

**RMSCIEVID 55**  
Reference Manual on Scientific Evidence (Third Edition)  
FEDERAL JUDICIAL CENTER  
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## **FINGERPRINTS**

FBI examiners generally follow a procedure known as analysis, comparison, evaluation, and verification (ACE-V). In the analysis stage, the examiner studies the latent print to determine whether the quantity and quality of details in the print are sufficient to permit further evaluation. [FN117] The latent print may be so fragmentary or smudged that analysis is impossible. In the evaluation stage, the examiner considers at least the Level 2 details, including “the type of minutiae (forks or ridge endings), their direction (loss or production of a ridge) and their relative position (how many intervening ridges there are between minutiae and how far along the ridges it is from one minutiae to the next).” [FN118] Again, if the examiner finds a single, inexplicable difference between the two prints, the examiner concludes that there is no match. [FN119] Alternatively, if the examiner concludes that there is a match, the examiner seeks verification by a second examiner. “[T]he friction ridge community actively discourages its members from testifying in terms of the probability of a match; when a latent print examiner testifies that two impressions [76] ‘match,’ they are communicating the notion that the prints could not possibly have come from two different individuals.” [FN120] The typical fingerprint analyst will give one of only three opinions: (1) the prints are unsuitable for analysis, (2) the suspect is definitely excluded, or (3) the latent print is definitely that of the suspect.

### **B. The Empirical Record**

At several points, the 2009 NRC report noted that there is room for human error in fingerprint analysis. For example, the report stated that because “the ACE-V method does not specify particular measurements or a standard test protocol, . . . examiners must make subjective assessments throughout.” [FN121] The report further commented that the ACE-V method is too “broadly stated” to “qualify as a validated method for this type of analysis.” [FN122] The report added that “[f]he latent print community in the United States has eschewed numerical scores and corresponding thresholds” and consequently relies “on primarily subjective criteria” in making the ultimate attribution decision. [FN123] In making the decision, the examiner must draw on his or her personal experience to evaluate such factors as “inevitable variations” in pressure, but to date these factors have not been “characterized, quantified, or compared.” [FN124] At the conclusion of the section devoted to fingerprint analysis, the report outlined an agenda for the research it considered necessary “[t]o properly underpin the process of friction ridge identification.” [FN125] The report noted that some of these research projects have already begun. [FN126]

With the exception of one federal district court decision that was later withdrawn, [FN169] the post-Daubert federal cases have continued to accept fingerprint testimony about individuation at least as

sufficiently reliable nonscientific expertise. [FN170]

FN170. See, e.g., *United States v. Baines*, 573 F.3d 979, 990 (10th Cir. 2009) (“[U]nquestionably the technique has been subject to testing, albeit less rigorous than a scientific ideal, in the world of criminal investigation, court proceedings, and other practical applications, such as identification of victims of disasters. Thus, while we must agree with defendant that this record does not show that the technique has been subject to testing that would meet all of the standards of science, it would be unrealistic in the extreme for us to ignore the countervailing evidence. Fingerprint identification has been used extensively by law enforcement agencies all over the world for almost a century.”); *United States v. Abreu*, 406 F.3d 1304, 1307 (11th Cir. 2005) (“We agree with the decisions of our sister circuits and hold that the fingerprint evidence admitted in this case satisfied Daubert.”); *United States v. Janis*, 387 F.3d 682, 690 (8th Cir. 2004) (finding fingerprint evidence to be reliable); *United States v. Mitchell*, 365 F.3d 215, 234-52 (3d Cir. 2004); *United States v. Crisp*, 324 F.3d 261, 268-71 (4th Cir. 2003); *United States v. Collins*, 340 F.3d 672, 682 (8th Cir. 2002) (“Fingerprint evidence and analysis is generally accepted.”); *United States v. Hernandez*, 299 F.3d 984, 991 (8th Cir. 2002); *United States v. Sullivan*, 246 F. Supp. 2d 700, 704 (E.D. Ky. 2003); *United States v. Martinez-Cintrón*, 136 F. Supp. 2d 17, 20 (D.P.R. 2001).

## **HANDWRITING**

Questioned document examiners are called on to perform a variety of tasks such as determining the sequence of strokes on a page and whether a particular ink formulation existed on the purported date of a writing. [FN177] However, the most common task performed is signature authentication--that is, deciding whether to attribute the handwriting on a document to a particular person. Here, the examiner compares known samples of the person's writing to the questioned [84] document. In performing this comparison, examiners consider (1) class and (2) individual characteristics. Of class characteristics, two types are weighed: system [FN178] and group. People exhibiting system characteristics would include, for example, those who learned the Palmer method of cursive writing, taught in many schools. Such people should manifest some of the characteristics of that writing style. An example of people exhibiting group characteristics would include persons of certain nationalities who tend to have some writing mannerisms in common. [FN179] The writing of arthritic or blind persons also tends to exhibit some common general characteristics. [FN180]

Individual characteristics take several forms: (1) the manner in which the author begins or ends the word, (2) the height of the letters, (3) the slant of the letters, (4) the shading of the letters, and (5) the distance between the words. An identification rarely rests on a single characteristic. More commonly, a combination of characteristics is the basis for an identification. As in fingerprint analysis, there is no universally accepted number of points of similarity required for an individuation opinion. As with fingerprints, the examiner's ultimate judgment is subjective.

There is one major difference, though, between the approaches taken by fingerprint analysts and questioned document examiners. As previously stated, the typical fingerprint analyst will give one of only

three opinions: (1) the prints are unsuitable for analysis, (2) the suspect is definitely excluded, or (3) the latent print is definitely that of the suspect. In contrast, questioned document examiners recognize a wider range of permissible opinions: (1) definite identification, (2) strong probability of identification, (3) probable identification, (4) indication of identification, (5) no conclusion, (6) indication of nonauthorship, (7) probability of nonauthorship, (8) strong probability of nonauthorship, and (9) elimination. [FN181] In short, in many cases, a questioned document examiner explicitly acknowledges the uncertainty of his or her opinion. [FN182] Whether such a nine-level scale is justified is another matter. [FN183]

examiners to express individuation opinions. [FN216] As one court noted, “all six circuits that have addressed the admissibility of handwriting expert [testimony] . . . [have] determined that it can satisfy the reliability threshold” for nonscientific expertise. [FN217] In contrast, several courts have excluded expert testimony, [FN218] although one involved handprinting [FN219] and another Japanese handprinting. [FN220] Many district courts have endorsed a third view. These courts limit the reach of the examiner's opinion, permitting expert testimony about similarities and dissimilarities between exemplars but not an ultimate conclusion that the defendant was the author (“common authorship” opinion) of the questioned document. [FN221] The expert is allowed to testify about “the specific similarities and idiosyncrasies between the known writings and the questioned writings, as well as testimony regarding, for example, how frequently or infrequently in his experience, [the expert] has seen a particular idiosyncrasy” [FN222] As the justification for this limitation, these courts often state that the examiners' claimed ability to individuate lacks “empirical support.” [FN223]

FN215. See, e.g., *United States v. Hidalgo*, 229 F. Supp. 2d 961, 967 (D. Ariz. 2002) (“Because the principle of uniqueness is without empirical support, we conclude that a document examiner will not be permitted to testify that the maker of a known document is the maker of the questioned document. Nor will a document examiner be able to testify as to identity in terms of probabilities.”).

FN216. See, e.g., *United States v. Prime*, 363 F.3d 1028, 1033 (9th Cir. 2004); *United States v. Crisp*, 324 F.3d 261, 265-71 (4th Cir. 2003); *United States v. Jolivet*, 224 F.3d 902, 906 (8th Cir. 2000) (affirming the introduction of expert testimony that it was likely that the accused wrote the questioned documents); *United States v. Velasquez*, 64 F.3d 844, 848--52 (3d Cir. 1995); *United States v. Ruth*, 42 M.J. 730, 732 (A. Ct. Crim. App. 1995), *aff'd* on other grounds, 46 M.J. 1 (CA.A.F. 1997); *United States v. Morris*, No. 06-87-DCR, 2006 U.S. Dist. LEXIS 53983, \*5 (E.D. Ky. July 20, 2006); *Orix Fin. Servs. v. Thunder Ridge Energy, Inc.*, No. 01 Civ. 4788 (RJH) (HBP). 2005 U.S. Dist. LEXIS 41889 (S.D.N.Y. Dec. 29, 2005).

FN217. *Prime*, 363 F.3d at 1034.

FN218. *United States v. Lewis*, 220 F. Supp. 2d 548 (S.D. W. Va. 2002).

FN219. *United States v. Saelee*, 162 F. Supp. 2d 1097 (D. Alaska 2001).

FN220. *United States v. Fujii*, 152 F. Supp. 2d 939, 940 (N.D. Ill. 2000) (holding expert testimony concerning Japanese handprinting inadmissible: ““Handwriting analysis does not stand up well under the

Daubert standards. Despite its long history of use and acceptance, validation studies supporting its reliability are few, and the few that exist have been criticized for methodological flaws.”).

FN221. See, e.g., *United States v. Oskowitz*, 294 F. Supp. 2d 379, 384 (E.D.N.Y. 2003) (“Many other district courts have similarly permitted a handwriting expert to analyze a writing sample for the jury without permitting the expert to offer an opinion on the ultimate question of authorship.”); *United States v. Rutherford*, 104 F. Supp. 2d 1190, 1194 (D. Neb. 2000) (“[T]he Court concludes that FDE Rauscher's testimony meets the requirements of Rule 702 to the extent that he limits his testimony to identifying and explaining the similarities and dissimilarities between the known exemplars and the questioned documents. FDE Rauscher is precluded from rendering any ultimate conclusions on authorship of the questioned documents and is similarly precluded from testifying to the degree of confidence or certainty on which his opinions are based.”); *United States v. Hines*, 55 F. Supp. 2d 62, 69 (D. Mass. 1999) (expert testimony concerning the general similarities and differences between a defendant's handwriting exemplar and a stick-up note was admissible while the specific conclusion that the defendant was the author was not).

FN222. *United States v. Van Wyk*, 83 F. Supp. 2d 515, 524 (D.N.J. 2000).

FN223. *United States v. Hidalgo*, 229 F. Supp. 2d 961, 967 (D. Ariz. 2002).

## **FIREARMS- BALLISTICS**

Bullet identification involves a comparison of the evidence bullet and a test bullet fired from the firearm. [FN239] The two bullets are examined by means of a comparison microscope, which permits a split-screen view of the two bullets and manipulation in order to attempt to align the striations (marks) on the two bullets.

Barrels are machined during the manufacturing process, and imperfections in the tools used in the machining process are imprinted on the bore. [FN240] The subsequent use of the firearm adds further individual imperfections. For example, mechanical action (erosion) caused by the friction of bullets passing through the bore of the firearm produces accidental imperfections. Similarly, chemical action (corrosion) caused by moisture (rust), as well as primer and propellant chemicals, produce other imperfections.

When a bullet is fired, microscopic striations are imprinted on the bullet surface as it passes through the bore of the firearm. These bullet markings are produced by the imperfections in the bore. Because these imperfections are randomly produced, examiners assume that they are unique to each firearm. [FN241] Although the assumption is plausible, there is no statistical basis for this assumption. [FN242]

[94] Although an identification is based on objective data (the striations on the bullet surface), the AFTE

explains that the examiner's individuation is essentially a subjective judgment. The AFTE describes the traditional pattern recognition methodology as “subjective in nature, founded on scientific principles and based on the examiner's training and experience.” [FN243] There are no objective criteria governing this determination: ““Ultimately, unless other issues are involved, it remains for the examiner to determine for himself the modicum of proof necessary to arrive at a definitive opinion.” [FN244]

### **Automated identification systems**

“These ballistic imaging systems use the powerful searching capabilities of the computer to match the images of recovered crime scene evidence against digitized images stored in a computer database.” [FN250] The current system is the Integrated Ballistics Information System (IBIS). [FN251] Automated systems “give[ ] firearms examiners the ability to screen virtually unlimited numbers of bullets and cartridge casings for possible matches.” [FN252] These systems identify a number of candidate matches. They do not replace the examiner, who still must make the final comparison: “High Confidence' candidates (likely hits) are referred to a firearms examiner for examination on a comparison microscope.” [FN253] The examiner need [96] not accept the highest ranked candidate identified by the system. For that matter, the examiner may reject all the candidates.

The early post-Daubert challenges to the admissibility of firearms identification evidence failed. [FN282] This changed in 2005 in *United States v. Green*, [FN283] where the court ruled that the expert could describe only the ways in which the casings were similar but not that the casings came from a specific weapon “to the exclusion of every other firearm in the world.” [FN284] In *United States v. Monteiro* [FN285] the expert had not made any sketches or taken photographs and thus adequate documentation was lacking: “Until the basis for the identification is described in such a way that the procedure performed by [the examiner] is reproducible and verifiable, it is inadmissible under Rule 702.” [FN286]

In 2007 in *United States v. Diaz* [FN287] the court found that the record did not support the conclusion that identifications could be made to the exclusion of all other firearms in the world. Thus, “the examiners who testify in this case may only testify that a match has been made to a ‘reasonable degree of certainty in the ballistics field.’” [FN288] In 2008, *United States v. Glynn* [FN289] ruled that the expert could [102] not use the term “‘reasonable scientific certainty’” in testifying. Rather, the expert would be permitted to testify only that it was “more likely than not” that recovered bullets and cartridge cases came from a particular weapon.

Yet other courts continued to uphold admission. [FN290] By way of example, in *United States v. Williams*, [FN291] the Second Circuit upheld the admissibility of firearms identification evidence--bullets and cartridge casings. The opinion, however, contained some cautionary language: “We do not wish this opinion to be taken as saying that any proffered ballistic expert should be routinely admitted.” [FN292] Several cases limited testimony after the 2009 NAS Report was published. [FN293] In the past, courts often have admitted toolmark identification evidence, [FN294] [103]

including screwdrivers, [FN295] crowbars, [FN296] punches, [FN297] knives, [FN298] as well as other objects. [FN299] An expert's opinion is admissible even if the expert cannot testify to a positive identification. [FN300]

FN283. 405 F. Supp. 2d 104 (D. Mass. 2005).

FN284. *Id.* at 107. The court had followed the same approach in a handwriting case. See *United States v. Hines*, 55 F. Supp. 2d 62, 67 (D. Mass. 1999) (expert testimony concerning the general similarities and differences between a defendant's handwriting exemplar and a stick-up note was admissible but not the specific conclusion that the defendant was the author).

FN285. 407 F. Supp. 2d 351 (D. Mass. 2006).

FN286. *Id.* at 374.

FN287. No. CR 05-00167 WHA, 2007 WL 485967 (N.D. Cal. Feb. 12, 2007).

FN288. *Id.* at \*1.

FN289. 578 F. Supp. 2d 567 (S.D.N.Y. 2008).

FN290. See *United States v. Natson*, 469 F. Supp. 2d 1253, 1261 (M.D. Ga. 2007) (“According to his testimony, these toolmarks were sufficiently similar to allow him to identify Defendant's gun as the gun that fired the cartridge found at the crime scene. He opined that he held this opinion to a 100% degree of certainty. . . . The Court also finds [the examiner's] opinions reliable and based upon a scientifically valid methodology. Evidence was presented at the hearing that the toolmark testing methodology he employed has been tested, has been subjected to peer review, has an ascertainable error rate, and is generally accepted in the scientific community.”); *Commonwealth v. Meeks*, Nos. 2002-10961, 2003-10575, 2006 WL 2819423, at \*50 (Mass. Super. Ct. Sept. 28, 2006) (“The theory and process of firearms identification are generally accepted and reliable, and the process has been reliably applied in these cases. Accordingly, the firearms identification evidence, including opinions as to matches, may be presented to the juries for their consideration, but only if that evidence includes a detailed statement of the reasons for those opinions together with appropriate documentation.”).

FN291. 506 F.3d 151, 161-62 (2d Cir. 2007) (“Daubert did make plain that Rule 702 embodies a

more liberal standard of admissibility for expert opinions than did Frye.... But this shift to a more permissive approach to expert testimony did not abrogate the district court's gatekeeping function. Nor did it 'grandfather' or protect from Daubert scrutiny evidence that had previously been admitted under Frye.") (citations omitted).

FN292. *Id.* at 161.

FN293. See *United States v. Willock*, 696 F. Supp. 2d 536, 546, 549 (D. Md. 2010) (holding, based on a comprehensive magistrate's report, that "Sgt. Ensor shall not opine that it is a 'practical impossibility' for a firearm to have fired the cartridges other than the common 'unknown firearm' to which Sgt. Ensor attributes the cartridges." Thus, "Sgt. Ensor shall state his opinions and conclusions without any characterization as to the degree of certainty with which he holds them."); *United States v. Taylor*, 663 F. Supp. 2d 1170, 1180 (D.N.M. 2009) ("[B]ecause of the limitations on the reliability of firearms identification evidence discussed above, Mr. Nichols will not be permitted to testify that his methodology allows him to reach this conclusion as a matter of scientific certainty. Mr. Nichols also will not be allowed to testify that he can conclude that there is a match to the exclusion, either practical or absolute, of all other guns. He may only testify that, in his opinion, the bullet came from the suspect rifle to within a reasonable degree of certainty in the firearms examination field.").

FN294. In 1975, the Ninth Circuit noted that toolmark identification "rests upon a scientific basis and is a reliable and generally accepted procedure." *United States v. Bowers*, 534 F.2d 186, 193 (9th Cir. 1976).

FN295. E.g., *State v. Dillon*, 161 N.W.2d 738, 741 (Iowa 1968) (screwdriver and nail bar fit marks on door frame); *State v. Wessling*, 150 N.W.2d 301 (Iowa 1967) (screwdriver); *State v. Hazelwood*, 498 P.2d 607, 612 (Kan. 1972) (screwdriver and imprint on window molding); *State v. Wade*, 465 S.W.2d 498, 499--500 (Mo. 1971) (screwdriver and pry marks on door jamb); *State v. Brown*, 291 S.W.2d 615, 618--19 (Mo. 1956) (crowbar and screwdriver marks on window sash and door); *State v. Eickmeier*, 191 N.W.2d 815, 816 (Neb. 1971) (screwdriver and marks on door).

FN296. E.g., *Brown*, 291 S.W.2d at 618--19 (Mo. 1956) (crowbar and screwdriver marks on window sash and door); *State v. Raines*, 224 S.E.2d 232, 234 (N.C. Ct. App. 1976).

FN297. E.g., *State v. Montgomery*, 261 P.2d 1009, 1011-12 (Kan. 1953) (punch marks on safe).

FN298. E.g., *State v. Baldwin*, 12 P. 318, 324--25 (Kan. 1886) (experienced carpenters could testify

that wood panel could have been cut by accused's knife); *Graves v. State*, 563 P.2d 646, 650 (Okla. Crim. App. 1977) (blade and knife handle matched); *State v. Clark*, 287 P. 18, 20 (Wash. 1930) (knife and cuts on tree branches); *State v. Bernson*, 700 P.2d 758, 764 (Wash. Ct. App. 1985) (knife tip comparison).

FN299. E.g., *United States v. Taylor*, 334 F. Supp. 1050, 1056-57 (E.D. Pa. 1971) (impressions on stolen vehicle and impressions made by dies found in defendant's possession), *aff'd*, 469 F.2d 284 (3d Cir. 1972); *State v. McClelland*, 162 N.W.2d 457, 462 (Iowa 1968) (pry bar and marks on "jimmied" door); *Adcock v. State*, 444 P.2d 242, 243-44 (Okla. Crim. App. 1968) (tool matched pry marks on door molding); *State v. Olsen*, 317 P.2d 938, 940 (Or. 1957) (hammer marks on the spindle of a safe).

FN300. For example, in *United States v. Murphy*, 996 F.2d 94 (5th Cir. 1993), an FBI expert gave limited testimony "that the tools such as the screwdriver associated with Murphy 'could' have made the marks on the ignitions but that he could not positively attribute the marks to the tools identified with Murphy." *Id.* at 99; see also *State v. Genrich*, 928 P.2d 799, 802 (Colo. App. 1996) (upholding expert testimony that three different sets of pliers recovered from the accused's house were used to cut wire and fasten a cap found in the debris from pipe bombs: "The expert's premise, that no two tools make exactly the same mark, is not challenged by any evidence in this record. Hence, the lack of a database and points of comparison does not render the opinion inadmissible.").

Although most courts have been receptive to toolmark evidence, a notable exception was *Ramirez v. State*, 810 So. 2d 836, 849-51 (Fla. 2001). In *Ramirez*, the Florida Supreme Court rejected the testimony of five experts who claimed general acceptance for a process of matching a knife with a cartilage wound in a murder victim--a type of "toolmark" comparison. Although the court applied *Frye*, it emphasized the lack of testing, the paucity of "meaningful peer review," the absence of a quantified error rate, and the lack of developed objective standards. In *Sexton v. State*, 93 S.W.3d 96 (Tex. Crim. App. 2002), an expert testified that cartridge cases from unfired bullets found in the appellant's apartment had distinct marks that matched fired cartridge cases found at the scene of the offense. The court ruled the testimony inadmissible: "This record qualifies Crumley as a firearms identification expert, but does not support his capacity to identify cartridge cases on the basis of magazine marks only." *Id.* at 101.

## **BITEMARK**

Identification of a suspect by matching his or her dentition with a bite mark found on the victim of a crime rests on the theory that each person's dentition is unique. However, there are significant differences between the use of forensic dental techniques to identify a decedent and the use of bite mark analysis to identify a perpetrator. [FN313] In 1969, when bite mark comparisons were first studied, one authority raised the following problems:

[Bite]marks can never be taken to reproduce accurately the dental features of the originator. This is due partially to the fact that bite marks generally include only a limited number of teeth. Furthermore, the material (whether food stuff or human skin) in which the mark has been left is usually found to be a very unsatisfactory impression material with shrinkage and distortion characteristics that are unknown. Finally, these marks represent only the remaining and fixed picture of an action, the mechanism of which may vary from case to case. For instance, there is as yet no precise knowledge of the possible differences between biting off a morsel of food and using one's teeth for purposes of attack or defense. [FN314]

[106] Dental identifications of decedents do not pose any of these problems; the expert can often compare all 32 teeth with X rays depicting all those teeth. However, in the typical bite mark case, all 32 teeth cannot be compared; often only 4 to 8 are biting teeth that can be compared. Similarly, all five anatomic surfaces are not engaged in biting; only the edges of the front teeth come into play. In sum, bite mark identification depends not only on the uniqueness of each person's dentition but also on "whether there is a [sufficient] representation of that uniqueness in the mark found on the skin or other inanimate object." [FN315]

## 2. Methods of comparison

Several methods of bite mark analysis have been reported. All involve three steps: (1) registration of both the bite mark and the suspect's dentition, (2) comparison of the dentition and bite mark, and (3) evaluation of the points of similarity or dissimilarity. The reproductions of the bite mark and the suspect's dentition are analyzed through a variety of methods. [FN316] The comparison may be either direct or indirect. A model of the suspect's teeth is used in direct comparisons; the model is compared to life-size photographs of the bite mark. Transparent overlays made from the model are used in indirect comparisons.

Although the expert's conclusions are based on objective data, the ultimate opinion regarding individuation is essentially a subjective one. [FN317] There is no accepted minimum number of points of identity required for a positive identification. [FN318] The experts who have appeared in published bite mark cases have testified to a wide range of points of similarity, from a low of eight points to a [107] high of 52 points. [FN319] Moreover, disagreements among experts in court appear commonplace: "Although bite mark evidence has demonstrated a high degree of acceptance, it continues to be hotly contested in 'battles of the experts.' Review of trial transcripts reveals that distortion and the interpretation of distortion is a factor in most cases." [FN320] Because of the subjectivity, some odontologists have argued that "bitemark evidence should only be used to exclude a suspect. This [argument] is supported by research which shows that the exclusion of non-biters within a population of suspects is extremely accurate; far more so than the positive identification of biters." [FN321]

Although some commentators questioned the underlying basis for the technique after Daubert [FN352] courts have continued to admit the evidence. [FN353]

FN353. See *State v. Timmendequas*, 737 A.2d 55, 114 (N.J. 1999) (“Judicial opinion from other jurisdictions establish that bite-mark analysis has gained general acceptance and therefore is reliable. Over thirty states considering such evidence have found it admissible and no state has rejected bitemark evidence as unreliable.”) (citations omitted); *Stubbs*, 845 So. 2d at 670; *Howard v. State*, 853 So. 2d 781, 795-96 (Miss. 2003); *Seivewright v. State*, 7 P.3d 24, 30 (Wyo. 2000) (“Given the wide acceptance of bite mark identification testimony and Seivewright's failure to present evidence challenging the methodology, we find no abuse of discretion in the district court's refusal to hold an evidentiary hearing to analyze Dr. Huber's testimony.”).

## **HAIR**

The most common subject for hair testimony involves an attempt to individuate the hair sample, at least to some degree. If the unknown is head hair, the expert might gather approximately 50 hair strands from five different areas of the scalp (the top, front, back, and both sides) from the known source. [FN359] Before the microscopic analysis, the expert examines the hair macroscopically to identify obvious features visible to the naked eye such as the color of the hair and its form, that is, whether it is straight, wavy, or curved. [FN360] The expert next mounts the unknown hair and the known samples on microscope slides for a more detailed examination of characteristics such as scale patterns, size, color, pigment distribution, maximum diameter, shaft length, and scale count. Some of these comparative judgments are subjective in nature: “Human hair characteristics (e.g., scale patterns, pigmentation, size) vary within a single individual. . . . Although the examination procedure involves objective methods of analysis, the subjective weights associated with the characteristics rest with the examiner.” [FN361]

Often the examiner determines only whether the hair samples from the crime scene and the accused are “microscopically indistinguishable.” Although this finding is consistent with the hypothesis that the samples had the same source, its probative value would, of course, vary if only a hundred people had microscopically indistinguishable hair as opposed to several million. As discussed below, experts have often gone beyond this “consistent with” testimony.

Post-Daubert, many cases have continued to admit testimony about microscopic hair analysis. [FN409] In 1999, one state court judicially noticed the reliability of hair evidence, [FN410] implicitly finding this evidence to be not only admissible but also based on a technique of indisputable validity [FN411] In contrast, a Missouri court reasoned that, without the benefit of population frequency data, an expert overreached in opining to “a reasonable degree of certainty that the unidentified hairs were in fact from” the defendant. [FN412] The NRC report commented that there appears to be growing judicial support

for the view that “testimony linking microscopic hair analysis with particular defendants is highly unreliable.” [FN413]

FN409. E.g., *State v. Fukusaku*, 946 P.2d 32, 44 (Haw. 1997) (“Because the scientific principles and procedures underlying hair and fiber evidence are well-established and of proven reliability, the evidence in the present case can be treated as ‘technical knowledge.’ Thus, an independent reliability determination was unnecessary.”); *McGrew v. State*, 682 N.E.2d 1289, 1292 (Ind. 1997) (concluding that hair comparison is “more a ‘matter of observation by persons with specialized knowledge’ than ‘a matter of scientific principles’”); see also NRC Forensic Science Report, *supra* note 3, at 161 n.88 (citing *State v. West*, 877 A.2d 787 (Conn. 2005), and *Bookins v. State*, 922 A.2d 389 (Del. Super. Ct. 2007)).

FN410. See *Johnson v. Commonwealth*, 12 S.W.3d 258, 262 (Ky. 1999).

FN411. See Fed. R. Evid. 201(b); *Daubert*, 509 U.S. at 593 n.11 (“[T]heories that are so firmly established as to have attained the status of scientific law, such as the laws of thermodynamics, properly are subject to judicial notice under Federal Rule [of] Evidence 201.”).

FN412. *Buder v. State*, 108 S.W.3d 18, 21-22 (Mo. Ct. App. 2003).

Some courts have limited the scope of the testimony, permitting expert testimony about the similarities and dissimilarities between exemplars but not the specific conclusion that the defendant was the author (“common authorship” opinion). [FN426] Although the courts have used this approach most frequently in questioned [122] document cases, they have sometimes applied the same approach to other types of forensic expertise such as firearms examination as well. [FN427]

The NRC report criticized “exaggerated” [FN428] testimony such as claims of perfect accuracy, [FN429] infallibility, [FN430] or a zero error rate. [FN431] Several courts have barred excessive expert claims for lack of empirical support. For example, in *United States v. Mitchell*, [FN432] the court commented: “Testimony at the Daubert hearing indicated that some latent fingerprint examiners insist that there is no error rate associated with their activities. . . . This would be out-of-place under Rule 702.” [FN433] Similarly, in a firearms identification case, one court noted that

during the testimony at the hearing, the examiners testified to the effect that they could be 100 percent sure of a match. Because an examiner's bottom line opinion as to an identification is largely a subjective one, there is no reliable statistical or scientific methodology which will currently permit the expert to testify that it is a ‘match’ to an absolute certainty, or to an arbitrary degree of statistical certainty. [FN434]

Other courts have excluded the use of terms such as “science” or “scientific,” because of the risk that jurors may bestow the aura of the infallibility of science on the testimony [FN435]

In particular, some courts are troubled by the use of the expression ““reasonable scientific certainty” by some forensic experts. The term ““reasonable scientific certainty” is problematic. Although it is used frequently in cases, its legal meaning is ambiguous. [FN436] Sometimes it is used in lieu of a confidence statement (i.e., “high degree of certainty”), in which case the expert could altogether avoid the term and directly testify how confident he or she is in the opinion.

In other cases, courts have interpreted reasonable scientific certainty to mean that the expert must testify that a sample probably came from the defendant and not [123] that it possibly came from the defendant. [FN437] However, experts frequently testify that two samples “could have come from the same source.” Such testimony meets the relevancy standard of Federal Rule 401, and there is no requirement in Article VII of the Federal Rules that an expert's opinion be expressed in terms of “probabilities.” Thus, in *United States v. Cyphers* [FN438] the expert testified that hair samples found on items used in a robbery “could have come” from the defendants. [FN439] The defendants argued that the testimony was inadmissible because the expert did not express his opinion in terms of reasonable scientific certainty. The court wrote: “There is no such requirement.” [FN440]

In *Burke v. Town of Walpole*, [FN441] a bite mark identification case, the court of appeals had to interpret the term as used in an arrest warrant:

[W]e must assume that the magistrate who issued the arrest warrant assigned no more than the commonly accepted meaning among lawyers and judges to the term ““reasonable degree of scientific certainty”--“a standard requiring a showing that the injury was more likely than not caused by a particular stimulus, based on the general consensus of recognized [scientific] thought.” *Black's Law Dictionary* 1294 (8th ed. 2004) (defining “reasonable medical probability,” or ““reasonable medical certainty,” as used in tort actions). That standard, of course, is fully consistent with the probable cause standard. [FN442]

The case involved the guidelines adopted by ABFO that recognized several levels of certainty (“reasonable medical certainty,” “high degree of certainty,” and ““virtual certainty”). The guidelines described “reasonable medical certainty” as “convey[ing] the connotation of virtual certainty or beyond reasonable doubt.” [FN443] This is not the way that some courts use the term.

[124] Moreover, the term may be problematic for a different reason--misleading the jury. One court ruled that the term “reasonable scientific certainty” could not be used because of the subjective nature of

the opinion. [FN444]

### C. Restriction of Final Argument

In a number of cases, in summation counsel has overstated the content of the expert testimony. In *People v. Linscott*, [FN445] for example, “the prosecutor argued that hairs found in the victim's apartment and on the victim's body were in fact defendant's hairs.” [FN446] Reversing, the Illinois Supreme Court wrote: “With these statements, the prosecutor improperly argued that the hairs removed from the victim's apartment were conclusively identified as coming from defendant's head and pubic region. There simply was no testimony at trial to support these statements. In fact, [the prosecution experts] and the defense hair expert . . . testified that no such identification was possible.” [FN447] DNA testing exculpated Linscott. [FN448] Trial judges can police the attorneys' descriptions of the testimony during closing argument as well as the content of expert testimony presented.

## **XII. Procedural Issues**

The Daubert standard operates in a procedural setting, not a vacuum. In *Daubert*, the Supreme Court noted that “[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.” [FN449] Adversarial testing presupposes advance notice of the content of the expert's testimony and access to comparable expertise to evaluate that testimony. This section discusses some of the procedural mechanisms that trial judges may use to assure that jurors properly evaluate any expert testimony by forensic identification experts.

FN415. The technique compared trace chemicals found in bullets at crime scenes with ammunition found in the possession of a suspect. It was used when firearms (“ballistics”) identification could not be employed. FBI experts used various analytical techniques (first, neutron activation analysis, and then inductively coupled plasma-atomic emission spectrometry) to determine the concentrations of seven elements--arsenic, antimony, tin, copper, bismuth, silver, and cadmium--in the bullet lead alloy of both the crime-scene and suspect's bullets. Statistical tests were then used to compare the elements in each bullet and determine whether the fragments and suspect's bullets were “analytically indistinguishable” for each of the elemental concentration means.

FN416. See *Wilkerson v. State*, 776 A.2d 685, 689 (Md. Ct. Spec. App. 2001).

FN417. See *State v. Krummacher*, 523 P.2d 1009, 1012-13 (Or. 1974) (en banc).

FN418. See *United States v. Davis*, 103 F.3d 660, 673-74 (8th Cir. 1996); *People v. Lane*, 628 N.E.2d 682, 689-90 (Ill. App. Ct. 1993).

FN419. See *State v. Jones*, 425 N.E.2d 128, 131 (Ind. 1981); *State v. Strain*, 885 P.2d 810, 817 (Utah Ct. App. 1994).

FN420. See *State v. Grube*, 883 P.2d 1069, 1078 (Idaho 1994); *People v. Johnson*, 499 N.E.2d 1355, 1366 (Ill. 1986); *Earhart v. State*, 823 S.W.2d 607, 614 (Tex. Crim. App. 1991) (en banc) (“He later modified that statement to acknowledge that analytically indistinguishable bullets which do not come from the same box most likely would have been manufactured at the same place on or about the same day; that is, in the same batch.”), vacated, 509 U.S. 917 (1993).

FN421. See *State v. Reynolds*, 297 S.E.2d 532, 534 (N.C. 1982).

FN422. See *Bryan v. State*, 935 P.2d 338, 360 (Okla. Crim. App. 1997).

FN423. See *Davis*, 103 F.3d at 666--67 (“An expert testified that such a finding is rare and that the bullets must have come from the same box or from another box that would have been made by the same company on the same day.”); *Commonwealth v. Daye*, 587 N.E.2d 194, 207 (Mass. 1992); *State v. King*, 546 S.E.2d 575, 584 (N.C. 2001) (Kathleen Lundy “opined that, based on her lead analysis, the bullets she examined either came from the same box of cartridges or came from different boxes of the same caliber, manufactured at the same time.”).

FN424. National Research Council, *Forensic Analysis: Weighing Bullet Lead Evidence* 6 (2004), [hereinafter *NRC Bullet Lead Evidence*], available at [http://www.nap.edu/catalog.php?record\\_id=10924](http://www.nap.edu/catalog.php?record_id=10924).

FN425. *Id.*

FN426. See *United States v. Oskowitz*, 294 F. Supp. 2d 379, 384 (E.D.N.Y. 2003) (“Many other district courts have similarly permitted a handwriting expert to analyze a writing sample for the jury

without permitting the expert to offer an opinion on the ultimate question of authorship.”); *United States v. Rutherford*, 104 F. Supp. 2d 1190, 1194 (D. Neb. 2000) (“[T]he Court concludes that FDE Rauscher's testimony meets the requirements of Rule 702 to the extent that he limits his testimony to identifying and explaining the similarities and dissimilarities between the known exemplars and the questioned documents. FDE Rauscher is precluded from rendering any ultimate conclusions on authorship of the questioned documents and is similarly precluded from testifying to the degree of confidence or certainty on which his opinions are based.”); *United States v. Hines*, 55 F. Supp. 2d 62, 69 (D. Mass. 1999) (expert testimony concerning the general similarities and differences between a defendant's handwriting exemplar and a stick-up note was admissible but not the specific conclusion that the defendant was the author).

FN427. *United States v. Green*, 405 F. Supp. 2d 104, 124 (D. Mass. 2005).

FN428. NRC Forensic Science Report, *supra* note 3, at 4.

FN429. *Id.* at 47.

FN430. *Id.* at 104.

FN431. *Id.* at 142-43.

FN432. 365 F.3d 215 (3d Cir. 2004).

FN433. *Id.* at 246.

FN434. *United States v. Monteiro*, 407 F. Supp. 2d 351, 372 (D. Mass. 2006).

FN435. *United States v. Starzecpyzel*, 880 F. Supp. 1027, 1038 (S.D.N.Y. 1995).

FN436. James E. Hullverson, *Reasonable Degree of Medical Certainty: A Tort et a Trovers*, 31 St. Louis U. L.J. 577, 582 (1987) (“[T]here is nevertheless an undercurrent that the expert in federal court express some basis for both the confidence with which his conclusion is formed, and the probability that his conclusion is accurate.”); Edward J. Imwinkelried & Robert G. Scofield, *The Recognition of an*

Accused's Constitutional Right to Introduce Expert Testimony Attacking the Weight of Prosecution Science Evidence: The Antidote for the Supreme Court's Mistaken Assumption in *California v. Trombetta*, 33 Ariz. L. Rev. 59, 69 (1991) (“Many courts continue to exclude opinions which fall short of expressing a probability or certainty. . . . These opinions have been excluded in jurisdictions which have adopted the Federal Rules of Evidence.”).

FN437. *State v. Holt*, 246 N.E.2d 365, 368 (Ohio 1969). The expert testified, based on neutron activation analysis, that two hair samples were “similar and . . . likely to be from the same source” (emphasis in original).

FN438. 553 F.2d 1064 (7th Cir. 1977).

FN439. *Id.* at 1072; see also *United States v. Davis*, 44 M.J. 13, 16 (C.A.A.F. 1996) (“Evidence was also admitted that appellant owned sneakers which ‘could have’ made these prints.”).

FN440. *Cyphers*, 553 F.2d at 1072; see also *United States v. Oaxaca*, 569 F.2d 518, 526 (9th Cir. 1978) (expert's opinion regarding hair comparison admissible even though expert was less than certain); *United States v. Spencer*, 439 F.2d 1047, 1049 (2d Cir. 1971) (expert's opinion regarding handwriting comparison admissible even though expert did not make a positive identification); *United States v. Longfellow*, 406 F.2d 415, 416 (4th Cir. 1969) (expert's opinion regarding paint comparison admissible, even though expert did not make a positive identification); *State v. Boyer*, 406 So. 2d 143, 148 (La. 1981) (reasonable scientific certainty not required where expert testifies concerning the presence of gunshot residue based on neutron activation analysis).

FN441. 405 F.3d 66 (1st Cir. 2005).

FN442. *Id.* at 91.

FN443. *Id.* at 91 n.30 (emphasis omitted).

FN444. *United States v. Glynn*, 578 F. Supp. 2d 567, 568-75 (S.D.N.Y. 2008) (firearms identification case).

FN445. 566 N.E.2d 1355 (Ill. 1991).

FN446. *Id.* at 1358.

FN447. *Id.* at 1359.

FN448. See *Connors et al.*, *supra* note 387, at 65 (“The State's expert on the hair examination testified that only 1 in 4,500 persons would have consistent hairs when tested for 40 different characteristics. He only tested between 8 and 12 characteristics, however, and could not remember which ones. The appellate court ruled on July 29, 1987, that his testimony, coupled with the prosecution's use of it at closing arguments, constituted denial of a fair trial.”) (citation omitted).

FN449. 509 U.S. at 596 (citing *Rock v. Arkansas*, 483 U.S. 44, 61 (1987)).