position of reverence, with few successful challenges to its admissibility in court. Part of the reason fingerprint evidence has historically been viewed as one of the most powerful types of forensic evidence can be attributed to the way, in which it has been presented in court. Fingerprint examiners routinely claim to have "identified" or "individualized" an unknown mark to a single known print. This identification is often characterized as being "to the exclusion of all others" on earth to a 100% certainty, and the comparison method used is claimed to have a zero percent error rate. These claims are based on the premises that friction ridge skin is unique and permanent.

With credentials like these, it is unsurprising that fingerprint evidence saw few challenges in the courtroom or that challenges in the literature were casually dismissed as being the rantings of critics looking to make a name for themselves by attacking what was clearly infallible evidence.

In 2004, the Federal Bureau of Investigation (FBI) made a high-profile error, misidentifying Portland lawyer Brandon Mayfield as the source of an unknown mark recovered from a bag of detonators found at the scene of a terrorist train bombing in Madrid. While this very public and embarrassing error should have shaken the foundations of fingerprint comparison science, it too was frequently minimized in subsequent testimony and characterized by other examiners as being an aberration – the failure of some employees to properly follow the perfect method, not a possible flaw in the system itself.

It was not until after the release of the National Research Council's 2009 report Strengthening Forensic Science in the United States: A Path Forward (hereafter "National Achievement Survey [NAS] Report")[1] that the fingerprint community began to take a hard look at the statements that were being made in reporting and testimony and to reevaluate the best way to present fingerprint evidence.

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Since 2009, change has been slow to take effect, yet changes are underway. This paper will begin with a brief history of court acceptance of fingerprint testimony, then will present the arguments for why the commonly used style of testimony should be updated and will end with some discussion of a possible future direction for fingerprint reporting and testimony.

A Very Brief History of Admissibility in the United States

Fingerprint testimony has hitherto existed under a kind of grace in the American court system. As an early "police science", the field of fingerprint identification was already well-established in the courts by the time the Frye standard was introduced in 1923 (Frye v. United States, 293 F. 1013, 1014 (D.C. Cir. 1923). The Frye decision stated that a novel scientific practice "must be sufficiently established to have gained general acceptance in the particular field to which it belongs" to be admissible in court. However, since fingerprint evidence had already been in use for 13 years at that point, its general acceptance was never questioned nor was it considered novel.

The Frye standard held for 50 years in the United States until, in 1973, Federal Rules of Evidence (FRE) 702 stated:

> "If scientific, technical or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise."

The significance of the introduction of FRE 702 was that it conferred on the expert scientific or technical witness the right to offer opinion testimony, as opposed to being limited to testifying to only facts within their personal knowledge, as is the case with other witnesses.

Finally, in 1993, the decision in Daubert v. Merrell Dow Pharmaceuticals (Daubert v. Merrell Dow Pharms, Inc. 509 U.S. 579, 113 S.Ct. 2786 [1992]) once again took up the issue of admissibility of scientific evidence, designating the judge to a gatekeeper role, and providing five guidelines for judges to consider in determining admissibility:

1. Whether the theory or technique in question can be (and has been) tested
2. Whether it has been subjected to peer review and publication
3. Its known or potential error rate
4. Existence and maintenance of standards controlling its operation
5. Whether it has attracted widespread acceptance within a relevant scientific community.

These broad guidelines were not intended to be a required checklist, but rather to provide guidance in the kinds of things judges should be considering in their decisions. In most jurisdictions in the United States, one of these three standards still prevails in determining the admissibility of fingerprint evidence.

The Role of the Expert in the Courtroom

FRE 702 best describes why expert testimony is needed in the courtroom – to assist the trier of fact with understanding technical or scientific information that is beyond the scope of a layman's knowledge. For this reason, the main role of the expert in the courtroom is to educate. Expert witnesses should see themselves as teachers, although teachers with severe constraints on the time and methods available to them to teach their subjects. They should endeavor to use simple, straightforward explanations that make their results unambiguous and easy to understand.

Unfortunately, this is often not the case. Rather than using testimony as an opportunity to educate, traditional testimony training has emphasized the tactic of saying as little as possible, using short, memorized phrases to give an impression of infallibility that will discourage questions on cross-examination and convince the trier of fact to believe the offered conclusions implicitly. This attitude does a disservice to the trier of fact because it deprives them of information they need to make an informed decision on the weight of the evidence.

While FRE 702 gives the expert witness permission to testify in the form of an opinion, fingerprint experts often believe that they can only be of use to the courts if they are presenting facts. The threshold for admissibility of evidence is that it be probative, a word encompassing that it must (1) be relevant and (2) tend to prove or disprove a fact in question (i.e., to make the fact more or less likely than it was before hearing the evidence). There is a great deal of probative information that a fingerprint examiner can share with the courts without resorting to speaking in absolutes, but they fear that if they do not claim infallibility in their methods and 100% certainty in their results, their testimony will be found inadmissible. It is because of this fear that the style of testimony outlined above has been in vogue for more than 100 years.

The Dogma Expert and the Transparent Expert

When considering testimonial styles, fingerprint experts fall largely into one of the two categories: the dogma expert and the transparent expert. Throughout this paper, the old style of the dogma expert will be contrasted with the new style of the emerging transparent expert.

The dogma expert represents the traditional style of testimony. He speaks in absolutes, using familiar catch phrases such as "exclusion of all others," "100% certain," and "zero-error rate." His testimony sounds unassailable, but under close examination has very little substance behind it. He speaks in generalities and supports his claims with vague statements, such as "there are studies" without citing any. He is skilled at reframing difficult questions to answer the question he wants to answer rather than the one that was actually asked. If

backed into a corner, he becomes defensive or condescending, relying on phrases such as "I've been doing this for X number of years" or "based on my training and experience" or "I've never been shown to have made an error" that imply his years of experience have somehow made him flawless.

In contrast, the transparent expert is characterized by openness and modesty. She does not claim to be perfect. She qualifies her answers to minimize ambiguity and offers an additional explanation to clarify her answers. When discussing her conclusions or studies in her field, she is specific and will voluntarily discuss the limitations of those conclusions and studies, providing context and caveats. Rather than trying to state the unknowable with authority (e.g., "fingerprints are unique"), she will admit the limitations of her knowledge, then go on to describe what she does know and how that knowledge is helpful to the issue at hand. She is always returning to the particular case and her particular policies and standards, to give the trier of fact an accurate view of the weight that can be put on the evidence she is presenting.

The Argument for Change

In this section, many traditionally used phrases and approaches will be examined, juxtaposing the way they have been presented in the past with the arguments for why they should be changed and suggestions for better ways to present the evidence.

Based on my training and experience

This phrase is commonly used as a rationale for the identification conclusion. When asked how one reached a decision of identification, an examiner will often respond, "based on my training and experience, I concluded that the mark was made by John Doe."

The trouble with this phrasing is that it is unscientific. Conclusions are not based on training and experience; they should be based on data. Training and experience are important, but they are not the basis of a scientific conclusion. The conclusion should be based on the quantity, clarity, and rarity of features noted in agreement or disagreement between two impressions being compared. The interpretation of that data is done using training and experience. A better way to phase this idea might be, "My conclusion is based on the data I observed in the two impressions, which I interpreted using my training and experience."

The unassailable progression

Conventionally, the foundation on which fingerprint identification rests is built something like the following:

- Fingerprints are unique
- Because friction ridge skin is unique, latent marks can be matched back to their sole source (individualized)
- The comparison method has a zero-error rate
- Therefore, you can be 100% certain of the result.

The logic of this progression of statements is watertight. If each premise is accepted at face value, there is no room for argument. Unfortunately, each statement represents a gross overstatement of the science. We will examine each one individually.

Uniqueness

Conventionally, uniqueness has been stated as a known fact. Fingerprints are unique. If questioned, this statement has been supported by reference to stochastic processes during ridge formation, snowflake theory (everything in nature is unique), and the black swan argument ("I've never seen two that were the same, therefore they must be unique"). The trouble with these weak arguments is that none of them constitutes proof although they have been presented as proof, such as in the following testimony by well-respected fingerprint examiner Pat Wertheim (In Transcript of Hearing in State of Arizona v. Juan Angel Ruiz, Superior Court of the State of Arizona No. CR-20100857, August 30, 2010 [Div. 10]):

Q. One of the premises in fingerprint analysis is that the friction ridges persist, correct?
A. Yes, ma'am.

Q. And that those formations are unique; is that right?
A. That's correct.

Q. Has there been, to your knowledge, has the question ever been asked scientifically and then studied and research performed to determine whether fingerprints are unique?
A. Yes.

Q. And what is that study?
A. Well, there have been a number of studies. I mentioned Dr. William Babler's work on the formation of friction skin, and his observations regarding the random or accidental formation of those features. We are talking about uniqueness here, correct?

Q. Yes.
A. Yes. The empirical proof of uniqueness derives more from 100 years of use in fingerprints. No two people have ever been found to have the same areas of skin, but even more importantly since 1978 the automated fingerprint identification systems (AFIS) computers, have been in use worldwide. In those computers, millions, tens of millions of fingerprints are continuously being compared to each other and no two have every been found to be the same.

When Mr. Wertheim is further pressed to provide a scientific study that specifically demonstrates the uniqueness of fingerprints, he references a nonpeer-reviewed study that provides a weak statistical model of the likelihood of a fingerprint pattern being repeated, but again, does not constitute proof of uniqueness. To Mr. Wertheim's credit, he did include in his testimony some caveats on the limitations of the study:

Q. But as far as, a scientific study goes to determine whether fingerprints are unique, there has not been a determination about that?
A. There was. There was the FBI study in 1999 that they referred to as the 50 K study [description of study cut for length]. Now, that particular study was on the biology of the skin,

and it has very limited application to the comparison between a latent print and an inked print, but those studies have been done.

In a more egregious example from tenprint comparison testimony, which often cites the same uniqueness premise as latent print testimony, the analyst in Acosta-Roque (In Transcript of Hearing in Acosta-Roque v. Holder, File A 73 523 551, Immigration Court, Executive Office for Immigration Review, U.S. Dept. of Justice, Oct. 13, 2010 [9th Cir. 2012]) gives the following testimony:

Q. What is the likelihood of two people possessing the same fingerprints?
A. That won't happen. No two people have the same fingerprints

Q. Okay, is that – and how – I mean, how do you know that? Is there a scientific study?
A. There have been scientific studies, yes.

At this juncture, the defense attorney (the defendant, in this case, was representing himself) should have asked what studies the examiner was referring to. She would have been hard pressed to produce one since none exist. The fact is that we don't know whether fingerprints are unique. The only way to determine such a thing would be to compare every finger on earth with every other finger – and even that would only give us a snapshot of the fingers on earth at the moment the study was done. It would not account for those of the previously deceased, nor those who had not yet been born. Practically speaking, there is no possible way to conduct a study that could conclusively prove that fingerprints are unique.

The argument that no two have been found to be indistinguishably similar is weak. It takes only a single instance to prove the argument wrong (such as with the early belief that there were no black swans because only white ones had ever been observed – until a population of black swans was discovered in Australia). Added to this is the fact that there has not been a comprehensive search. Out of all the fingers that have ever existed or ever will exist on the planet, only a very small subset has been compared to one another.

Another counter-argument sometimes offered to "fingerprints haven't been proven to be unique" is "well, they haven't been proven to repeat either". While this is a true statement, it is not an effective argument for uniqueness. When the truth of matter is unknown and insufficient experimentation has been done to settle the matter, one does not simply choose the alternative they prefer and call it proven. To claim that fingerprints either are or are not unique, one of these positions must be sufficiently demonstrated. Until that is done, all that can be said is that we do not know.

There exists a wealth of literature[2-6] that tends to support the premise of uniqueness, but support for a premise is not the same as claiming it is unequivocally true. Furthermore, the support for the premise of uniqueness comes in the form of biological and statistical studies that demonstrate the high degree of variability among fingerprints. Now, here is a demonstrable fact. Fingerprints are highly variable.

Moreover, this is helpful information. Variability leads to discriminability. The more different kinds of things there are, the easier it is to separate them. Imagine a world, in which there were only two possible sets of fingerprints – everyone possessed one set or the other. In such a world, it would be possible to neatly sort the world's population into one of these two classes. Were we to increase the number of fingerprint sets to ten, it would be possible to discriminate between individuals as being a member of one of ten classes. And so it goes, as we add more variations, we are better and better able to resolve people into smaller and smaller groups.

The fact is fingerprints have been shown to be incredibly variable. So variable, in fact, that not only do identical twins have different patterns, but even the ten fingers on the same person display different ridge paths. Explained to a jury in this way, it becomes clear that there is more than enough variability between individual fingerprints to be useful in discriminating between them without ever making an insupportable claim of uniqueness.

However, there is also a weakness in the link between uniqueness and the claim by fingerprint examiners that they can correctly associate latent marks with the sole source that created them. Even if one were to grant the uniqueness claim as true regarding complete fingers, it does not necessarily follow that all marks are discernably unique to the degree that the correct (and only the correct) association can be made nor that all examiners have the ability to do so on all days.

When fingerprint comparisons are being made, they are not being made from friction ridge skin to friction ridge skin. They are being made from one imperfect, incomplete recording to another. Sometimes, the recordings are extremely imperfect or incomplete. Take for example, the Mayfield error alluded to earlier. One of the factors held responsible for the error was the "unusual similarity of the prints."[7] However, on examining the three images side by side [Figure 1], one notes that the two exemplars (far right and far left) though somewhat similar, exhibit many clear differences. The two are demonstrably unique to one another. Yet, the unknown mark acts as a bridge

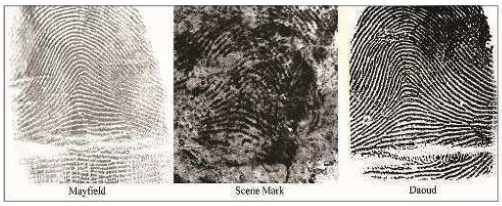

Figure 1: Three impressions from the Mayfield error. On the left is the erroneously identified known exemplar from Brandon Mayfield, in the middle is the unknown mark from the scene, and on the right is the subsequently identified known exemplar from Ouhnane Daoud

between them, confusing the issue of identity. Add in the fact that examiners vary in skill throughout their careers, and even day to day, as fatigue, visual acuity, training, and other human factors affect them, and it becomes clear that the proposition of correctly associating a degraded mark to its true source is by no means a certainty, even were one to presume absolute uniqueness of all friction ridge skin.

Individualization (and the exclusion of all others)

Once the decision to identify has been made, the examiner is stating that, in their opinion, the unknown mark has been made by the same source as the known print and that the possibility that it could have been made by another source is so small that it can be dismissed. In the past, the terms identification and individualization were viewed as synonymous in the fingerprint community and the term individualization was often appended with the phrase "to the exclusion of all others." This was a logical extension of the uniqueness argument, for if fingerprints are unique, and this mark has been individualized to that source, then logically, nobody else could have made it.

In the wake of the NAS report, the International Association for Identification (IAI) responded almost immediately, suggesting "(…) members are advised to avoid stating their conclusions in absolute terms when dealing with population issues."[8] However, as Cole[9] rightly pointed out, simply excising the "six words" really didn't solve anything, for whether one says "individualization" or "individualization to the exclusion of all others", the implication is the same. To individualize is to reduce the pool of candidates down to one single source, which *de* facto excludes all others.

And as with uniqueness, the exclusion of all others is a defensive construct that is unnecessary. Examiners like it because it makes their conclusion sound more absolute – this person made the mark, and nobody else could have. However, it is once again an unnecessary overstatement of the evidence.

The claims of uniqueness and the exclusion of all others depend on the idea of no two fingers in the world being the same. However, when one takes an identification to court, the trier of fact is not interested in any two fingers in the world. They are interested in the mark that is at issue in the trial.

When an identification to one mark is being considered, there are two possible situations of interest: the identification was the result of a one-to-one comparison (e.g., to a named suspect, victim, or officer), or the identification was the result of a one-to-many comparison (e.g., a search in a large database, such as an AFIS).

In a one-to-one comparison, the question of interest is: what is the probability that someone other than the defendant could have made the unknown mark? In other words, the probability that some other member of the population made the mark, but the defendant happens to be the one unlucky, random member of the population whose finger is so similar it was mistaken for the true source. This is what is known as the random match probability and due to the high variability of fingerprints, it is assumed to be quite small. Furthermore, because this random match probability is a proportion within the population, it is not population-size dependent. In other words, as the size of the population increases, the number of chances increases with it so that the ratio is always the same.

In a one-to-many comparison, the question of interest is: what is the probability of a coincidental match? In other words, the probability that any other finger in the database could be so similar to the unknown mark that it could be mistaken as its source. In this case, the size of the population does matter, such that as the database size increases, the probability of finding a coincidental match also increases. However, note that we are still not asking whether any two fingers in the database match; we are still focused only on finding a match for the unknown mark of interest.

To understand the relationship between these two cases, and without doing any math, we will use the visual representation in Figure 2. Figure 2 shows a theoretical world population consisting of ten individuals. In panel 2(A), we see the one-to-one comparison. The red arrow indicates the unknown mark/identified individual pairing. The line represents the one chance of those features matching those of one random person in the population. In panel 2(B), we see the one-to-many comparison. The red arrow still indicates the unknown mark/identified individual pairing, but now, there are more lines, showing all the extra chances there are to find any finger in the population that shares the same characteristics. It can be seen that there are many more chances of this occurring in the one-to-many comparison than in the one-to-one comparison. Finally, in panel 2(C), we examine the proposition that is claimed under uniqueness/exclusion of all others, namely, that of any two fingers in the entire population being indistinguishably similar. Note that, we are no longer confining ourselves to a single finger of interest and that there are now many, many more chances to find two similar fingers – and this was with a population of only ten. Now imagine how many chances there would be to find two indistinguishable fingers among a population over 70 billion (the current approximate population of the earth multiplied by ten fingers each).

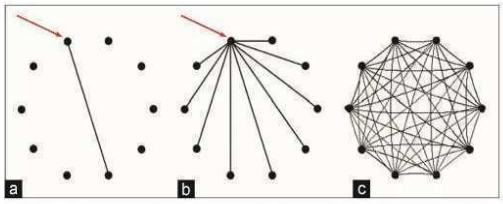

Figure 2: The conceptual difference in the number of chances to find a coincidental match under three different propositions in a hypothetical world population of ten individuals. (a) One-to-one comparison. The identified individual is being compared to a single other individual chosen randomly from the population. (b) One-to-many comparison. The identified individual is being compared to every other member of the population. (c) Global uniqueness. Every individual in the population is being compared to every other individual in the population

With this many chances to find indistinguishably similar fingerprints, it is conceivable that there may be two such in the world – but it is irrelevant. The entire world's population did not have access to the crime scene, and we are not interested in if any two fingerprints may be found to be indistinguishably similar. We are interested in whether this fingerprint that is being presented in court could be confused for either one random person in the population, or anyone else in a database (depending on the source of the identification). As was just demonstrated, these numbers are much smaller.

Is there a risk of a misidentification to the wrong source under the right conditions of distortion due to two people having similar fingerprints? Of course, there is. The Mayfield error demonstrated that it can happen. However, in a one-to-one comparison, that risk is very small. In a one-to-many comparison (which is what Mayfield was), the risk is considerably larger and needs to be managed. However, in neither case is it necessary nor desirable to claim global uniqueness, or that the entire world's population has been excluded.

100% certainty

If asked about their level of certainty in their decision, fingerprint examiners have traditionally testified that they are 100% certain of their results.The claim of 100% certainty comes from a laudable desire by agencies and practitioners to be sure they got it right. During training, new examiners are generally told something along the lines of your testimony could be directly responsible for someone spending their life in prison, or even being executed, so you had better not sign your name to a report unless you are 100% certain of your result.

While it is true that examiners should not be reporting results, in which they do not have a very high level of personal confidence, there are several problems with couching that confidence in terms of 100% certainty. The first is that 100% certainty is a foreign concept to the practice of science. Science is built on principles of repeatability and falsifiability – in other words, scientific conclusions are always open to being repeated by someone else, and updated if new data are discovered. At one time, Newton's laws were considered to be 100% certain, until it was found that they did not hold in every case and were updated by Einstein's theory of relativity, which was more universal.

The second problem with a claim of 100% certainty is that it is misleading to the trier of fact because it implies that some mathematical calculation has been done. Since fingerprint examiners do not currently calculate uncertainty in their measurements, it is misleading to report a number that sounds as if they have. They can report the subjective level of their personal confidence, but they should not make it sound as if there is no chance of error.

One appropriate way to convey this information is through the use of a subjective probability. A subjective probability is an examiner's assessment of how strong they feel the evidence is and it should vary from case to case based on the complexity of the comparison. The examiner should feel comfortable discussing the amount of data in agreement, the clarity of that data, and the rarity of the data to support the strength of the evidence.

Recall that the expert is allowed to testify in the form of an opinion. That is a critical point here because the examiner is not presenting a fact with 100% certainty attached; they are offering an opinion on which of two propositions is better supported by the evidence that the two impressions under consideration came from the same source, or they came from different sources.

One suggestion for a way to phrase this has been made by the Expert Working Group on Human Factors in Latent Print Analysis:[10]

It is far more probable that this degree of similarity would occur when comparing the latent print with the defendant's fingers that with someone else's fingers.

Zero-error rate

The genesis of the zero error rate claim was the case of US v. Mitchell (1993), (In Transcript of Hearing in United States v. Byron Mitchell, U.S. District Court for the Eastern District of Pennsylvania Case No. 96-407, July 1999) which was the first case in the United States, in which fingerprint admissibility was challenged under Daubert. During his testimony, Steve Meagher of the FBI testified that there were two types of error – methodological error and practitioner error – and that the error in the process was zero.

There are two problems with this statement. The first is that, in fingerprint examinations, you cannot separate the methodology from the practitioner. Because the identification decision is ultimately a subjective one, taking place in the mind of the examiner, the examiner is the instrument of the examination. Thus, the examiner is the method. It is not like in controlled substance analysis where there is an instrument performing analyses, which may introduce error of its own, separate from interpretive error of the analyst. For fingerprints, the analyst does both the analysis and the interpretation.

In addition, the Analysis, Comparison, Evaluation, and Verification (ACE-V) method has been criticized as being too broad a framework to qualify as a methodology,[1,11] and this criticism has merit. ACE-V is not properly a methodology in the sense of being a detailed list of specific tasks. It is simply a framework for articulating a mental process that one goes through during a comparative examination – the analysis and interpretation of the analyst, as alluded to above. Considered in this light, one could argue that there is no methodology and therefore, no methodological error rate. There is a process, but it is a mental process and is an integral part of the practitioner. Methodological error and practitioner error are one and the same in this case.

The second problem with a claim of zero-error rate is that errors have occurred. The known errors in fingerprint comparison make a claim of zero-error rate demonstrably false.

On February 19, 2009, in response to the NAS Report, Garrett (then president of the IAI) issued a letter stating that, "It is suggested that members not assert 100% infallibility (zero error rate) when addressing the reliability of fingerprint comparisons."[8] While this is excellent advice, it may leave examiners wondering what error rate they ought to report.

Providing an error rate for fingerprint comparisons turns out to be a challenging task. There really is not one, single-error rate for all of fingerprint comparison practice. There are many reasons for this.

The first difficulty lies in defining what error rate is wanted. When someone asks, "what is the error rate for fingerprint comparisons", are they asking about the false positive rate, the false negative rate, or the positive or negative predictive values? Are they considering inconclusive conclusions to be errors? Are they considering suitability decisions as potential errors? What about clerical errors?" Each of these situations requires a different calculation and will result in a different number.

But perhaps, more important is the issue of where do the data come from for the error rate calculation? Ideally, there would be a benefit to knowing the rate of false positives committed in casework, but this can never be calculated because in casework, ground truth is never known. Error rates can be constructed based on a consensus of conclusions from several experts, but error rates constructed in this way would not test accuracy; they would only test reproducibility.

To test accuracy, one must rely on structured research and testing, in which ground truth is known, but studies of this sort introduce their own host of issues. The first is the fact that, in most cases, participants are aware they are being tested. This makes them vulnerable to a phenomenon known as the Hawthorne Effect, in which people alter their behavior when they know they are being observed.

In addition to the Hawthorne Effect, in structured experiments participants are generally asked to work in unfamiliar conditions, often using unfamiliar conclusions and under time constraints. The difficulty of marks encountered may differ from typical casework as well as the ratio of same source to different source trials. In addition, structured research experiments are often presented as one-to-one comparisons where the unknown and known image are presented side-by-side, and the participant is asked to render a decision, but no searching task is incorporated. Each of these variables may change the results of the study incrementally from the "true value" of what the error rate may be in casework.

Furthermore, there is not one error rate for fingerprint comparisons because not all comparisons are the same and not all examiners are the same. Some comparisons are very easy; these are unlikely to result in error. Some are very complex; these are more likely to result in error. Logically, one would expect the error rate to be higher in difficult comparisons, and this has been demonstrated.[12] However, different examiners also have different skill levels based on training, visual acuity, and other human factors, and in fact, even the same examiner may have different skill levels on different days, or at different times of the day. Factors such as fatigue, emotional state, and recent experience (e.g., discovery of an erroneous identification in one's work) can affect an examiner's responses.

At the end of the day, existing error rate studies are an estimate of the true error rate for the field. How good that estimate is will depend on how similar the testing conditions were to working conditions. Because of this, it would be inappropriate to say something like, "the study reported a 1% error rate, so there is a 1% chance I made an error in this case." It would instead be appropriate to say something like, "the study reported a false positive error rate of 1% which means that, under the study conditions, participants made false positive errors 1% of the time on average." It would then be most appropriate to continue the explanation to present the limitations of the studies.

The important point to convey to the trier of fact is that error rate studies are a useful tool for getting an estimated error rate for a field, but they cannot be taken as predictive of anyone examiner's performance in any one case. So what is a good predictor of an examiner's performance? The difficulty level of the examination, the demonstrated skill of the examiner (through rigorous proficiency testing) and the quality system in the examiner's workplace.

After dealing with error rate studies in general terms, the transparent expert will return the conversation to the case at hand. She will discuss the difficulty level of the comparison in the case, and if it was difficult, explain how she reached her decision and what quality measures her laboratory has in place to minimize the risks of an error.

The Evolution of Testimony

The previously highlighted testimony provides examples of the sort of testimony offered by the dogma expert. Unfortunately, these are neither isolated cases, nor relics of the distant past. This sort of testimony is still being used by many fingerprint experts in the United States today.

Summaries of pretrial conferences between the public defender and fingerprint experts have been included as appendices to some 2015 motions to exclude fingerprint testimony in Cook County, Illinois and are startling in the degree of ignorance about advances in the field that they display. In the interviews, experts claimed to have no knowledge of such watershed documents as the NAS Report,[1] the NIST Human Factors Report,[10] the NIJ Sufficiency study,[13] or the IAI response to the NAS Report by then-President Garrett.[8] When asked questions such as if they've ever heard of the Scientific Working Group on Friction Ridge Analysis, Study, and

Technology or of cognitive bias; if they'refamiliar with studies in the literature on error rates; or what standard they use to reach an identification conclusion, they respond that they are not going to answer the question. Clearly, the dogma expert is alive and well in 2015.

While these types of responses are shocking in this day and age, other experts have been trying to make the shift to more transparent testimony. An early example came in 2008 with Minnesota v. Hull, (MN v. Hull,[2008] No. 48-CR-07-2336 [Minn. D. Ct. Cty. Of Mille Lacs]), in which fingerprint experts Bergeron and Langenburg first tried to separate the concepts of identification and individualization and to introduce subjective probabilities during a motion to exclude hearing. In summarizing the distinction between the two as described by Mr. Bergeron, Mr. Langenburg stated:

> What Mr. Bergeron said is he has examined a latent print; he has found these features; they're corresponding to another individual; and he's made a decision that the chance that someone else could have left that is so remotely small, he's willing to dismiss it and say yes, I believe that this latent print in my opinion was produced by that individual. He did not say that he's excluded everyone else on the planet and he left a theoretical possibility that there might be someone else on the planet that could have produced a similar looking latent print. And he has no way of calculating what that probability is at this time. So, you know, I agree with the testimony that he provided.

This testimony represents a major departure from the testimony of a dogma expert and a large step in the direction of transparency. A second example of this style of testimony can be found in Oregon v. Angius (2010) (OR v. Angius,[2010] No. 200924231 [Cir. Ct. Ore. Lane Cty]) where fingerprint expert Eldridge articulated testimony similar to that offered in Hull in regard to the definition of identification, and further made an attempt to describe the smaller, relevant population that should be considered in lieu of excluding the earth's population.

Q. Okay. And who is the relevant population?
A. Anybody who may have had reasonable access. I'm – start off with people in the United States, if you like, or people alive right now. You know, something smaller than all the prints:

Q. So which – those are three very different things.
A. Yes.

Q. On the one hand, you're looking at the facts of the case and you're saying, well, anyone who had access.
A. Mn-hmm.

Q. Okay. What is the scientific justification for you to consider that as your pool?
A. Well, the pool isn't really up to me. I mean that's – that's kind of information about the case that I'm not privy to. Really I'm just looking at the prints. The less I know about the case the happier I am …

Q. Right. But we're talking about the relevant population.
A. Mm-hmm.

Q. Who is the relevant population that you are excluding?
A. It's going to vary. I mean, I don't think I can give you a sort of solid answer on that because it's going to depend on where the incident happened, who was around when it happened. A lot of things we don't know.

Q. So you – so then how can you know – how can you make this conclusion without knowing who you're excluding?
A. I guess what I'm saying is that I'm not specifically excluding anyone, because I haven't made a comparison against that person. What I'm doing is including someone. And I'm allowing for the possibility that there may theoretically be another possible conclusion out there…

While this testimony occurred early in the field's emergent transition from dogma to transparent expert and is thus somewhat unsophisticated in its presentation, the expert is attempting to convey the mathematical power of reducing the pool of candidates to have donated the unknown mark from all the fingers in the world, to a much smaller, relevant population who may have had access to the scene. Without knowing contextual case information, the fingerprint expert is not equipped to determine the size of this population, but may be confident that it is exponentially smaller than the population of the earth.

This testimony represents another step in the right direction toward modesty and transparency, but as is correctly pointed out by Cole[9,14] does not go far enough toward providing the trier of fact with truly clear information regarding the strength of the evidence.

As noted by Cole,[14] and advocated by Champod,[15] another approach to transparent testimony (and the next step in the evolutionary process) is to present only the strength of the evidence in the form of a likelihood ratio and allow the trier of fact to put it into the case context to arrive at an appropriate conclusion regarding source. There are some challenges to implementing this approach as well since the models needed to support the strength of the evidence have not yet been completed and validated.

However, the Department of Defense's Defense Forensic Science Center (DFSC) took this approach in 2015, changing their reporting language to a statement that sounds very much like a verbal statement of parts of the likelihood ratio:

> The latent print on Exhibit ## and the record finger/palm prints bearing the name XXXX have corresponding ridge detail. The likelihood of observing this amount of correspondence when two impressions are made by different sources is considered extremely low.

This statement indicates the direction of the likelihood ratio (in support of the proposition the two impressions share a common source), but does not indicate the strength of the support, which would need to be elaborated on by the testifying expert. This

support could be expressed numerically (e.g., 100,000 times more likely), or verbally (e.g., very strong support for the proposition).

There are some concerns about this mode of presenting fingerprint testimony. One is that without a validated numerical model in place to support the strength of the evidence, the expert is essentially choosing it subjectively. This argument has some merit, but neglects two essential points. The first is that models themselves are susceptible to subjectivity due to underlying assumptions built into the model, or specific features entered into the model by the examiner. Thus, even through the use of a model, subjectivity will not be entirely avoided. The second is that subjective expressions of weight of evidence are still a vast improvement over traditional statements of 100% certainty to the exclusion of all others in that they at least transparently admit that it is not possible to exclude all others and provide a rationale for the expert's perceived strength of the evidence. This position could be further strengthened by providing numerical support for the strength of the evidence in the form of estimates of the prevalence of pattern types or specific features in the population based on known population data.

In fact, the DFSC recently took the additional step of incorporating a numerical strength of the evidence based on an internally developed statistical model. In March of 2017, they released an information paper describing the use of their tool, FRStat, and providing the following modified reporting language, which they have subsequently begun using to report associations made by their fingerprint unit:

> The latent print on exhibit ## and the standards bearing the name XXXX have corresponding ridge detail. The probability of observing this amount of correspondence is approximately ## times greater when impressions are made by the same source rather than by different sources.

The second barrier to presenting probabilistic testimony is a lack of awareness of how it will be received by the trier of fact. Current research on jury interpretation of probabilistic evidence is sparse, but the research that has been done has tended to indicate that jurors are not particularly good at assigning it appropriate weight within the context of a case.[16,17]

Conclusion

Fingerprint comparison testimony in the United States is in the midst of a major philosophical shift. For more than 100 years, testimony has been characterized by speaking in absolutes, presenting the method and results as infallible, 100% certain, and factual. These dogma experts have provided short, memorized answers that tend to overstate the evidence and mislead the trier of fact, and they become defensive and condescending if challenged on these dogmatic statements.

In the wake of the NAS Report, some high profile errors, and several other important reports and studies, a gradual shift is underway toward more transparent testimony. The transparent expert is characterized by an attempt to provide fuller explanations and more nuanced conclusions. Rather than overstating the science behind the conclusions, she is careful to point out its limitations and endeavors to present conclusions in a logical framework that allows the trier of fact to assess the weight of the evidence in an appropriate context.

This transition is not without its growing pains as experts struggle to evolve better means of communicating their findings and understand how their words are interpreted by the trier of fact, and models to support this new style of testimony are still being developed and validated for use. However, the overall trend has been toward an improvement in communication that one hopes will result in a greater understanding of conclusions and a reduction in miscarriages of justice.

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Conflicts of interest

There are no conflicts of interest.

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