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The Impact of *Daubert* : Implications for Testimony and Research in Forensic Anthropology (and the Use of Frontal Sinuses in Personal Identification)*

ABSTRACT: This paper emphasizes the need for objectivity and standardized methodologies in the forensic sciences, particularly physical anthropology. To this end, a review of important events in scientific evidence admissibility law, particularly the standards set in the case of *Daubert v. Merrell-Dow Pharmaceuticals, Inc., 1993*, is presented. The method of confirming a putative identification by visual comparison of antemortem and postmortem frontal sinus radiographs is examined in light of current admissibility standards. The technique is revealed to have a number of shortcomings, including a lack of empirical testing, no estimates of potential error rates, no standards controlling the technique's operation, and no objective determination standards. These shortcomings may, in some instances, prevent resulting conclusions from being admissible evidence. It is suggested that some methods (including frontal sinus comparison) may require more rigorous testing in order to meet these new and stricter standards.

KEYWORDS: forensic science, forensic anthropology, *Daubert*, frontal sinuses, personal identification

As forensic scientists, our pursuits differ from those of purely academic (research-driven) physical anthropologists; in addition to performing scientific research and acquiring knowledge as an end unto itself, we must also consider the applications of our findings to legal matters. For example, in the case of confirming a putative identification using frontal sinus radiographs, it is necessary to consider the legal applications and ramifications of comparison methodologies. While many recognize the necessity and usefulness of frontal sinus radiograph comparisons in confirming identity, previous methods of comparison and studies of uniqueness may not be sufficiently rigorous to meet federal guidelines for the admissibility of scientific evidence in court. Forensic experts, including anthropologists, radiologists and pathologists, are now expected to meet stricter standards when substantiating their claims that two radiographs belong to the same individual. The present paper presents a brief summary of important events in scientific evidence admissibility law, followed by a discussion of the impact of these events on testimony and research in forensic anthropology. Specifically, the technique of frontal sinus radiograph comparison will be reviewed in light of several observed shortcomings of comparison methodologies.

History of Scientific Evidence Admissibility

In the American system of law, scientific evidence is generally thought of as somewhat novel even though the use of scientific evidence in trial dates back nearly 500 years (1). As late as the middle of the 19th century, however, there was still an abundance of controversy and ensuing legal challenges during court trials due to the lack of sophistication and rigor in various scientific disciplines, rendering investigations largely subjective (2,3). Forensic medicine, however, would soon thereafter begin a rapid increase in sophistication followed closely by other forensic sciences, including forensic toxicology, serology, criminology, odontology, and anthropology (3).

Scientific techniques in many disciplines became more varied and sophisticated and the use of scientific evidence in the criminal justice system became an increasing trend. Concurrent with this increase, debate in the legal community arose regarding standards for the admissibility of such evidence (4). These standards have evolved significantly in the last century largely due to several Supreme Court rulings and Congressional Acts.

The first important ruling regarding the admissibility of scientific evidence was issued in *Frye v. United States* (5). In this case, the Court gave an opinion on the standard for the admissibility of scientific expert witness testimony, stating:

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential forces of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs. (5)

The "*Frye* Rule," as this general acceptance test came to be known, became the dominant standard for determining admissibility of scientific evidence in the majority of courts. This dominance was facilitated in large part by the fact that the rule was easy to apply and required little scientific sophistication on the part of the judges.

Over time and with advancements in science, many courts and legal commentators began to modify or ignore the *Frye* standard, prompting the eventual enactment of the *Federal Rules of Evidence*

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(6) in 1975, which was the first uniform set of evidentiary rules for the trial of civil and criminal cases in federal courts. *Rule 702* specifically addressed expert witness testimony, stating:

> 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. (6)

The adoption of the *Federal Rules of Evidence* did not remove the confusion in the courts concerning the admissibility of scientific evidence. The text of the *Federal Rules* did not include the *Frye* standard, and the legislative history made no mention of *Frye* or its general acceptance standard. This led to a mixed use of *Frye*, the *Federal Rules of Evidence* or some hybrid of the two. When called upon to apply *Rule 702*, a majority of federal courts continued to utilize *Frye*, being reluctant to accept the overruling of a precedent of *Frye*'s stature (7).

The confusion surrounding this issue continued until the United States Supreme Court decided *Daubert v. Merrell-Dow Pharmaceuticals, Inc* (8). The Supreme Court addressed the question of whether the general acceptance test of *Frye* survived the enactment of the *Federal Rules of Evidence*. The Court ultimately concluded that the *Federal Rules of Evidence* superceded *Frye* and should thus govern admissibility, indicating that a "rigid and absolute general acceptance test" should not be the standard in order that a reasonable minority opinion may be admitted into evidence, usually in the form of new and emerging research based on reliable, well-designed studies (8).

In addition to acknowledging that the *Federal Rules of Evidence* superceded *Frye*, the Court interpreted the language of *Rule 702* to set forth standards for the admissibility of scientific evidence: *reliability* (which requires "scientific knowledge" be grounded in the methods and procedures of science and more than subjective belief or speculation), and *relevance* (which requires that the information facilitate the fact-finder in reaching a conclusion in the case, i.e., that there is a valid scientific connection to the pertinent inquiry). Furthermore, the Court identified some of the factors relevant to determining whether the evidence is scientific. These factors are often referred to as the "*Daubert* guidelines" (Table 1).

The first of these guidelines pertains to whether the content of the testimony can be (and has been) empirically tested using the scientific method. This guideline was based upon the persuasions of two philosophers of science who have indicated that the scientific status of a theory rests in its falsifiability, or refutability, or testability (9), and that statements constituting a scientific explanation must be capable of empirical testing (10). Second, the technique should be subject to peer review, preferably in the form of publication in peer-reviewed literature. Although publication is not required for admissibility and in some instances may not ensure reliability, the review process increases the likelihood that the scientific community will detect any error or fundamental flaw that exists in the technique or its application.

TABLE 1—*The* Daubert *Guidelines for determining whether evidence is scientific and therefore admissible under* Federal Rule 702 (8).

1. The content of the testimony can be (and has been) tested using the scientific method.
2. The technique has been subject to peer review, preferably in the form of publication in peer reviewed literature.
3. There are consistently and reliably applied professional standards and known or potential error rates for the technique.
4. Consider general acceptance within the relevant scientific community.

Third, for particular techniques, the court should consider applicable professional standards as well as known or potential error rates for the technique. Such standards refer primarily to protocols that ensure consistency and reliability in the application of the methodology. Lastly, the Court may also consider general acceptance by identifying the relevant scientific community and assessing the degree of acceptance within that community.

In 2000, the *Federal Rules of Evidence*, including *Federal Rule 702,* were amended, effective December 1, 2000 to read:

> 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, if (1) the testimony is based upon sufficient facts or data, (2) the test is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case. (6)

This amendment considers *Daubert* guidelines and interpretations and better clarifies the issues of reliability and relevance.

Implications for Forensic Anthropology (and Frontal Sinuses)

Although forensic anthropology is a relatively young discipline, testifying as an expert witness has become an important and increasingly accepted role of the forensic anthropologist. However, given the novelty of the field of forensic anthropology coupled with the rate of scientific progress in general, many techniques testified to by forensic anthropologists may be considered new and emerging information. Anthropologists should thus be particularly cautious that their investigations result in methods and techniques that will be admissible under the *Daubert* guidelines. This is not to say that anthropological research has been or is lacking in scientific rigor, but forensic anthropological techniques have not often encountered the *Daubert* test, so it is as of yet unclear how many of them will or would be received in court if and when they are put to this challenge. It should be a specific aim of forensic anthropological studies to meet *Daubert* standards when the potential exists for the resulting technique to be considered in court.

In the case of identification by frontal sinus morphology, many have proffered (or at least supported) the notion that frontal sinuses are unique to each individual, and they have been used in numerous published cases as a method of confirming identity (11–30). Indeed, the use of frontal sinus radiographs in positive identification has become an increasingly applied and accepted technique among forensic anthropologists, radiologists, and pathologists. However, in order to be considered a viable means of confirming identity (from an evidentiary standpoint), we must know whether observed details of the morphology of frontal sinus outlines are unique to each individual (i.e., whether frontal sinus radiographs are a reliable method for confirming or rejecting an identification), and standardized methods must be applied when making comparisons.

Few may have considered these issues to be potential shortcomings until the case of *United States v. Plaza* (31) seriously questioned the admissibility of fingerprint analysis due to the Court's original finding that the technique did not meet several of the *Daubert* guidelines. While the Court eventually allowed the fingerprint examiner's identification and opinion into evidence (32), the fact that the issue was raised at all has very important implications

for the potential of frontal sinus identifications to meet the *Daubert* guidelines.

With regard to the four *Daubert* guidelines, the technique of identification by frontal sinus comparison appears to fulfill two of the criteria, but the remaining two may present challenges. There are certainly a large number of publications relating to the possible uniqueness of each individual's frontal sinus morphology and substantial literature on case studies marking situations where the technique has been used to establish a positive identification. There also appears to be general acceptance within the fields of forensic anthropology and radiology that the technique is sufficiently reliable.

However, while the technique is *capable* of being empirically tested, no such tests have ever been performed or perhaps even devised. While many claim that frontal sinuses are unique to each individual, no empirical studies that establish this claim as a fact have ever been carried out. While the literature cited presents evidence of the uniqueness of frontal sinus morphology, there is a need for additional research aimed at quantification. As a consequence of the previous lack of empirical testing and quantification, there seems to have been no attempt made to estimate the potential error rate of the identification technique. The lack of reliability estimates is an important point because the courts have a history of strongly emphasizing this issue, and indeterminate or essentially unknown error rates have often contributed to decisions to exclude evidence, as have noncompliance with standards in assessing the reliability of a technique and the use of flawed statistics (7).

Many researchers' claims of the individualized nature of frontal sinus morphology stem from observations of numerous, even thousands, of radiographs and failing to find two that were identical (15,33–36). While these observations are noteworthy in that they provide some subjective support for claims of uniqueness, they fall short of actually being able to quantify the chances that two different people would have identical or very similar frontal sinus patterns since they did not quantitatively assess sinus shape.

Some studies have made attempts at more quantitative assessments of uniqueness, but many of these involved very small sample sizes (29,37). Others have used larger samples, but addressed somewhat different questions such as applying standard measurements and the effect of experience level on the ability to recognize a correct match (38–40). Other studies (28,30) involving code systems reveal quantifiable differences in frontal sinus characteristics as observed in radiographs and suggest that the probability of misidentification would be small, but have not attempted to estimate this probability. Most investigations of frontal sinus variability have focused on intergroup variation and often describe differences in terms of linear dimensions of the frontal sinus from the radiograph, including maximum height and lateral extension or an index based on these measurements, surface areas, or asymmetry of left versus right sinus lobes (37,38,41–45).

Unfortunately, the technique is also characterized by a distinct lack of standardized methods when being applied to confirm or reject a putative identification. The method generally involves a simple visual comparison of side-by-side or superimposed radiographs with the consequence that the final identification decision is subjective and based solely on the knowledge, experience, or ability of the examiner. Moreover, there is no established professional standard controlling operation of the technique and no objective determination standard.

Conclusion

Anyone offering a novel theoretical basis or methodology that has not been subject to meticulous adversarial or empirical testing should be prepared to present convincing evidence that the methodology has a basis in good science as required by *Daubert*. While the value of comparing antemortem and postmortem frontal sinus radiographs in forensic contexts is fully and widely appreciated, more extensive research into the uniqueness of each individual's frontal sinus and the statistical reliability of diagnostic features used in positive identification is necessary, and more objective standards for confirming or rejecting an identification should be established.

Currently, the author is involved in a study with the aim of providing this basis by empirically testing the variability of frontal sinus outlines as seen in radiographs, estimating the potential rate of error when using frontal sinus outlines in identification, and suggesting a more objective determination standard. It is hoped that this review will serve to stimulate further discussion in forensic anthropology and other forensic sciences and perhaps encourage evaluation of the extent to which other techniques satisfy the *Daubert* guidelines.

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