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Kumho, *Daubert*, and the Nature of Scientific Inquiry: Implications for Forensic Anthropology*

ABSTRACT: In the last 15 years, the US Supreme Court has implemented major changes concerning the admittance of expert testimony. In 1993, *Daubert v. Merrell Dow Pharmaceuticals* superseded the *Frye* ruling in federal courts and established judges, not the scientific community, as the gatekeepers regarding the credibility of scientific evidence. In 1999, a lesser-known but equally important decision, *Kumho Tire v. Carmichael*, ruled that technical expert testimony needed to employ the same rigor as outlined in *Daubert*, but experts can develop theories based on observations and apply such theories to the case before the court. Anthropology has never been defined as a hard science. Yet, many recent publications have modified existing techniques to meet the *Daubert* criteria, while none have discussed the significance of *Kumho* to anthropological testimony. This paper examines the impact of *Daubert* and *Kumho* on forensic anthropology and illustrates areas of anthropological testimony best admitted under *Kumho's* guidance.

KEYWORDS: forensic science, forensic anthropology, expert testimony, taphonomy, trauma assessment, identification, *Daubert, Kumho,* Federal Rules of Evidence

Forensic anthropology is a branch of applied physical anthropology that incorporates a wide array of scientific techniques and skills modified from a multitude of disciplines and applies them to questions of medico-legal significance. Some of these techniques are quantitative and empirically testable, such as those employed to estimate sex and age from unidentified skeletal remains. Others are more qualitative, reliant on observation and the technical or specialized experience of the observer rather than measurement or scoring. For example, assessments of traumatic, pathological, and taphonomic alterations to a body are no less valid or scientific; however, they must be evaluated separately from empirical methods.

As an expert witness in criminal proceedings, forensic anthropologists must be cognizant of the discipline's methodological variation and limitations, especially in light of the changes that have occurred within the last 15 years regarding standards for the admission of expert witness testimony. In particular, two cases that have come before the Supreme Court of the United States, *Daubert v. Merrill Dow Pharmaceuticals, Inc.* (1993) and *Kumho Tire, Ltd v. Carmichael* (1999) have catalyzed these changes. The first decision, *Daubert*, applies explicitly to scientific expert witness testimony, providing five guidelines (Table 1) to evaluate scientific testimony (1). Conversely, the second decision, *Kumho* (Table 2), represents an acknowledgement by the court that science is too complex to evaluate with a single set of standards (2,3). While the *Daubert* standards address most empirical forms of scientific testimony, the same cannot be said for other technical and specialized (but still scientifically based) forms of expert testimony. Significantly, *Kumho* established that, although the *Daubert* standards may not always apply, all expert witness testimony must be evaluated with the same level of rigor as evidence subjected to empirical testing. As there is not always a clear distinction between scientific and technical testimony, the responsibility falls to the presiding judge to evaluate expert witness testimony on a case-by-case basis.

Ultimately, *Daubert* and *Kumho* are not opposing forces but complementary. Despite the importance of both, the *Daubert* decision produced a wide array of reactions in general legal and medical publications (4–15), and eventually in the anthropological literature (16–22). In contrast, the *Kumho* decision has produced much less reaction in the general literature (23) and none in the anthropological literature, despite its potentially significant consequences for anthropological and other forms of expert witness testimony. Thus, the purpose of this paper is two-fold: to review the history of the rules of expert witness testimony, and use anthropological examples to address and discuss the implications of the *Daubert* and *Kumho* decisions for expert witness testimony.

History of Rules Governing Expert Witness Testimony

For most of its history, common law rules governed the United States judicial system, varying from jurisdiction to jurisdiction and from judge to judge. One such rule, based on a 1923 District of Columbia Court of Appeals decision, *Frye v. United States*, was the guideline typically used to determine the admissibility of expert testimony for most of the 20th century. Included in the opinion was the statement that "... 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" (24). This pronouncement became known as the *Frye* test, which states that scientific expert testimony is admissible if the technique is "generally accepted" as reliable by the relevant scientific community. The decision defined reliable opinions as those that applied "the methods and procedures of science" (24). Thus, courts based determinations of reliability on

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TABLE 1—*Guidelines from the Daubert decision.*

Content of testimony must:
1. Be testable and have been tested through the scientific method.
2. Have been subject to peer review.
3. Have established standards.
4. Have a known or potential error rate.
5. Have widespread acceptance by the relevant scientific community.

TABLE 2—*Guidance from the Kumho decision.*

1. Expert witnesses can develop theories based on their observations and experience and then apply those theories to the case before the court.
2. All forms of expert witness testimony should be evaluated with the same level of rigor.
3. The Daubert standards are flexible guidelines that may not be applicable in every instance of expert witness testimony.

whether most other practitioners in the applicable field considered the techniques described in the testimony to be valid.

Interestingly, the *Frye* test was rarely discussed or analyzed until the implementation of the Federal Rules of Evidence (FRE) in 1975 (25,26), which Congress adopted in an attempt to formally standardize and clarify the trial process in the federal judicial system. With the passing of the Federal Rules of Evidence, FRE Rule 702 now governed the admissibility of expert witness testimony in federal court. Yet, the rule made no mention of the *Frye* test. Prior to 2000, FRE Rule 702 stated "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education may testify thereto in the form of an opinion or otherwise" (27,28). Though the rule defined when scientific expert testimony is appropriate and who can qualify as an expert, it did not provide guidelines to determine whether the scientific methodology is relevant and/or reliable. As a result, the *Frye* test, and its premise that the scientific community should decide issues of reliability, continued to be the general standard by which courts admitted expert testimony.

However, after the implementation of the FRE, debate began as to the merits of *Frye*, and how and if it should be incorporated with FRE Rule 702. As the realm of science has expanded, the lack of an official standard commonly led to the admission of questionable scientific testimony, often termed "junk science" (29), which may have unnecessarily confused, misled, and overwhelmed juries. Without a set standard, courts still applied a common law rule open to interpretation, resulting in the very inconsistencies that the FRE were created to correct. Somewhat surprisingly, however, neither the Supreme Court nor Congress made any attempt to clarify this inconsistency until almost 20 years after its implementation.

The Supreme Court did not address this issue until the 1993 *Daubert* ruling. In its decision, the Supreme Court concluded that the FRE superseded the *Frye* rule; thus, the general acceptance test should no longer be considered. In addition, the Court decided that the presiding judge, not the relevant scientific community, should make the final determination as to whether scientific methodology is relevant and reliable, to be determined on a case-by-case basis (1). Judges now have an additional duty to act as a gatekeeper in deciding the admissibility of scientific expert witness testimony (25,30).

However, since judges are often not qualified to critique scientific techniques, the Supreme Court provided five basic guidelines (Table 1) following a philosophical interpretation of the definition of science to help judges evaluate the reliability and relevance of scientific testimony (1,3,10,11,31). The Court instructed judges to use these standards when determining the admissibility of scientific evidence, but emphasized that the factors were not necessarily all-encompassing. In essence, the Court shifted the focus of admissibility more to the methodology, rather than the conclusions that methodology generated (1,31).

In theory, the results of the *Daubert* decision put clear and significant constraints on the admissibility of scientific expert witness testimony. Yet in practice, the entire judicial community, including judges, lawyers, and expert witnesses, have struggled with exactly what *Daubert* really meant and how to respond to it (9,12,32–34). In a subsequent case, *General Electric v. Joiner* (1997), the Supreme Court determined that scientific experts must explain how their methodology bridges the gap between the evidence and their conclusions and that the inclusion and exclusion of scientific expert witness testimony can only be reviewed by appellate courts on the grounds of abuse of discretion, not on whether it might have affected the outcome of a case (31,35). Thus, *Joiner* established that an expert's opinion now needed some form of justification, shifting some of the focus of admissibility back to an expert's conclusion, and fortified a trial judge's gatekeeping responsibilities. As the Supreme Court made explicitly clear, the *Daubert* decision only applied to scientific expert testimony but never defined what constituted scientific testimony (1). What remained unclear was whether a judge's gatekeeping responsibilities and the *Daubert* standards applied only to scientific testimony or whether the decision encompassed all other forms of specialized expert witness testimony, such as technical testimony based on scientific principles, as well.

This uncertainty set the stage for *Kumho*, which reached the Supreme Court in the summer of 1998. At issue was the admissibility of an engineer's technical testimony claiming that a defective tire led to an accident. The lower courts split as to whether technical testimony based on scientific principles should fall under the rules established by *Daubert* (30,36,37). Although specifically referring to engineering testimony, the implications of the impending *Kumho* decision applied to other experts as well, such as medical professionals who account for more than a third of expert witness testimony (38) and testify in a similar capacity as engineers (36).

In the 1999 *Kumho* ruling, the Supreme Court established that experts could develop theories based on their observations and experience and then apply those theories to the case before the court (2). As a result, the Court reemphasized that the *Daubert* standards should only be interpreted as a set of flexible guidelines rather than a strict set of rules. Judges have the latitude to apply all, some, or none of the *Daubert* standards, depending on the context of the testimony (25,30,31,39). By highlighting this flexibility, the Court acknowledged that a single set of rules should not define the totality of scientific inquiry and application, and recognized that scientific publication moves at an inconsistent pace. For example, new techniques may be viable even if they have not yet been peer-reviewed and generally accepted; such innovative techniques that have not yet been "generally accepted" are inadmissible under the *Frye* standard. Thus, in certain situations the *Daubert* standards are actually more liberal than *Frye*.

Additionally, in the *Kumho* ruling, the Supreme Court reaffirmed its earlier stance that the presiding judge should function as the gatekeeper, not only in regards to the admittance of scientific expert witness testimony but for all forms of expert witness testimony (2). Ultimately, the Court determined that it is virtually impossible for judges to differentiate scientific and technical testimony. Therefore, judges should evaluate all forms of expert witness testimony for relevance and reliability with the same level of rigor,

TABLE 3—*Additional questions or considerations that judges have employed to evaluate expert testimony.*

1. Does the testimony concern matters growing naturally and directly out of the research the expert has conducted independent of litigation?
2. Has the expert unjustifiably extrapolated from an accepted premise to an unfounded conclusion?
3. Has the expert adequately accounted for obvious alternative explanations?
4. Is the expert being as careful as he/she would in his/her regular professional work outside his/her paid litigation consulting?
5. Is the field of expertise claimed by the expert known to reach reliable results for the type of opinion the expert would give?

but retain discretion as to how this should be determined. The Court provided no additional criteria for determining admissibility, much to the chagrin of many in the legal community (25,26,30,39). However, shortly thereafter, the Federal Rules Committee identified five other valid inquiries (Table 3) that various federal courts had used before and since *Daubert* when assessing the reliability of expert witness testimony (31,40).

Together *Daubert*, *Joiner*, and *Kumho* are often referred to as a trilogy that has established the guidelines for admissibility of expert witness testimony (3,25,30,33). The coexistence of *Daubert* and *Joiner*, and *Kumho* and *Joiner* is not contentious, but there has been some debate about reconciling *Daubert* and *Kumho* (25,26,39–43). In reality, *Kumho* is not inconsistent with and does not lessen the value of the *Daubert* decision (30,31). For example, the Supreme Court noted that a judge should consider the *Daubert* standards in situations where they are a reasonable measure of reliability of expert testimony (2). Thus, judges should consider whether the *Daubert* standard is appropriate first, then consider other factors that may help in the determination of reliability and relevancy to the case at hand. When bypassing some or all of the *Daubert* standards, a judge must justify that decision or risk reversal on the grounds of abuse of discretion (25). As a result, *Kumho* does not supersede or contradict *Daubert*. Rather, it is an addendum that provides justification for the necessary flexibility in evaluating the reliability of specialized expert witness testimony. Once admitted, it is up to the jury to decide the significance of the testimony; juries are much better at evaluating such testimony and less swayed by it than generally credited (37).

Primarily as a result of these two decisions in 2000, the United States Congress added a three-pronged "if" clause to rule 702, stating that expert witness testimony is admissible if: (i) the testimony is based upon sufficient facts or data; (ii) the testimony is the product of reliable principles and methods; and (iii) the witness has applied the principles and methods reliably to the facts of the case (28,31).

Although the *Kumho* decision has received much less attention than *Daubert*, both were taken into account during the revision of rule 702. This is evidenced by the fact that the *Daubert* standards are not explicitly stated in the rule, but the flexibility encouraged by *Kumho* is included. For example, the first subclause refers to "facts or data," thus covering both quantitative and qualitative forms of expert testimony (31). While *Daubert* and *Kumho* only apply to federal cases, most states have adopted these standards or are moving towards adopting them (44,45). Furthermore, even those states officially retaining the *Frye* rule are incorporating aspects of *Daubert* and *Kumho* as well (44).

Daubert, *Kumho*, and Forensic Anthropological Testimony

Exactly how do these decisions affect expert witness testimony, specifically anthropological testimony? Is anthropologically based testimony scientific, technical, or potentially a mixture of both? Should anthropologists revise their methodology to meet these standards, or does it already meet them? In other words, should anthropologists alter established approaches in response to a legal precedent or in response to furthering scientific investigation?

Many recent forensic anthropology publications in this journal have stressed the importance of developing and modifying anthropological techniques to meet *Daubert* standards (16–22). Anthropologists should bear in mind, however, that a common consideration by judges is whether the testimony is developed in the normal course of scientific investigation (25,31,39,40). Altering a technique to meet a legal standard may not meet this criterion. Significantly, none of the aforementioned publications have discussed or considered the impact of the *Kumho* ruling, despite its relevance to anthropological testimony. Many anthropological techniques already meet the criteria for admissibility under *Kumho*, potentially making many revisions unnecessary. Given the absence of *Kumho* references in the anthropological literature, it appears that many anthropologists may simply be unaware of the *Kumho* decision or fail to see its relevance to anthropological testimony.

To understand the impact and implications of *Daubert* and *Kumho* on forensic anthropological testimony, we must examine the basic principles of physical anthropology. Previous publications discussing anthropological methodology and courtroom testimony have focused solely on more quantitative techniques (16–19), implying that physical anthropology is a robust empirical science. However, in reality human biological and cultural complexity produce infinite variation. As such, data will not be available for every possible situation. Plus, this empirical focus may misrepresent the actual state of the field, as much anthropological testimony appears to be based on more qualitative methodologies (46). In addition, the reliability of many forensic anthropological techniques is strengthened by the experience of the observer to recognize such complications and apply the correct methodology or appropriate comparative sample. Of utmost importance is the observer's experience with the particular technique, as the judge may consider not only the accuracy and reliability of the method, but the observer's competency in utilizing the method as well. Finally, although biological anthropology regularly applies scientific principles to anthropologically based problems, it rarely, if ever, produces laws of its own. Given these limitations, forensic anthropology should be considered an applied discipline and treated as such. Consequently, not all anthropological testimony is classified strictly as scientific. As medical professionals, who often testify in a similar capacity as forensic anthropologists, have realized with their testimony (15), nothing is preventing at least some types of anthropological testimony from being admitted as technical expert testimony under the *Kumho* standard.

Some forms of anthropological testimony are subject to the guidelines in the *Daubert* standards. This type of testimony is based on methodology that is quantitative, testable, and has definable error rates, such as the methods used to estimate the sex and age of an unknown skeleton. These techniques have established biologically based categories and a limited number of variables that determine which category best describes an unidentified individual. It should be noted, however, that testimony based on these analyses is not purely objective, as these methods are limited not only by the data on which they were developed, but also by the experience of the observer. Numerous studies have shown that observer experience does affect results and conclusions (47–49). Therefore, even the most "robust" forms of physical anthropology are reliant on at least some observer interpretation and opinion.

Not every anthropological method follows this paradigm, however. Other types of anthropological testimony are rooted in observation and the application of established theory to the case at hand, rather than empirical testing. Examples include testimony focusing on taphonomic assessments and pathological and traumatic analyses. Although diagnostic parameters aid in such analyses, they are based on a myriad of intrinsic biological and extrinsic environment variables that prevent an empirical and definitive description. As a result, such inquiries are based on pattern recognition and generally require experience for the observer to reach reliable conclusions. According to the strict interpretation of the *Daubert* standards that has been presented in previous anthropological publications (16–22), such testimony would be inadmissible. However, these observations and conclusions are admissible under *Kumho*. The rigidity required by a strict interpretation of the *Daubert* guidelines would lessen the utility of these techniques by imposing inappropriate limits to their use.

This point can be further emphasized by examining the analysis of bone modifications. While recording certain observations of ante-, peri-, and postmortem modifications, such as the dimensions of lytic lesions or cutmarks on bone, does produce quantifiable data, empirical measurement alone does not provide a meaningful diagnosis or interpretation of the events that produced that modification. While examination of such features can benefit from the guidance of an interpretive framework, one cannot reliably assess them through quantitative analysis alone. Rather, it is up to the experience and expertise of the observer to rule out other possible explanations in order to reach a conclusion (50). Through such analyses, anthropologists can make valid inferences through multiple avenues of inquiry. Such research should be limited only by the data and means to answer the question at hand, not by a legal standard. Forensic anthropologists, as good scientists, should be more concerned with explaining how we reach a particular conclusion. By trying needlessly to force powerful qualitative techniques into quantifiable categories, anthropologists may inadvertently be lessening the effectiveness of their methodologies and testimony.

Unfortunately, not every methodology fits squarely within the *Daubert* or *Kumho* standards. Exactly how these other anthropological techniques should be evaluated is less clear. The basic question remains: to what extent are data testable and subject to an error rate? Techniques used by anthropologists to establish positive identification epitomize this conundrum. Some that rely on pattern recognition, like the comparison of ante- and postmortem radiographs of the frontal sinus, can and have begun to be empirically tested (16,17,21). But what of the use of "unique" identifiers such as fractures, surgical implants, and other anatomical anomalies that anthropologists use to establish identity? Is it possible to establish an error rate using these techniques? Unlike DNA identifications, where a probability can be calculated because of a finite number of possibilities, there are an almost infinite number of potential skeletal and soft tissue alterations and virtually no way to quantify them, even within a particular population (51). However, such techniques can still be useful and valid when attempting to establish a positive identification.

Another example of a skill that falls under both standards is the estimation of time since death. Some techniques used to establish the postmortem interval are more empirical and are subject to the *Daubert* standard as they utilize well-defined stages and mathematical and statistical description. Other methods are more qualitative and are best addressed by the *Kumho* standard as they are dependent more on subjective description, interpretation, and observer experience (52,53). Typically, the more quantitative methodologies are only applicable to the relative short period after death (less than 72 h), and are affected by relatively few variables (52–54). Examples of such techniques include those that measure changes in body temperature after death (55) and chemical changes associated with autolysis and putrefaction such as potassium in the vitreous humor of the eye (54,56,57). In general, anthropologists are usually not called upon to establish time since death in such short postmortem intervals; rather, the skills and expertise of anthropologists are more commonly employed in cases with a much longer postmortem interval. The more qualitative techniques generally involve decomposition over longer postmortem periods and are affected by a large number of external factors including temperature, body covering, humidity, presence of animal scavengers, and depositional environment (58–64), making a meaningful quantitative interpretation virtually impossible. These techniques include estimations of time since death using decomposition of soft tissue (65,66), bone (67,68), other organic biochemicals (69), and scavenger activity, namely insects (70,71), producing a relative frame of reference (i.e., minimum or maximum postmortem interval) rather than concrete time estimates. Unnecessary manipulation of such methodologies to meet the guidelines established by *Daubert* could generate potentially misleading error rates or misperceptions of methodological accuracy and severely limit their application. *Kumho* allows for the admittance of the more qualitative techniques in their present form.

Conclusions

The forensic anthropological community needs to fully understand the rules that govern their testimony and how these rules must be reconciled with the limitations of the discipline. While a perusal of the literature shows that many recognize the significance of the *Daubert* decision, not all authors appear to be familiar with all the rules governing expert witness testimony, exemplified by the lack of articles that mention the *Kumho* decision and its impact on the admissibility of expert witness testimony. Without such an understanding, forensic anthropologists may struggle to meet unattainable standards, potentially undermining their own testimony. Furthermore, a recent survey of practicing forensic anthropologists found that most of their testimony centers on trauma and pathology, recovery and scene investigation, or the postmortem interval (46), all of which can fall under the standards established by *Kumho*. Thus, it appears that *Kumho*, not *Daubert*, has a greater impact on most anthropological testimony. Although the admissibility of expert testimony has become tougher, the *Kumho* decision allows anthropologists latitude in presenting evidence that cannot be empirically tested, provided the analysis is both scientific and rigorous.

The questions raised in this review and discussion apply not only to anthropology, but also to the other forms of expert witness testimony as well. While the *Daubert* decision has produced a far greater and more diverse literary reaction, its direct legal impact has also been questioned as legal reviews have shown a general lack of successful *Daubert* challenges (31,34). For example, one of the most widely discussed successful *Daubert* challenges (16,18,23,72), which involved the reliability of fingerprint evidence, was quickly overturned by the same judge 2 months later after recognizing that the *Daubert* standards are not exclusively applicable in every case (73,74). As a result, *Kumho* may end up being the more influential decision overall, particularly since medical personnel (who make up the largest class of expert witnesses) are generally classified technical expert witnesses (15,38). Scientists in medico-legal fields need to be aware of the legal climate before reacting to it.

Finally, in no way is *Kumho* a lesser standard than *Daubert.* Rather, *Kumho* represents recognition by the legal system that scientific inquiry is too broad to be evaluated with a single set of standards. While these recent revisions may have had very little overall effect on the admittance of expert witness testimony, they have forced scientists and other specialists to re-examine and justify their methodology and reasoning and have established a level of accountability for expert testimony. Despite the judge's role as gatekeeper, most practitioners in the legal community lack the scientific expertise to evaluate methodology or theory. Given this, it is up to the specific scientific communities to educate both judges and themselves to recognize what constitutes acceptable testimony and to communicate their techniques, justifications, and conclusions effectively.

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