

Metrology, Jury Voir Dire and Scientific Evidence in Litigation

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Attorneys should reconceptualize the individual jurors' voir dire when a case involves the presentation of scientific evidence. One of the attorney's objectives must be encouraging the jury's acceptance of scientific concepts and the scientific method as applied to forensic science. Although each case is decided based upon its facts and circumstances, the laws of nature and practice of good science are still applicable to the case. Scientific evidence is derived from a process governed by the scientific method. Forensic science is the application of science to law. Law enforcement agents extensively rely upon evidence couched in what are presented as scientific principles and technology in criminal prosecutions. All cases involving criminal charges generally entail some aspect of scientific evidence and forensic science. The discipline of criminalistics utilizes familiar laboratory techniques and procedures to solve crime but does not always do so scientifically. Forensic science is applicable to civil cases in certain instances. Forensic science is the most persuasive of all evidence. Jurors must be prepared to treat it as science and be given basic scientific tools to evaluate it by the attorneys in the case.

This article briefly offers another perspective on the jury selection process at the trial court level when scientific evidence is an indispensable element of the case. It will focus on metrology (science of measurement) in forensic science and related litigation. Metrology usually concerns the probative weight and credibility, not necessarily the admissibility of evidence. The article will not address different types of juries, juror's response to scientific evidence or expert witness testimony, jury instructions (scientific evidence), and complex case litigation. Litigation advantage goes to the experienced jury trial attorney who knows and understands science. The jury selection process should include educating the jury from a lateral thinking perspective. It is incumbent upon the attorney to confront the specific applied science's fallibility and result. Ergo, metrology during the jury's voir dire [1].

The Anglo-American judicial system and jury voir dire is used as an illustration for the purpose of initially educating the trier of fact in metrology, how metrology is perceived

and metrological implications. Similar orientation principles for international use are applicable without a jury issuing the verdict. The proposed focused informative questions and simple educational explanations are presented during the case's opening statement before the judge. The same format is repeated with the questions including answers during the case's summation and closing argument. The trier of fact is exposed to metrological principles through cognitive reinforcement during the jury voir dire, opening statement, witness examination and closing argument.

Jurors

Jurors interpret the case commensurate with their life, education, experiences, common sense, morals and mores. A juror's knowledge or opinion of science may affect the case's outcome. What does the jury actually know about science? Society's knowledge of specific facts connected with life sciences, earth sciences and other physical sciences varies. This variation of scientific knowledge is applicable to both forensic science and general science. Jurors need to be educated on basic relevant terminology and principles of metrology during the voir dire process. Too often lay people confuse science with other disciplines (e.g., metrology / meteorology) or science with pseudo-science (e.g., astronomy / astrology, cosmology / cosmetology).

All scientific testimony must be established from solid theory, and accepted practice; test results [2] presented as evidence must be accurate and reliable. However, all tests use metrology and uncertainty that must be accounted for as well. Emphasizing metrology is necessary for conveying the fact that all scientific results exist within a range of possible answers. Ergo, the results' reliability and trustworthiness must include the inherent uncertainty that necessarily attaches to the evidence.

Right to Jury Trial

Jury selection is the beginning phase of the courtroom trial process. It is a critical aspect. Prospective jurors ("venirepersons") are selected for service through voir dire, a process

contingent upon their qualifications, attitudes and beliefs. The jury voir dire process and questioning is controlled by the court. In some courts, this is preformed through personal questioning by attorneys, in others, questioning is conducted by the court, and still others, attorneys are permitted to submit written questions and oral suggestions for the judge to ask. Thereafter, depending on the jurisdiction, the attorneys may supplement the questioning.

The defendant's right to a fair jury trial is either statutory or constitutional depending upon the nature of the case. A jury trial for serious offenses is a fundamental right and cornerstone of the criminal justice system, unless the entitlement to a jury is voluntarily waived by the defendant [3]. The impartial jury is supposed to be a representative cross section of community, but not necessarily of any particular composition.

Jury Composition and Selection

The function of voir dire is to assist the parties in ensuring an impartial jury. Each party (litigant) is permitted a predetermined number of peremptory challenges and unlimited number of challenges for cause to dismiss a potential juror. Parties are entitled to truthful and honest answers from jurors for determining use of their challenges. The voir dire process is within the judge's broad discretion and control.

A significant aspect of the jury voir dire process is to: 1) obtain background information on the juror (education, personal background, possible sources of bias or prejudice, knowledge of the case, preconceptions as to subject matter etc.); 2) condition and sensitize jurors to the theory of the case and the evidence; 3) expose weakness and detrimental aspects of the case and defuse them; and 4) establish attorney credibility, trustworthiness and a rapport with the jurors.

Jurors are selected due to their personal characteristics (demographics, personality factors, attitudes related and unrelated to the case). However, the better educated person or person trained in the case's subject matter will usually make more accurate decisions than other jurors [4] and are more likely to take notes [5] during the case. This characteristic is important when considering scientific evidence or technical matters [6].

Jury Challenges and Removal

Prospective jurors are selected during the jury voir dire (questioning of the jurors) phase of the trial. Attorneys may object or exempt venirepersons by formally challenging them through two methods - cause or peremptory challenges.

A challenge for cause is an objection to an individual juror alleging a specific reason, or cause [7] that the person is incapable or unfit to serve on the jury as a matter of law. An unlimited number of causal challenges may be used to dismiss the person if counsel establishes a valid reason pending the judge's approval.

A peremptory challenge is made to a juror without assigning any reason [8] and these are limited in number by court rules or statute. Peremptory challenges may not be used in an arbitrary, capricious or unfettered manner by either party if it

purposefully violates equal protection (e.g., shared or different race [9], gender [10]). Excluding jurors contingent on their attitudes, interest and bias pertaining to science and technology are still discretionary deciding factors in the jury voir dire. Use of peremptory challenges due to the juror's intelligence, education, knowledge of science or technology is problematic and adversely effects fairness and equal justice. When the number of peremptory challenges is exhausted, the attorney may only challenge a juror for cause.

Science and Technology Discrimination

Attorneys should inquire about the basis for an opponent's removing people from the panel with science or technical backgrounds. The implication is that the opponent is lowering the general intelligence level ("dumbing down") of the jury [11], thereby denying the defendant a fair trial, while simultaneously relying upon science or technology as its primary evidence. An argument of de facto intellectual discrimination (equal protection) should be pursued. This practice of intellectual juror discrimination is indicative of fundamental unfairness and undermines the necessity of finding the truth.

The case of *State of Washington v. Corey Engstrom* presents an example of intellectual discrimination practiced during jury voir dire. Engstrom was charged with driving while intoxicated (DUI) with a breath alcohol concentration above the statutory limit. Scientific evidence was critical to proving the *per se* violation. The prosecution used its peremptory challenges to remove the only two members of the jury venire with technical backgrounds. Upon being dismissed, one of the venirepersons asked the judge:

"Maybe it's just my opinion, but I guess, I don't quite understand why [the only] two technical people were rejected by the State."

The judge responded saying the government's decision was not provided. Whereupon, the prosecutor replied:

"The State felt that Mr. X as an electrical engineer and as a supervisor thought as typically people in the situation do ... Just that in my experience as a lawyer, people in Mr. X's position frequently find themselves of the opinion that they are smarter than any of the witnesses and will adjust their opinions as to reject the opinions of State's experts ... I believe that the prejudice that's resulted from allowing this excused juror to ask that question has prejudiced my case, my presentation of the evidence beyond any question, especially with Mr. Vosk here who I know is particularly acute at challenging these technical aspects" [12].

The case was dismissed without prejudice on different grounds, thereby avoiding a ruling on intellectual discrimination premised on a violation of equal protection. (*Batson v. Kentucky* [9] and *J.E.B. v. Alabama* [10]).

What Jurors Need to Know

The jury needs to understand and appreciate both the test result value and its context within the various sources of uncertainty (error and reliability) as part of its decision making process. However, most forensic science reports do not discuss measurement uncertainties or their meaning.

Test Results

The test results in forensic science are routinely generated through law enforcement's crime laboratory. The education level in crime laboratories is usually: Doctorate (Ph.D.) degree—1%; Master of Science degree—3%; and Bachelor of Science degree or less—96%. Non-scientists practicing science: 1) rely upon equipment, manufacturer provided information and reputation; and 2) do not intrinsically know and understand science, interpretation and use [13]. Ways of understanding this information should be conveyed to the jury venire.

Litigator vs Trial Attorney

The experienced trial attorney who knows and understands science has the litigation advantage primarily in the criminal justice system. In the courtroom there is a difference between a litigator and trial attorney. The lawyer may be a litigator but not a trial attorney. The litigator engages in motion practice encompassing civil matters and legal action that may entail filing lawsuits and presenting preliminary matters in court. The lawsuits are usually settled before trial. The trial attorney's practice specializes in trials (bench and jury) most often in the criminal justice system and actually litigates the case to completion or verdict.

Voir Dire Information Questions—Science

The jury voir dire can be developed in a clear and concise manner, using simple, short single fact statements or questions.

Educational Explanations for Prospective Jurors

The attorney should consider educating the jury by explaining selected sample metrological concepts (alphabetically presented):

Accuracy: Accuracy is the lack of error; how close a measurement is to its true value.

Error:

- ▶ Error is the difference between the true value of the measurand (quantity or object being measured) and the measured value.
- ▶ The difference between error and uncertainty.
- ▶ The different types of error (random, systematic (procedural), arithmetic, gross and confirmation bias).

Forensic Science: The difference between real science (astronomy, cosmology) with pseudoscience (astrology, cosmetology) or pattern identification (latent prints, firearms and ballistics, document/handwriting etc.) [14]–[16] and “junk science” [17]–[19] or “pseudoscience” [20] (e.g., bite mark impressions [21],

comparative bullet lead analysis, hair morphology evidence, voice print identification, dog-scent lineups [22], blood pattern (spatter) analysis [23], Abel Assessment [24], Penile Plethysmography [25]–[27], clothing (based pattern seams on denim pants) [28], cheiloscopy (lip prints) [29], and phrenology) [30], [31].

Metrology:

- ▶ The science of metrology.
- ▶ The difference between metrology and meteorology.

Phrases: Explain the nonsense of the phrases “reasonable scientific certainty” or “to a reasonable degree of a discipline's certainty” or “practical certainty” and that they are misleading, ambiguous, idiosyncratic, confusing and must not be used or implied [32]. These idiomatic expressions are being taken out of existence by the adoption of standards for reporting forensic science and discussion of results. No basis for certainty exists, especially when it is not known what the “certainty” is, its definition and its application [33]–[37]. The meaningless colloquialism was historically created and perpetuated by attorneys without a basis in law or fact [38].

Scientific Evidence:

- ▶ The definition of scientific evidence and forensic science.
- ▶ Scientific evidence being supported by empirical data and objective criteria.

Terminology:

- ▶ The difference between accuracy, precision, reproducibility, traceability and reliability of results offered as scientific evidence.
- ▶ The difference between quality control and quality assurance requirements.
- ▶ The difference between scientific knowledge and scientific method.
- ▶ The term individualization refers to “absolute specificity” and “absolute identification.” There is no scientific basis for the individualization in criminalistics [39]–[40].
- ▶ The term uncertainty as the range of values that may be true or false within with a level of confidence.
- ▶ The difference between error rates (methodology in general) and likelihood ratios (specific analysis) [41].

Questions for Prospective Jurors

The attorney should consider asking jurors the following sample questions regarding scientific evidence and metrological concepts. (alphabetically presented)

Accreditation: Does laboratory accreditation and proficiency testing prevent mistakes or errors. (e.g., driver's licence renewals and interim traffic violations)

Bias:

- ▶ If human bias effect test results.
- ▶ If technological results are affected by bias.

- ▶ If bias in measuring instruments and values can artificially elevate or depress the true value or result.
- ▶ If the instrument or equipment self-corrects for bias.

Calibration / Certification: If the measuring device or instrument must be regularly calibrated and certified.

Deception/Fraud:

- ▶ Whether or not “lexicographic dexterity” and “weasel words” should be used to conceal, confuse, exaggerate or obfuscate the results.
- ▶ If misnomers, conclusory terminology, operative words, expressions, results, individualizing statements, verbal labels, categorical decisions etc. can be used to mischaracterized the results [42]–[48].
- ▶ If misleading terminology and phraseology of uniqueness, absoluteness and exaggeration are used should the result be disregarded [49].

Error:

- ▶ If error begets error.
- ▶ If new analytical techniques are subject to error.
- ▶ If algorithms are impartial or subject to error [50].
- ▶ If zero error rates exist.
- ▶ If verbal scales without degrees of uncertainty or error should be used to report results [51].

Fairness / Equal Justice: If impartial forensic science is crucial to equal justice and promoting fairness.

Instrumentation / Equipment: If equipment or instrumentation mandated or approved by statute or administration regulation is it inherently accurate and reliable.

Measurement: If all types of measurement are subject to uncertainty.

Methodology: Does the juror trust the scientific method and science generally.

Quality Assurance / Quality Control:

- ▶ If quality assurance requirements must be maintained.
- ▶ If quality control requirements must be maintained.

Science:

- ▶ If they believe in science.
- ▶ If language and facts are indispensable in communicating science.
- ▶ If scientific facts are self-evident or obvious.
- ▶ If the aura of mythical scientific infallibility exists.
- ▶ Does the juror ideologically accept science?
- ▶ Is science fact or faith based.
- ▶ Does the juror understand science and the specific topic of analysis in this case?
- ▶ If science is supposed to be systematic, logical, and methodical.

Scientific Evidence:

- ▶ If results and scientific evidence should include the limitations of analysis, measurement, reported uncertainty and associated estimated probabilities.
- ▶ If faulty scientific evidence exists.
- ▶ If faulty scientific evidence has been used to convict the innocent.
- ▶ If “The absence of evidence is not evidence of absence” [52].
- ▶ If there are strengths and weaknesses to scientific evidence.
- ▶ If there are any areas or types of scientific evidence that are considered or assumed to be highly reliable.

Standards / Proof:

- ▶ If forensic science must be impartial.
- ▶ If one of forensic science’s objectives is to impartially serve and benefit society.
- ▶ If forensic science is used to convict the guilty and protect or exonerate the innocent.
- ▶ If the government must prosecute and convict based on all of the evidence.
- ▶ If the proponent of an item of evidence must prove that the item is in fact what it is claimed to be [53].
- ▶ If scientific evidence is better evidence than other evidence.

Test Results / Conclusions:

- ▶ If the imprimatur of a government agency, laboratory, office, or title makes the results authoritative, accurate, trustworthy, credible or reliable.
- ▶ If evidence, reports and opinions should be within the bounds of empirical findings and available knowledge and not faith based [54].
- ▶ Whether science test results and conclusions must be clear and reproducible.
- ▶ Whether results and conclusions must be derived from the scientific method.
- ▶ If scientific results can be misunderstood.
- ▶ If accuracy is the difference between the measurement and the actual value.
- ▶ If precision is the reproducibility or repeatability of a measurement or value.
- ▶ If reports and testimony should use clear and straightforward terminology, clearly distinguishing data from interpretations, opinions, and conclusions.
- ▶ If reports and testimony should disclose known limitations that are necessary to understand the significance of the findings.
- ▶ If laboratory accreditation is separate and different from the analysts’s competency, credibility, and test results.
- ▶ If membership in a scientific organization is dependent upon the analyst’s competency or ability to pay membership dues.

Uncertainty:

- ▶ If uncertainty is a vagueness as to preclude anything more than guesswork, as a result that is questionable, doubtful, or not definite.

- If uncertainty and error are critical measurements necessary to ascertain the weight of evidence [55].

Validation:

- If validation must be performed on the method or process for a result and particular purpose.

Conclusion

“Illegal and unconstitutional jury selection procedures cast doubt on the integrity of the whole judicial process. They create the appearance of bias in the decision of individual cases, and they increase the risk of actual bias as well.” Justice Thurgood Marshall [55].

Justice requires science must be accurately and effectively communicated to the fact finder. Peremptory challenges due to the juror’s knowledge of science or technology adversely affects fairness and equal justice. The practice of intellectual jury discrimination is problematic and undermines the necessity of finding the truth. The attorney has a moral, ethical and legal duty to confront peremptory dismissals of jurors through metrological information during the jury voir dire. The government must not prosecute and convict on less than all of the evidence. Freedom is only a word until it is lost.

Disclaimer

This article is intended to provide general information; it does not provide legal advice applicable to any specific matter and should not be relied upon for that purpose. Interested parties should review the laws with their attorney to determine how they will be affected by the laws.

Endnotes and References

[1] Voir dire is from the French language meaning “to speak the truth.” The term is used in two contexts relating to trials: first, the prospective jury is voir dired by the attorneys to determine their qualifications and second, after the proponent of an expert witness asks questions of the witness to bring out the person’s qualifications, the opposing attorney is allowed to voir dire the witness to bring out matters that might prevent his qualification as an expert. G. Sapiro, “Qualifying the expert witness: a practical voir dire,” *Forensic Mag.*, February/March, vol. 4, no. 1, 2007; 30, 34.

[2] “Result” is too often used generically (e.g., conclusion, decision, determination, findings, opinion, results) by examiners for the result of analysis even though differences may exist in epistemic strength and use (decision theory and decision analysis) when applied to forensic science. S. Cole and A. Biederman, “How can a forensic result be a ‘decision’? a critical analysis of ongoing reforms of forensic reporting formats for federal examiners,” *Hous. L. Rev.*, vol. 57, pp. 555-560, 2020, accessed Jun. 28, 2020; 551. [Online]. Available: <https://bit.ly/3eZJdbD>.

[3] In the United States of America the right to a jury trial is created through the Sixth and Fourteenth Amendments to the U.S. Constitution.

[4] B. Kennedy and M. Hefferon, “What americans know about science, science knowledge levels remain strongly tied to

education, republicans and democrats are about equally knowledgeable,” *Science*, Mar. 28, 2019, (accessed June 1, 2020). [Online]. Available: <https://www.pewresearch.org/science/2019/03/28/what-americans-know-about-science/>.

[5] Note taking does not appear to improve comprehension of complicated or scientific testimony. D. L. Faigman, D. H. Kaye, M. J. Saks, J. Sanders and E. K. Cheng, “Ethical standards of and concerning expert witnesses,” in *Modern Scientific Evidence: The Law and Science of Expert Testimony*, vol. 1. Eaton, MN, USA: Thomson/West, 2017-2018; sect. 4.2.

[6] [5, Sec. 4.34].

[7] Specific reason or cause, for example, are: statutory; physical infirmity; physical or economic hardship; age; language impediments; incompetence; pecuniary interest; pending litigation; partiality; cannot be fair; biases; hostilities; friendships, etc.

[8] Peremptory challenges are premised upon intuition, belief or voir dire answers, and if the person is biased or not impartial.

[9] *Batson v. Kentucky*, 476 U.S. 79 (1986) (race).

[10] *J.E.B. v. Alabama ex rel. T.B.*, 511 U.S. 127 (1994) (gender).

[11] “The essence of science is to ask an impertinent question, and you are on your way to a pertinent answer.” J. Bronowski, *The Ascent of Man*. London, UK: BBC Books, 1973.

[12] BrAC test results of .112 & .113 from a model BAC Datamaster CDM. *State of Washington v. Corey Engstrom*, Case No. 3Z0306792, King County District Court, Seattle Division, State of Washington (Jan. 2014).

[13] M. J. Saks, “What makes forensic scientists open or closed to change?” presented at *Bioinformatics 5th Ann. Conf. 2006: The Science of DNA Profiling*, Dayton, Ohio, USA, Aug. 2006.

[14] Common items in forensic science, for example are: fibers; breath and blood alcohol concentration analysis; drug concentrations; tool marks; ballistics identification; voice and facial analysis; forensic DNA analysis; velocity measurements of vehicles (radar devices and LIDAR); chemical identification and concentrations, etc. The impression and pattern analyst’s subjectively information reasoned opinions (Bayesian) are generally scientifically unsubstantiated (imprint analysis, finger prints, bloodstain pattern analysis, hair morphology, bullet striations, bite marks, footwear analysis, tire tracks, handwriting).

[15] G. Sapiro, “Legal aspects of forensic science,” in *Forensic Science Handbook*, vol. 1, 3rd ed., R. Saferstein and A. Hall, Eds., ch. 1, p. 23. Boca Raton, FL, USA: CRC Press/Francis-Taylor, 2020.

[16] T. Vosk and A. Emery, *Forensic Metrology: Scientific Measurement and Inference for Lawyers, Judges, and Criminalists*. Boca Raton, FL, USA: CRC Press/Francis-Taylor, 2014; 153.

[17] “Junk science” is the mirror image of real science, with much of the same form but none of the same substance.” P. W. Huber, *Galileo’s Revenge: Junk Science in the Courtroom*. New York, NY, USA: Basic Books/Harper Collins Publishers, 1991; 2.

[18] J. J. Koehler, “Forensics or fauxrensicis: ascertaining accuracy in the forensic sciences,” *Ariz. St. LJ*, vol. 49, 2017; 1369.

[19] [15]. Junk science usually consists of flawed, unreliable, exaggerated, and sometimes fabricated testimony usually founded on questionable methodology.

[20] [15, p. 23].

- [21] Bitemarks. C. M. Bowers, "Review of a forensic pseudoscience: identification of criminals from bitemark patterns," *J. Forensic and Legal Medicine*, vol. 61, pp. 34-39, 2019.
- [22] Dog-scent lineup. *Winfrey v. State of Texas*, 323 S.W.3d 875, 881 (Tex. Court of Criminal Appeals, 2010).
- [23] Blood pattern analysis. Texas Forensic Science Commission, Final Report on Complaint by the Harris County Public Defender's Office Against the Harris County Institute of Forensic Sciences, Harris County Sheriff's Office and Houston Police Department, 2018, accessed Nov. 22, 2018. [Online]. Available: www.txcourts.gov/media/1441773/16-40-final-report-harris-co-public-defenders-office-for-norma-clark-02022018.pdf.
- [24] Abel Assessment for Sexual Interest (Abel Screening) is unreliable and rejected in federal court. *People v. Fortin*, CA Court of Appeal, 2nd App. Dist. 6th Div., 2017; 524, 533-534.
- [25] Penile Plethysmograph (PPG). The penile plethysmograph (phallometric) for evidentiary purposes is not reliable and fails the "scientific validity" prong of *Daubert*. The scientific validity of the technique as a diagnostic tool is suspect, not reliable or therapeutically beneficial, highly invasive and does not deter crime. As with the polygraph, the PPG may not be used for evidential purposes. P. C. Giannelli, E. J. Imwinkelried, A. Roth and J. C. Moriarty, *Scientific Evidence*, vol. 1, 5th ed. New Providence, NJ, USA: LexisNexis, 2012; sect 9.08.
- [26] R. O'Shaughnessy, "Commentary: phallometry in court problems outweigh benefits," *Am. Acad. Psychiatry Law*, vol. 43, no. 2, 2015; 154.
- [27] A fictional account of the diagnostic and therapy business of libido. K. Amis, *Jake's Thing*. New York, NY, USA: Viking Press, 1978.
- [28] Pattern seams on denim pants. S. J. Nightingale and H. Farid, "Assessing the reliability of a clothing-based forensic identification." *Proc. National Acad. of Sciences*, vol. 117, no. 10, pp. 5176-5183, Mar. 2020.
- [29] Cheiloscopy in forensic science is the comparison of human lip imprints and impressions for personal identification. The purported discipline relies primarily on outdated or erroneous references from non-primary sources. Confirmatory salivary DNA is not used. The methodology lacks standardization, validity, reliability, and metrological testing analysis. G. M. Fonseca *et al.*, "Lip print identification: current perspectives," *J. of Forensic and Legal Medicine*, vol. 65, 2019; 32-38. Its proponents ignore the severe criticism of the National Academy of Science Report 2009 and the wrongful conviction case of *People of Illinois v. Levelle Davis*, 879 N.E.2d 996 (Ill. App. Ct. 2007) which relied on the "phoney forensic testimony." Cheiloscopy should be considered "pseudo-science" or "junk science."
- [30] D. L. Faigman, "Anecdotal forensics, phrenology, and other abject lessons from the history of science, UC Hastings Scholarship Repository, 59 *Hastings L. J.* 979, 2008, accessed Sep. 6, 2020. [Online]. Available: http://repository.uchastings.edu/faculty_scholarship/867.
- [31] H. H. Bauer, "Anomalistics, pseudo-science, junk science, denialism: corollaries of the role of science in society," *J. Sci. Exploration*, vol. 28, no. 1, 2014.
- [32] Use of these words, "scientific" or "medical" and "certainty" together is an "empty formalism." The phrase is a mantra repeated by experts for legal decision makers who similarly have no idea what it means. D. L. Faigman, "Evidentiary incommensurability: a preliminary exploration of the problem of reasoning from general scientific data to individualized decision-making," *Brooklyn L. Rev.*, vol. 75, 2010; 1115,1134-35.
- [33] National Commission on Forensic Science, *Recommendations to the Attorney General Regarding Use of the Term "Reasonable Scientific Certainty"*, Mar. 22, 2016; 1.
- [34] P. Hora, T. Stalcup, B. MacKenzie and D. Wallace, Eds., *Science Bench Book for Judges*, The National Judicial College, Justice Speakers Institute, Reno, NV., July, 2019; sect.3.10.2, 33,35, sect. 9.1.2, 261-262, accessed Jun. 21, 2020. [Online]. Available: <http://resources.judges.org/downloads/science-bb.pdf>.
- [35] United States Department of Justice Uniform Language for Testimony and Reports for the Forensic Firearms/Toolmarks Discipline Pattern Examination, sect iv, eff. Aug. 15, 2020. [Online]. Available: <https://www.justice.gov/olp/uniform-language-testimony-and-reports>.
- [36] P. C. Giannelli, "Scientific evidence 'reasonable scientific certainty': a phrase in search of a meaning," *Criminal Justice*, vol. 25, pp. 40-41, 2010.
- [37] T. Vosk, "Measurement uncertainty: requirement for admission of forensic science evidence," *Wiley Encyclopedia of Forensic Science*, A. Jamieson and A. Moenssens, Eds. Chichester, UK: John Wiley, 2015; 14, p. 235.
- [38] [15, p. 13].
- [39] M. J. Saks and J. J. Koehler, "The individualization fallacy in forensic science evidence," *Vand. L. Rev.*, vol. 61, 2008; 199, 205.
- [40] Forensic scientists use the fallacious term "individualization" instead of the word "match" because the analysis is about probability, not necessarily certainty. J. J. Koehler and M. J. Saks, "Individualization claims in forensic science: still unwarranted," *Brook. L. Rev.*, vol. 95, 2009; 1187, 1199.
- [41] "Error rates communicate information about the accuracy of a categorical conclusion, while likelihood ratios typically describe strength of evidence without requiring the examiner to make a categorical, match/no match determination." B. L. Garrett, W. E. Crozier, and R. Grady, "Error rates, likelihood ratios, and jury evaluation of forensic evidence," *J. Forensic Sci.*, vol. 65, Jul. 2020; 1199, 1200, 1205.
- [42] Language and facts are indispensable in communicating science. Operative words, expressions and terminology involving frequency, individualizing statements or probability such as "consistent with," "could have," "highly likely," "very or highly probable," "practical certainty," "far more probable," "did come from," "match," "identification," "rare or unusual shared set of features," "individualization," "unique," "discernable uniqueness," "sufficient agreement," "zero error rate" must be supported by empirical data and objective criteria. B. L. Garrett and P. J. Neufeld, "Invalid forensic science testimony and wrongful convictions," *Va. L. Rev.*, vol. 95, 2009; 1, 19.
- [43] K. Servick, "Sizing up the evidence," *Science*, pp. 1130-1132, 2016.
- [44] The identification standard utilized by Assoc. of Firearms and Tool Mark Examiners (AFTE) is "sufficient agreement," meaning "that the agreement [between the two items] is of a quantity and quality that the likelihood another tool could have made the mark

is so remote as to be considered a practical impossibility." *U.S. v. Otero*, 849 F.Supp.2d 425, 431 (quoting AFTE methodology).

- [45] The AFTE methodology, "acknowledges that there is a subjective component to the determination of 'sufficient agreement,' which must necessarily be based on the examiner's training and experience." *U.S. v. Ashburn*, 88 F. Supp.3d 239,243 (E.D.N.Y. 2015). The AFTE does not address variability, reliability, repeatability, number of correlations to achieve "a degree of confidence."
- [46] Verbal labels are personal, subjective and do not convey certainty. For example, "weak or limited support," "more likely" or expressions of likelihood ratio terminology (weak, moderate, moderately strong, strong, very strong, extremely strong). K. A. Martire, R. I. Kemp, I. Watkins, M. A. Sayle and B. R. Newell, "The expression and interpretation of uncertain forensic science evidence: verbal equivalence, evidence strength, and the weak evidence effect," *Law Hum. Behavior*, vol. 37, no. 3, 2013; 197, 198.
- [47] The English Courts have disapproved of the use of the term 'consistent with' by experts since 2005. "Whereas 'inconsistency' is often probative, the fact of consistency is quite often of no probative value at all. In this case his evidence of consistency had no probative value, assuming the correctness of this answer in re-examination." *Puaca, R. v* [2005] EWCA Crim 3001 (24 November 2005), para. 42, England and Wales Court of Appeal Decisions, accessed Nov. 4, 2018. [Online]. Available: <http://www.bailii.org/ew/cases/EWCA/Crim/2005/3001.html>.
- [48] American Statistical Association Position on Statistical Statements for Forensic Evidence Presented under the guidance of the ASA Forensic Science Advisory Committee, January 2, 2019; 2.
- [49] [38], [39]. "With words fine arguments can be weighted. With words whole Systems can be created. With words, the mind does its conceiving. No word suffers a jot from thieving." Mephistopheles, *Faust* by Johann Wolfgang von Goeth.
- [50] Algorithms are not impartial. Bias exists in algorithms due to being written by people. Empirical studies are required for sound analysis, probative values and decision. The judicial system should assume algorithms are not impartial.[45]; M. Hamilton, "Judicial gatekeeping on scientific validity with risk assessment tools," *Behav. Sci. Law*. vol. 38, pp. 226-245, 2020; 38.
- [51] I. E. Dror, and N. Scurich, "(Mis)use of scientific measurements in forensic science," *Forensic Science International: Synergy*, 2020.
- [52] Martin John Rees, Baron Rees of Ludlow.
- [53] The Authentication Doctrine is a prerequisite to reliability. When scientific testimony is offered, the proponent must prove the

testimony is produced by valid, scientific techniques and that the process or system produced an accurate result. E. J. Imwinkelried, *Exculpatory Evidence: The Accused's Constitutional Right to Introduce Favorable Evidence*. Charlottesville, VA, USA: Michie Co., 1990; sect. 6-4.

- [54] Too often the impression and pattern analyst's opinions are generally scientifically unsubstantiated (e.g., imprint analysis, finger prints, bloodstain pattern analysis, hair morphology, bullet striations, bite marks, footwear analysis, tire tracks). Historically this evidence relies upon on the trained eyes and subjective judgement of human examiners, not on rigorous statistical analysis or metrology. (uncertainty/error analysis). The analyst's opinions are usually predicated upon personal speculation, misconception, expectation or an overstatement of significance and leaps of faith. The imprimatur of the analyst's employment or title does not automatically make their findings and opinions inherently credible or reliable. [34], [35].
- [55] [51] Most forensic domains do not have established error rates.
- [56] Justice Thurgood Marshall (*Peters v. Kiff*, 407 U.S. 493, 502), 1972.

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